HUMAN SAFETY
AND
RISK MANAGEMENT
SECOND EDITION

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Preface

Much has happened in the 10 years or so since the first edition of *Human Safety and Risk Management* was published. New journals on risk and safety have appeared — for example, *Health, Risk & Society; Journal of Risk Research; Policy and Practice in Health and Safety; Risk, Decision and Policy; Risk Management: An International Journal;* and *Transportation Research Part F: Traffic Psychology and Behaviour*. Longer established journals in the risk and safety field have gone from strength to strength, including: *Accident Analysis and Prevention, Journal of Safety Research, Risk Analysis, Safety Science*, and *Work & Stress*. The large amount of recent research literature that has been generated in the risk and safety field is reflected in two completely new chapters in this second edition. Over 56% of more than the 300 works referenced in Chapter 2 have appeared since the first edition of this book was published, while well over 70% of the 200 referenced works in the new chapter on safety culture have appeared since the publication of the first edition. Nearly 500 references cited within the book have appeared since 2000. In addition to including the new substantive chapters in this edition (though it is inevitable that our attempts to access and include the considerable volume of potential new material fall short in many areas), we have updated our text in numerous ways and have reworked material from the earlier edition. In these endeavors, we are delighted that Dr. Sharon Clarke joined the author team, adding her expertise and knowledge to that of the authors of the first edition.

The greatly increased volume of relevant material has been accompanied by changes in the way in which some concepts associated with risk and safety have been understood and presented. Controversies that have developed since the first edition was published include use of the term accident. While still in widespread public use, many authorities and sources increasingly eschew this term as being value laden and potentially prejudging blame through ascribing exclusive or prime personal agency at an event’s location by attribution of emotional content. Workplace accidents typically involve one, or occasionally more, workers being injured as a result of encountering some energy force — for example, gravity, pressure, and heat — often exacerbated by other factors. We consider a more objective referent to be injuries — an undesired outcome that is frequently the object of prevention activity. Personal injuries can usefully be distinguished from incidents (a broader term that could involve plant or equipment damage), disasters — which are large-scale and could involve multiple fatalities, and near-hits (also called near-misses). The term accident has similarly come under critical scrutiny in the road transport domain, where it is increasingly being replaced by the more accurate and less emotive term crash. Wherever possible in this edition, we adopt this terminology. Exceptions include occasions when we describe the work of others whose use of the term accident cannot readily be reassigned.

This book’s orientation is primarily, though not exclusively, psychological. Understanding risk and safety issues inevitably involves many disciplines, as does their effective management, and we acknowledge that an approach from any single discipline will be inadequate in addressing the full gamut of relevant issues. Thus, in Chapter 2, we explore a
wide range of approaches to risk, only some of which have their origins within psychology and cognate fields. In subsequent chapters, individual differences, but also some of the many ways in which human beings are alike, are explored within a risk and safety context. Throughout the book we draw on a range of disciplines as appropriate, with the overriding aim of increasing understanding of this important field of scientific study and professional practice.

We have identified the core audience for this book by the generic term scientist practitioner, primarily, although not exclusively those who work in safety, risk, and related fields. This term is used in the United States, Australia, and elsewhere to refer to those who straddle the divide between research and practice, and whose orientation has been considered as under threat within the broader organizational psychology domain, particularly within the United Kingdom (Anderson et al., 2001). Our reference to safety and risk scientist practitioners throughout the book should be taken to imply that all those who consider themselves to be, or who aspire to become, scientists or researchers in the broadest sense, and those who have an interest in health, safety, risk, and related topics are also to an extent practitioners — again in the broadest sense, including for example, the practice of teaching and writing as well as other forms of practice, such as training and consultancy. Similarly, practitioners in any field of health, safety and risk, in whatever form, should have the option of basing their practice upon scientific findings, even if they themselves do not consider themselves primarily to be scientists. To this extent, the term could encompass all those who work in the health, safety, and risk field, in whatever guise. We occasionally use an alternative synonym health and safety professional. One of our hopes is that the combination of scientific evidence, practical examples, and case studies presented in this book will go some way toward bridging the practitioner–researcher divide described by Anderson et al. (2001), at least within the safety and risk domain of organizational psychology.
Acknowledgments

Ian Glendon expresses his deep appreciation of the enduring love and continuing support from his wife Mimi. He thanks his sons Oliver and Roland for their tolerance in seeing slightly less of him than he would have liked during the production of this book. He is also grateful to his Griffith colleagues, particularly Professor Peter Creed and Dr. Glenda Andrews, for facilitating his study leave and teaching relief that were essential for completing the book.

Sharon Clarke would like to thank her family, particularly husband Peter Axworthy, and children Emily Rose and Sam, for their continual support throughout the writing of this book.

Eugene McKenna appreciates the support of his children and coauthors. In particular he would like to express his thanks to Tony Moore, senior editor at Taylor & Francis, who played a major role initially by his enthusiastic support and decision to publish.

Our appreciation extends to our publishers and their staff at Taylor & Francis for their continued patience and support.

We would also like to thank Dr. Alan Waring and Anders af Wåhlberg for reading and commenting on draft sections of the book, and Courtney Jackson-Carroll for background research. Very special thanks to Anthony Ho for his expertise in designing the book cover.
About the Authors

Dr. Ian Glendon is associate professor in the School of Psychology, Griffith University, Queensland, Australia. His research interests include driver behavior/driver stress, OHS/risk management, and safety climate/culture. He has supervised over 20 research higher degree students to completion and has over 100 refereed publications, including three previous coauthored books. He has consulted for over 60 clients on OHS auditing, safety culture/climate analysis, accident/incident analysis, task analysis, and human error/reliability analysis. He is a registered psychologist in Queensland, a chartered occupational psychologist (U.K.), a Chartered Fellow of the Institution of Occupational Safety and Health, a member of several other professional bodies and president (2006–2010) of the International Association of Applied Psychology Traffic and Transportation Psychology Division.

Dr. Sharon Clarke is senior lecturer in organizational psychology with the Manchester Business School, The University of Manchester, U.K. Her research interests are in health and safety management, and safety culture and managing human risks. She has published widely on these topics, including articles in the Journal of Occupational and Organizational Psychology, Journal of Organizational Behavior, and Safety Science, amongst others, and is a regular presenter at international conferences. Her book, coauthored with professor Cary L. Cooper, Managing the Risk of Workplace Stress: Health and Safety Hazards, was published by Routledge in 2004. She is a member of the British Psychological Society, the American Psychological Association, and the Society of Industrial and Organizational Psychology.

Dr. Eugene McKenna, professor Emeritus, University of East London, is a practicing chartered psychologist, a fellow of the British Psychological Society, a Fellow of the Royal Society of Medicine, and is on the visiting faculty of the Graduate School of Business, University of Strathclyde. He is a member of the council of the National Conference of University Professors — a body representing U.K. university professors. His academic and consultancy interests cover organizational psychology and human resource management, and he has a particular interest in training and developing managers. He has published widely and is the author of Business Psychology and Organisational Behaviour (Psychology Press, 2006) and Human Resource Management — A Concise Analysis (coauthored with Professor Nic Beech, Prentice Hall/Pearson Education, 2002).
# Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>AA</td>
<td>Automobile Association (U.K.)</td>
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<tr>
<td>ABS</td>
<td>Advanced braking system</td>
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<tr>
<td>ACAS</td>
<td>Advisory, Conciliation, and Arbitration Service (U.K.)</td>
</tr>
<tr>
<td>ACSNI</td>
<td>Advisory Committee on the Safety of Nuclear Installations (U.K.)</td>
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<tr>
<td>ACTH</td>
<td>Adrenocorticotropin hormone</td>
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<tr>
<td>AET</td>
<td>Affective events theory</td>
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<tr>
<td>AIDS</td>
<td>Acquired immune deficiency syndrome</td>
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<tr>
<td>ALARA</td>
<td>As low as reasonably achievable</td>
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<tr>
<td>ALARP</td>
<td>As low as reasonably practicable</td>
</tr>
<tr>
<td>AS</td>
<td>Australian Standard</td>
</tr>
<tr>
<td>ATP</td>
<td>Automatic train protection</td>
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<tr>
<td>AUD</td>
<td>Australian dollar</td>
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<tr>
<td>AVM</td>
<td>Air vibration monitor</td>
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<tr>
<td>AWA</td>
<td>Australian workplace agreement</td>
</tr>
<tr>
<td>AWS</td>
<td>Automatic warning system (for trains)</td>
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<tr>
<td>BACT</td>
<td>Best available control technology</td>
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<tr>
<td>BBC</td>
<td>British Broadcasting Corporation</td>
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<tr>
<td>BBS</td>
<td>Behavior-based safety</td>
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<tr>
<td>BRPM</td>
<td>Basic risk perception model</td>
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<tr>
<td>BS</td>
<td>British Standard</td>
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<tr>
<td>BSI</td>
<td>British Standards Institution</td>
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<tr>
<td>BSP</td>
<td>Behavioral safety process</td>
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<td>CASA</td>
<td>Civil Airline Safety Authority (Australia)</td>
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<tr>
<td>CBA</td>
<td>Cost benefit analysis</td>
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<tr>
<td>CBI</td>
<td>Confederation of British Industry</td>
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<tr>
<td>CBT</td>
<td>Cognitive behavior therapy</td>
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<tr>
<td>CEO</td>
<td>Chief executive officer</td>
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<tr>
<td>CFIT</td>
<td>Controlled flight into terrain</td>
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<tr>
<td>CFQ</td>
<td>Cognitive Failures Questionnaire</td>
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<tr>
<td>CHD</td>
<td>Coronary heart disease</td>
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<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
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<tr>
<td>COSHH</td>
<td>Control of Substances Hazardous to Health (U.K. legislation)</td>
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<tr>
<td>CRM</td>
<td>Crew resource management</td>
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<tr>
<td>CST</td>
<td>Climate safety tool</td>
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<tr>
<td>CT</td>
<td>Cultural theory</td>
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</tbody>
</table>
dB: Decibel
DSE: Display screen equipment
DTA: Dynamic task allocation

EAP: Employee assistance program
EC: European Commission
EC-JRC: European Communities Joint Research Centre
EEC: European Economic Community
E.g.: For example
EPI: Eysenck Personality Inventory
ESP: Extra sensory perception
et al.: et alia (and others)
EU: European Union

f: Feet
°F: Degrees Fahrenheit
FA: Football Association (England)
FFPI: Five-Factor Personality Inventory
FMEA: Failure modes and effects analysis

GB: Great Britain
GDP: Gross domestic product
GEMS: Generic error modeling system
GFT: General failure type
GHQ: General Health Questionnaire
GSK: GlaxoSmithKline

h: Hours
H: High
HAM: Hierarchy of abstraction modeling
H&S: Health and safety
HAZOP: Hazard and operability study
HBM: Health belief model
HFIT: Human Factors Investigation Tool
HGV: Heavy goods vehicle
HIV: Human immuno deficiency virus
HMSO: Her Majesty’s Stationery Office (U.K.)
HPWS: High performance workplace system
HR: Human resources
HRA: Human reliability assessment
HRM: Human resources management
HRO: High reliability organization
HSC: Health and Safety Commission (U.K.)
HSE: Health and Safety Executive (U.K.)
HSG: Health and safety guidance
HSL: Health and Safety Laboratory (U.K.)
HTA: Hierarchical task analysis
Hz: Hertz
IAEA       International Atomic Energy Agency
ICT       Information and communications technology
i.e.      That is
ILO       International Labor Organization
INSAG     International Nuclear Safety Advisory Group
IPO       Inputs, process, outputs (model)
IQ        Intelligent quotient
IR        Industrial relations
ISO       International Standards Organization
IWO       Industrial, work, and organizational (psychology)

JCQ        Job content questionnaire

KB        Knowledge based
kph       Kilometers per hour
KSA       Knowledge, skills, abilities

L        Low
LMX       Leader–member exchange
LoC      Locus of control
LPC      Least preferred coworker
LTIFR    Lost time injury frequency rate

m        Meters
MAO      Monoaminooxidase
MAUT     Multi-attribute theory
MBE      Management-by-exception
ME       Myalgic encephalomyelitis
MIV      Main inlet valve
MLQ      Multifactor leadership questionnaire
MMR      Mumps, measles, and rubella (vaccine)
MORT     Management oversight and risk tree
MRI      Magnetic resonance imaging

N        Number
NA       Negative affectivity
n-Ach    Need for achievement
NASA     National Aeronautical Space Administration
n.d.     No date
NHS      National Health Service (U.K.)
NIOSH    National Institute for Occupational Health and Safety (U.S.)
NNC      National Nuclear Corporation (U.K.)
NOHSC    National Occupational Health and Safety Commission (Australia)
NPV      Net present value
NSW      New South Wales (Australia)
NZS      New Zealand Standard
OBMod  Organizational behavior modification
OCB  Organizational citizenship behavior
OECD  Organization for Economic Cooperation and Development
OHS  Occupational health and safety
OHSC  Occupational health and safety committee
OHSMS  Occupational health and safety management system
OIM  Offshore installation manager (company)
OPQ  Occupational Personality Questionnaire
OSCI  Organizational and safety climate inventory
OSHA  Occupational Safety and Health Administration (U.S.)

Probability

PA  Positive affectivity
PBR  Payment by results
PE  Person–environment (fit)
PhD  Doctor of Philosophy
PHEA  Predictive human error analysis
PIF  Performance influencing factor
PP  Precautionary principle
PPE  Personal protective equipment
PR  Public relations
PRA  Probabilistic risk assessment
PRP  Performance related pay
PSB  Pumped Storage Business (U.K.)
PSF  Performance shaping factor
PSV  Public service vehicle
PTSD  Post traumatic stress disorder

QC  Queen’s Counsel
QHSE  Quality, health, safety, and environment

Correlation coefficient

RA  Risk assessment
RAAF  Royal Australian Air Force
RAF  Royal Air Force
RB  Rules-based
RBR  Risk-based regulation
RET  Rational emotive therapy
RHT  Risk homeostasis theory
RM  Risk management
RMS  Risk management standard
RMT  Risk motivation theory
RP  Risk perception
RR  Risk resolution
RSI  Repetitive strain injury

SARF  Social amplification of risk framework
SB  Skills-based
SCT  Social capital theory
sec  Second (time unit)
SEM  Structural equation modeling
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>SHE</td>
<td>Safety, health, and environment</td>
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<tr>
<td>SIOP</td>
<td>Society of Industrial and Organizational Psychology</td>
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<td>SME</td>
<td>Small and medium-sized enterprise</td>
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<td>SMS</td>
<td>Safety management system</td>
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<td>SPAD</td>
<td>Signal passed at danger</td>
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<td>SS</td>
<td>Sensation seeking</td>
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<td>SSD</td>
<td>System state diagram</td>
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<td>SSS</td>
<td>Sensation seeking scale</td>
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<td>TA</td>
<td>Task analysis</td>
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<td>TABP</td>
<td>Type A behavior pattern</td>
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<td>TAFEI</td>
<td>Task analysis for human error identification</td>
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<tr>
<td>TAT</td>
<td>Thematic Apperception Test</td>
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<tr>
<td>THERP</td>
<td>Technique for human error rate prediction</td>
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<tr>
<td>TMI</td>
<td>Three Mile Island</td>
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<tr>
<td>TPB</td>
<td>Theory of planned behavior</td>
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<tr>
<td>TRA</td>
<td>Theory of reasoned action</td>
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<td>TRRL</td>
<td>Transport and Road Research Laboratory (U.K.)</td>
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<tr>
<td>TSC</td>
<td>Total safety culture</td>
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<tr>
<td>TV</td>
<td>Television</td>
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<tr>
<td>UCL</td>
<td>University College London</td>
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<tr>
<td>U.K.</td>
<td>United Kingdom</td>
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<tr>
<td>UKAEA</td>
<td>United Kingdom Atomic Energy Authority</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UQ</td>
<td>University of Queensland</td>
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<td>U.S.</td>
<td>United States</td>
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<tr>
<td>USAF</td>
<td>U.S. Airforce</td>
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<tr>
<td>USS</td>
<td>U.S. ship</td>
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<tr>
<td>UWIST</td>
<td>University of Wales Institute of Science and Technology</td>
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<tr>
<td>VALS</td>
<td>Values and lifestyle</td>
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<tr>
<td>VDU</td>
<td>Visual display unit</td>
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<tr>
<td>vs.</td>
<td>Versus</td>
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<tr>
<td>16PF</td>
<td>Sixteen personality factors (Cattell)</td>
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Introduction

In contrast to earlier epochs, it seems that contemporary issues are increasingly defined in terms of risk — a framework that is explored in greater detail in Chapter 2. That risk is in danger of becoming a catchall concept for much of human behavior is illustrated by a spoof claim in a satirical website that an international “consortium of scientists, mathematicians and philosophers is nearing the completion of the ambitious, decade-long project of cataloguing everything that can go wrong” (The Onion, 2005), with the added claim that once the list is completed it will be coded and categorized and that it could have widespread applications. Closer to reality, the Organization for Economic Cooperation and Development (OECD, 2003) has argued for a risk management approach to a wide range of risks that involves interdisciplinary cooperation — a theme revisited in later chapters.

Hovden (2004) considered that the philosophical basis for a science of risk could be traced back to Jean Jacques Rousseau’s attribution of the large death toll (> 100,000) in the 1755 Lisbon earthquake to human decision making that resulted in building 20,000 six to seven storey houses in a known seismic location. In a Norwegian case study, Hovden (2004) observed that Perrow (1984) and Turner and Pidgeon (1997) began a new era in risk research. One response to Perrow was the notion of high reliability organizations (HROs) (LaPorte & Consolini, 1991). Hopkins (2000) and Weick (1989) considered vulnerability and resilience of organizations, while Hale et al. (2002) dealt with consequences for risk legislation and regulation.

1.1 Establishing the field

Our prime concern in this book, as with the first edition, is to explore the role that psychology can usefully play in occupational health and safety (OHS) and risk management. Psychology and psychologists have been criticized for the shortcomings of their alleged role in OHS. For example, Frick et al. (2000) stated that, “The entrance of organizational and industrial psychologists to the ‘new’ field of systematic OHSM [occupational health and safety management] has also lent a more scientific nimbus to the authoritarian strategy of modifying worker behaviour rather than risk exposure at the workplace” (p. 5). In similar vein, Walters and Frick (2000) stated, “With the growing market of OHSM systems . . . industrial and organisational psychologists now try to reintroduce behaviour as the main ‘risk factor’ to control such systems” (p. 54). Such criticism is misdirected. First, it is highly selective and therefore inaccurate, in respect of much of psychologists’ current work in OHS, which spans a considerable range of human activities, including those relating to cognitive, social, organizational, environmental, and educational domains — in addition
to behavioral as well as the human factors field. Second, to criticize psychologists for studying behavior — or in this case safe behavior, is akin to criticizing physicians for studying health and illness — it’s what psychologists do! To berate a discipline for its subject material seems perverse.

As part of their general critique of technical approaches to OHS, including the medical model, and ergonomics for its individual approach, managerial orientation and apparent unwillingness to consider the broader picture, Bohle and Quinlan (2000) are similarly critical of psychologists’ contribution to OHS as being overly focused on individual factors in accident causation, having a management orientation and developing victim-blaming models. Sociologists on the other hand blame the system, perceive injury as inherent in the nature of work, and address conflicts of interest as a fundamental aspect of OHS. Compartmentalizing the contributions of various disciplinary areas risks labeling each too rigidly and ignores the potential for a more eclectic approach — for example, from individuals with higher OHS qualifications or by those able to transcend arbitrary disciplinary boundaries.

The essence of such criticism seems to be twofold. First, through their research and consulting activities in OHS, psychologists, serve management and not workers. Second, that psychologists focus upon safe person/behavior rather than safe place strategies. To the extent that psychologists are subject to the same constraints that attach to those who must work to survive, the first criticism may be valid. Psychologists are workers too — highly skilled ones, to the extent that they sell their labor to an employer, and like all workers are obliged to undertake the work for which they are remunerated. However, academic psychologists also have a disciplinary base from which they are expected to exercise a degree of balance in their work. For some years psychologists in all developed countries have been obliged to adhere to strict professional ethical codes, reinforced by sanctions, among whose strictures are that in their professional dealings they should serve all constituents within the context of the conflicts and power imbalances that are acknowledged to exist between parties — including that which exists between themselves and their clients or research participants (Lowman, 1998). Impugning the integrity of a profession that is genuinely seeking to acknowledge and to address power imbalances in workplaces and elsewhere is, at the very least, unhelpful.

There is a need to study human behavior as part of the complex OHS picture. Surely no one would suggest that it is neither useful nor helpful to educate and train people to be safe? The issue is more to do with the overall balance of safe person/safe place strategies, and clearly both are needed. The quote from Frick et al. (2000) implied that organizational psychologists are concerned exclusively with modifying worker behavior, rather than seeking to influence management behavior, and thereby reduce risk exposure. As a crude measure of the relative importance of this topic within the field of organizational psychology as applied to OHS, in the first edition of this book, the topic of behavior modification — perhaps the embodiment of a safe person approach, took up less than two pages out of the 341 pages of text. The topic is not ignored, but this gives some idea of our view of its place in the overall contribution of psychology to OHS. In this current edition, we have increased this coverage, both to reflect more recent work in the field and to outline more of the strengths and shortcomings of this approach. Most researchers and consultants recognize the need for a pragmatic approach on many occasions — seeking to determine what works. Unless we can talk the language of management there is virtually no hope of influencing the way organizations manage OHS, however apposite the underlying theory. Theorists from other disciplines, including economics (Bernstein, 1996) and anthropology (Douglas, 1992) have also denigrated or downplayed psychological contributions in the domain of risk. However, residing in an Ivory Tower is not an option for influencing OHS. It is totally acceptable to criticize psychologists and other technicians, but tools are needed to address issues — ideas and critique alone are insufficient to promulgate change.
Chapter one: Introduction

There is a third, more implied and subtle criticism within the quoted passage that psychologists are concerned with the minutiae of OHS — the coalface, rather than with a more strategic overview. This criticism has been leveled at psychology in another domain — that of psychometric testing, for example in the selection process — and by psychologists themselves (Anderson & Prutton, 1993). Again this criticism is valid to the extent that, by the nature of their subject matter, psychologists tend to focus upon human behavior and the forces that drive it. This is one aspect of a much broader criticism of organizational psychologists’ work, namely that they focus on micro rather than macro aspects of organizational functioning, again forwarded by psychologists themselves (Tharenou, 2001). Rousseau and House (1994) have argued for organizational psychologists to take a “meso” approach, which seeks to explain behavior at more than one level, recognizing, for example, that individuals are embedded within work groups that inter-relate and link with larger organizational structures. However, in state-of-the-art reviews, such as those of Tharenou, OHS and risk issues may not even rate a mention, indicating that this is still very much a minority field of interest for organizational psychologists.

However, over the past 15 years or so, in their research and related activities, increasing numbers of organizational psychologists have taken stock of the broader picture to seek insights relevant to OHS and related risk issues, and Sue Cox, Tom Cox, Rhona Flin, Andrew Hale, Jan Hovden, Nick Pidgeon, James Reason, and Dov Zohar, and their respective colleagues are among numerous examples of this relatively recent trend (Reason, 1997; Hale & Hovden, 1998). While there may be some historical currency in the sociological critique, in the contemporary era psychologists are increasingly likely to point to management as the prime source of OHS and workplace risk problems and to draw upon the work of other disciplines, including sociology, as well as working with researchers from other disciplines and practitioners from other professions. Other psychologists focus upon the work environment and its effects upon human behavior, for example, so-called sick building syndrome. Others consider how environments, including workplaces, should be designed so as to minimize risk from fire or other disasters and to maximize people’s opportunity to escape should the worst happen. From these examples, it is clear that psychologists have a key role to play as leading researchers in many aspects of OHS, including being part of a multidisciplinary approach to OHS.

A logical position that flows from a critique from the vantage point of industrial sociology is that if management holds the balance of power in the industrial domain, then it is primarily management who has to be convinced of the necessity and desirability for change. Psychologists have an important role to play in explaining not just the fact that people make errors, but also why those errors occur and what could be done to reduce either the errors or the likelihood of their causing harm. To this end, human factors principles (explored in Chapter 4) and some of the research now being undertaken in cognitive psychology can be very valuable, particularly when human cognitions and behavior are critical to the safety of vulnerable systems. As an illustration, Groeger’s (2005) study of inadequate human factors inherent in the long-standing design of railway signals can help us to understand the nature of this type of problem. Professor Groeger was an expert witness in the Southall and Ladbroke Grove rail disaster public inquiries in the United Kingdom, and his expertise has also served two criminal cases involving railway workers.

The sensing environment for a train driver approaching signals is complex — particularly for visual and auditory senses. In three major U.K. rail disasters involving signals passed at danger (SPADs) — Watford (in 1996) (HSE, 1998), Southall (in 1997) (Uff, 2000), and Ladbroke Grove (in 1999) (Cullen, 2001a, 2001b) — the importance of human factors was recognized in at least two of these; for a comprehensive analysis of the last of these, see Lawton and Ward (2005) as well as the official inquiry (Cullen, 2001a, 2001b). The signal sequence, which is predictive of the possible states of the following signal, is (1) green,
(2) double yellow, (3) single yellow, and (4) red. Using feature integration theory and guided search theory, Groeger (2005) determined the importance of complexity in a stimulus array, which is also affected by distractor load. The most important finding from this study was that the yellow signal, arguably the most critical for safety, takes the longest of the four to detect. This is because a driver has to determine two bits of information: both signal color and number of lights displayed. Groeger et al. (2005) confirmed by experiment that this conjunctive search, requiring two bits of information to find, takes longer than the other three.

A train driver has a limited time window to perceive the signal ahead, which could involve selecting the correct signal from a complex visual environment, with detection time being lengthened by adding further distractors, such as adjacent signals or masking by vegetation, track bends, or gantries (Lawton & Ward, 2005). The track system allows a 7-sec time period for perceiving and checking a signal, which should be continuously visible for the last 4 sec before it is reached. The signal is preceded by an AWS (automatic warning system) loop 180 m before the signal, which triggers a bell “warning” for a green signal and the (same) klaxon warning for the other three signals, the auditory warning being perceived in conjunction with the visual signal. However, while the auditory warning enhances detection slightly, particularly where it is unique, it does not discriminate between the different levels of caution. Given that critical features of human cognition involved in perceiving the signal and its associated warning are hard wired, practical implications of this work for signal siting, standards, and practice should be addressed through design and human factors applications.

This example shows that psychologists are far from being imprisoned by the notion of human error; in fact psychologists have rarely promulgated this term as a cause of crashes or injuries. Their stance has been more to seek to unpack this term and discover what internal (cognitive) and external (environmental) factors influence it (Reason, 1990; Edkins & Pollock, 1997; Lawton & Ward, 2005) and, recognizing the difficulty of changing human cognitions that have evolved over many millennia, recommending appropriate work environment changes. Psychologists have also pointed out that positioning human operators at safety critical junctures within systems can improve the reliability of those systems.

Another example can be taken from the Special Commission of Inquiry into the Waterfall Rail Accident, probably the largest public inquiry in Australian history, to which 113 days of evidence was presented and which resulted in three substantial volumes totaling 1400 pages (McInerney, 2004, 2005) as well as a 100-page inquiry report from the New South Wales government (NSW Ministry of Transport, 2003). The first author was an expert panel member for the Waterfall Commission of Inquiry. Psychologists increasingly study broader organizational phenomena and concepts such as safety climate and safety culture. An important contribution that they can make is to apply methodological rigor, qualitative as well as quantitative, to workplace safety issues. As part of the Waterfall Inquiry, a safety climate survey was conducted among a large sample of the workforce, including some managerial and supervisory staff, which with the help of strong trade union support achieved a 99%+ response rate — almost unprecedented in social science research, even in Scandinavian countries! The results of the survey, published in McInerney (2005), helped to show not only that safety was poorly regarded within the main organization involved, but also that there were statistically significant differences in perceptions between management and workers and between different groups of workers — a theme that is revisited in the discussion of safety subcultures in Chapter 12. Such research not only illustrates the divergence of views, in this case on safety issues, between management and workforce that are the stock in trade of the industrial sociologist, but can go further by indicating more precisely the magnitude and complexity of this divergence. Furthermore, while nothing
might be done about the overall balance of power between the parties, findings from such
surveys, particularly once (as in this case) they are in the public domain, might at the very
least encourage management to implement remedial action, not only to improve safety,
but also as part of a risk management approach to continue to monitor progress. Current
indications are that the organization involved in this Inquiry is doing exactly that.

In a case study of teacher stress, Larsson (2000) described some of the organizational
and contextual issues that form part of the etiology of teacher stress. Larsson argued for a
return to workplace development of OHSM, arguing that the large and impersonal public
or private corporation can no longer be regarded as the responsible employer demanded or
assumed by legislation or the voluntary regulatory process. If such workplace level regulation
is to become a reality, then detailed information will be required to support such local
systems. The methodological and conceptual rigor that psychologists can provide could be
an essential component in analyzing and understanding local workplace OHS issues, such
as stress. For example, in a large-scale longitudinal study of teacher stress, Dr. Graham
Bradley identified around 20 intervention strategies for reducing strain and enhancing
activity participation in school teachers (Bradley, 2004). These were based on painstaking
research using sophisticated theoretical modeling and complex statistical analyses and are
summarized in Table 1.1.

These examples serve to illustrate that organizational psychologists’ research into OHS
and wider issues ranges from the cognitive (e.g., describing relevant ways in which mind
functions can affect critical safety issues) to the macro-organizational (e.g., describing how
different groups within an organization define and perceive safety-related issues). Such
research can have useful things to say about how physical and organizational aspects of
an environment are structured to maximize well-being and to minimize harmful aspects
of stress. Its emphasis on a scientific approach and the breadth of its methodology, qualit-
avative as well as quantitative, longitudinal as well as cross-sectional, field study as well as
experimental, gives it an advantage over many other disciplinary approaches. Many organ-
zational psychologists with a contribution to make to OHS and risk management issues
are also heavily involved as practitioners or consultants, for example, in organizational
change programs or through advising on specific workplace interventions.

An important issue, and one that is particularly well defined by industrial sociologists,
is that of the changing world of work, including, but not restricted to, greater fragmentation
of work and isolation of workers from each other, limited social contact between workers,
reduced trade union representation and involvement, less worker participation in work-
places, greater managerial control of work processes, and fewer resources for inspectorates
to visit workplaces (for an excellent review see Quinlan & Mayhew, 2000). These and other
trends impact considerably upon individuals and are liable to lead, inter alia, to greater
stress for workers. Bohle and Quinlan (2000) were critical of psychologists’ approach to
work-related stress in so far as few interventions have been made at organizational level.
While this may be a fair criticism, it could become more important for psychologists to be
involved in seeking solutions at an individual level also because, as a result of changing
patterns of work, that is where many of the problems are located. If you cannot fight the
trends then you have to adapt. More research is needed into such matters as understand-
ing human resilience and how to enhance it, which is within the domain of psychology
(Deveson, 2003). Organizational psychologists have acknowledged that stress reduction
interventions are required at both individual and organizational level, a point made by

We do not decry industrial sociologists’ right to criticize — they are particularly good
at it! Nor would we challenge their general analyses of OHS, which from a sociological
perspective is also valid. It is, in parts, an ugly world, with many injustices and power
imbalance, as a perusal of any issue of The Human Rights Defender (Amnesty International)
Table 1.1  Illustrative Interventions Suggested by Bradley’s (2004) Research Findings on Job Factor–Outcome Relationships

<table>
<thead>
<tr>
<th>Aim of intervention</th>
<th>Consistently significant predictors identified in the research&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Examples of intervention strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strain reduction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce job stress</td>
<td>Demands (+)</td>
<td>Reduce teaching contact hours</td>
</tr>
<tr>
<td></td>
<td>Total and time/load control (−)</td>
<td>Give staff input into timetabling</td>
</tr>
<tr>
<td></td>
<td>Supervisor support (−)</td>
<td>Develop principals’ listening skills</td>
</tr>
<tr>
<td>Reduce job dissatisfaction</td>
<td>Total and student demands (+)</td>
<td>Employ additional special needs teachers</td>
</tr>
<tr>
<td></td>
<td>Total and student control (−)</td>
<td>Provide in-service training in classroom management</td>
</tr>
<tr>
<td></td>
<td>Colleague support (−)</td>
<td>Group discussion and feedback</td>
</tr>
<tr>
<td></td>
<td>Supervisor support (−)</td>
<td></td>
</tr>
<tr>
<td>Reduce job anxiety</td>
<td>Demands, especially qualitative demands (+)</td>
<td>Reduce extracurricular duties</td>
</tr>
<tr>
<td></td>
<td>Time/load control (−)</td>
<td>Give staff autonomy over timing of student assessments</td>
</tr>
<tr>
<td>Reduce somatic symptoms</td>
<td>Demands (not student demands) (+)</td>
<td>Clarify work roles</td>
</tr>
<tr>
<td></td>
<td>Time/load and conflict control (−)</td>
<td>Give advanced notice of deadlines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide access to conflict resolution programs</td>
</tr>
<tr>
<td>Reduce staff turnover</td>
<td>Demands (not time/load demands) (+)</td>
<td>Improve communication systems</td>
</tr>
<tr>
<td></td>
<td>Supervisor support (−)</td>
<td>Employ management practices that enhance staff recognition</td>
</tr>
<tr>
<td>Reduce absenteeism</td>
<td>Qualitative demands (+)</td>
<td>Change policies and practices at head office</td>
</tr>
<tr>
<td></td>
<td>Colleague support (−)</td>
<td>Arrange school-sponsored staff social outings</td>
</tr>
</tbody>
</table>

**Activity-participation enhancement**

<table>
<thead>
<tr>
<th>Aim of intervention</th>
<th>Consistently significant predictors identified in the research&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Examples of intervention strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase motivation</td>
<td>Time/load demands (+)</td>
<td>Give opportunities for staff to develop new subjects</td>
</tr>
<tr>
<td></td>
<td>Student and conflict control (+)</td>
<td>Encourage staff participation in school discipline policies</td>
</tr>
<tr>
<td>Increase vigor-activity</td>
<td>Control, esp. student control (+)</td>
<td>Collaborate on tasks that create a sense of “collective control”</td>
</tr>
<tr>
<td></td>
<td>Colleague support (+)</td>
<td></td>
</tr>
<tr>
<td>Increase involvement in extracurricular activities</td>
<td>Student demands (−)</td>
<td>Improve opportunities for referral of difficult students, and for staff to collaborate on new initiatives</td>
</tr>
<tr>
<td></td>
<td>Control, esp. student control (+)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colleague support (+)</td>
<td></td>
</tr>
<tr>
<td>Increase participation in organized nonwork activities</td>
<td>Time/load control (+)</td>
<td>Consult with staff regarding workload allocations</td>
</tr>
<tr>
<td>Acknowledge hours worked</td>
<td>Time/load demands (+)</td>
<td>Raise management expectations, support, and recognition for exceptional performance</td>
</tr>
<tr>
<td></td>
<td>Supervisor support (+)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> “+” = Bradley (2004) found a positive correlation between job factor and the outcome.  
“−” = the correlation was negative.

grimly reveals. However, we cannot change it overnight, if ever. To paraphrase a famous prayer, for psychological health and personal well-being we must learn to accept the things we cannot change and work on the things that we might be able to influence. An imbalance of power between parties within the workplace is axiomatic — but that is just the starting point. We recognize that reality and that we have to live with it and at least seek to make incremental improvements in working conditions when opportunities arise. We would humbly suggest that, as well as publishing their research, psychologists from a number of areas within the broad discipline are out there mixing it with management and workers, enforcing agencies, and other influential parties who are trying to do just that. Ultimately, it matters not one jot from which discipline area OHS improvements are made, but that they continue to be made. As part of multidisciplinary teams, psychologists undoubtedly have an important role to play. An important continuing task is to consider the further contribution that psychologists could make to OHS.

1.2 Emerging issues in OHS research and practice

In this section OHS issues are considered at three levels. The first comprises six broad contexts for OHS research and practice. Second, five main contributor discipline fields and the many OHS-related topics that they contain are described. Third are identified ten generic challenges for OHS research and practice. These components are summarized in Figure 1.1.

1.2.1 Contexts

The political context includes the role of government and state apparatus, for example, whether these broadly support OHS or whether they are indifferent, hostile, or promote mixed messages. To what extent does ideology drive OHS-relevant agendas or

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**Figure 1.1** Summary of emerging research issues in OHS.
Human safety and risk management

8 Human safety and risk management

can more pragmatic approaches be adopted? Broad criteria for research and practice are established within this context.

OHS issues are addressed within a social arena of changing attitudes and underlying values. For example, a complex mix of risk perceptions within society and acceptability of a wide variety of risks influence responsibilities for workplace health and safety. These are considered in greater detail in chapters dealing with topics allied to risk cognition.

Issues in the economic context include criteria for judging OHS interventions, for example, cost benefit analysis and the role of economic rationalism in the face of multiple and frequently conflicting criteria for action. Also within this context is the role of insurance in regulating OHS. Within this domain can be conducted the debate about how best to deploy resources so as to produce effective OHS outcomes, for example, between interventions based on education/training, legislation/enforcement, engineering/technological, rules/procedures, and managerial/organizational. This domain is considered in more detail in Chapter 2 and when addressing risk management issues.

While the scientific context is dependent to an extent on political and economic superstructures, its autonomy is founded upon more fundamental principles. Its strengths also reside in its multiple disciplinary bases, divergent methodologies, and increasingly global context. In terms of discovery, controversy, applications, and rigorous evaluation this is a critical context for OHS research and practice.

The historical context relates to all others. For individuals this might combine science with evolutionary theory to explain human perceptions of risk and safety. Understanding an organization’s history can help to explain its contemporary safety culture while science builds logically on its past discoveries, often challenging and replacing old knowledge. An important principle is to learn from history without being its prisoner.

From a cultural context it is possible to learn from others while recognizing the value of diversity and the validity of different forms of, and contexts for, knowledge. Increasing globalization of trade, communications, and the reach of many industrial sectors enhances the importance of this domain to OHS, both between, and also within societies, many of which are increasingly multicultural. Safety culture is the topic of Chapter 11.

1.2.2 Fields and topics

Five broad fields are distinguished, each containing many OHS-related topic areas. Some topics straddle two or more fields.

1.2.2.1 Legal and regulatory

The legal and regulatory field focuses upon structures and processes that are external to the workplace, but which seek to generate actions within workplaces that are externally monitored. Units of analysis may either be jurisdictions, regulatory institutions, industrial sectors, or organizations. General topics within this field concern issues of regulation and control of OHS within organizations and other entities. The focus of OHS regulation, including the extent to which this should be primarily external to the organization, for example, represented through inspections and compliance audits, is a continuing issue. Others include the balance between regulatory agencies in their role as providers of advice and information against being prosecutors and exercising other aspects of legal enforcement such as notices.

Hale (1997) and Johnstone (2003) considered how legal processes could isolate OHS events from broader managerial issues. Gunningham and Healy (2002, 2004) have argued that the traditional regulatory approach to chemical safety and OSH in agriculture is seriously flawed, while Davis (2004) and Tombs (2005) have reported reviews indicating that legislation backed by enforcement is the most important driver of management action to
improve OHS. Tombs (2005) reported evidence of declining enforcement agency inspections in the United Kingdom as a result of reduced funding. Other contemporary issues include moves by several jurisdictions to introduce what has been variously described as industrial killing or corporate manslaughter legislation, and the likely impact of such controversial legislation upon organizations and those who manage them. For a discussion of this issue within a U.K. context, see Home Office (2000) and Tombs and Whyte (2003); for a broader assessment, see Gilbert and Russell (2002). Another topic that has aroused interest in several places is that of “whistle-blower” protection. As enforcement agencies cannot cover all possible places where OHS breaches might occur to an extent they rely upon whistle-blowers to identify instances of wrongdoing. Traditionally whistle-blowers have not been protected and thus blowing the whistle has relied upon individuals’ ethical stance and their willingness to lose at least their job and possibly to jeopardize their career.

Areas of overlap with the managerial disciplinary field include responsibility attribution, which also has a history within individual psychology, and management–worker relations, including industrial/labor relations and human resource management as these relate to OHS issues. Emergent issues include the changing balance between primary, manufacturing, and service sectors, and effects of these changes on union representation, OHS, and other issues. Also of interest is the issue of worker compensation. A feature of contemporary risk society/risk culture is that when jurisdictions promote the view that a particular agency, whether an employing organization or the state, has primary responsibility for people’s safety, particularly in their role as workers, then if someone is hurt that agency is perceived to be blameworthy. It is then logical to argue that compensation is due. A robust debate is being waged on these issues in several jurisdictions. An example of the overlap between this disciplinary field and the health field is the adequacy of the recovery process for victims of workplace trauma, which includes legislation for treatment, compensation, rehabilitation, and, where feasible, reintegration into the workforce.

1.2.2.2 Technical

The technical field mainly originates from an engineering base and deals with issues representing hazards to which humans are susceptible. Its units of analysis range from large complex systems to nanotechnology. This field includes issues relating to physical hazards, including anything that can result in harm to individuals — essentially energy sources, and protection from them. A prime issue within this field is designing work environments to engender safety, as well as a wide range of human factor issues that straddle technical, psychological, and managerial disciplines. For example, Gunningham and Healy (2004) argued for implementing known technical ways to deliver pesticides so as to reduce risk to human users. Further issues included improving the accuracy and validity of risk assessments to ensure that these incorporate up-to-date scientific knowledge, that adequate recognition of the human element is accorded in developing such assessments, and ensuring that these are used in practice. Woolfson (2004) described a fatality in which completion of risk assessment forms was superficial and routine, rather than being a real assessment of the risks involved. Addressing system safety issues and the interface between multiple complex systems links the technical with the managerial disciplinary field. Of particular importance are systems with the potential for large-scale fatalities and damage, for example, nuclear power generation, petrochemical operations, and mass transport.

1.2.2.3 Health

The health field, with its origins in medicine and other health sciences, has a prime focus on the etiology, treatment, and prevention of disease and trauma. Its units of analysis include individual physiology and workplace environments. Research in occupational
health and hygiene, as well as discoveries in occupational medicine and epidemiology, has revealed the etiology of harm for many substances. However, the number of substances that have not been studied in sufficient depth and detail is many times again (Adams, 1995). The rate at which new substances are being introduced into workplaces and other aspects of people’s lives means that exploring the mechanisms of harm by chemical and other agents will be a continuing priority, along with seeking means for effective protection from harm to humans and the environment. Money et al. (2003) considered one approach to chemical risk assessment based upon hazard ratings. Along with the requirement to research the potential harmful impact of many agents, important issues include identifying long-term and intergenerational effects and, given the almost limitless possible combinations, the vast synergistic potential for harm. Issues that straddle the interface between health and both individual and organizational disciplinary fields include health promotion and occupational stress. One aspect of the latter that can be identified is a diminishing proportion of the workforce being at the sharp end of production, supporting an increasing proportion of managers and staff in nonproductive functions, which increases pressure on frontline workers. Given that stress is ubiquitous in all aspects of our lives, an important issue is how to develop effective resilience, both for individuals and for organizations.

1.2.2.4 Psychological
The psychological field focuses upon individuals’ cognitions, emotions, and behaviors, extending its domain of study to groups and organizations. While the study of individual and group differences, for example, in respect of susceptibilities to different hazards has made progress, sound methodologies are required to identify vulnerable groups and individuals within populations that are potentially exposed to an increasing variety of hazards. Emergent issues include fatigue, working hours (including shiftwork), the work–domestic life interface (including potential conflicts that can arise), and seeking effective mechanisms for dealing with these issues. While advances in determining the bases for risk perception have improved our understanding of this important aspect of OHS, the increasing complexity of this field means that further conceptual and methodological refinements are required. A controversial issue concerns the extent to which behavioral adaptation can occur in response to safety protective measures, which means that funds expended on OHS improvements may fail to generate returns in respect of reduced injury and other losses.

Allied with this continuing search is the need to understand more about intrinsic risk motivation — to balance the much more extensive study of extrinsic rewards for safe behavior. While this quest is more challenging, it is only by determining generic bases for safety motivation that substantial advances can be made in respect of enhancing individuals’ safety-oriented behavior. This involves greater understanding of the complex variety of human motivations, including moods and emotions, that result in safe/healthy behaviors on the one hand and that can lead to risky/dangerous behaviors on the other. The challenge is how to use relevant aspects of human nature to make effective changes, including determining aspects that can and cannot readily be altered, and focusing upon aspects that can be changed. Woolfson (2004) described an offshore drilling rig accident in which authority structures promoted form filling as a substitute for workers being encouraged to think about risks inherent in the work, with fatal consequences. Important research issues that interface with the managerial disciplinary field include effects of corrosive leadership, for example, as exemplified in workplace bullying (for a review, see McCarthy et al., 1996), and improving effectiveness of OHS training and education, which also links with intrinsic motivation.
1.2.2.5 Managerial

The managerial field has a prime focus toward organizations and applications. While the organization is generally its unit of analysis, it can also be teams or broader systems. A linking theme in the foregoing discussion is that of change and implementing change through managerial practice. While organizational change is a well-established area of organizational behavior its impact upon OHS has been little studied. Borrowing a methodology from the economic domain, in those high-risk sectors for which this is relevant, respective costs and benefits of reducing likelihoods and outcome severities of high consequence—low probability events with the potential to harm many people, including customers and the general public, need to be balanced against those required to produce effective countermeasures against everyday workplace hazards, which increasingly include varieties of workplace violence (Mayhew, 2003, 2004).

While the methodology for decision making of this type, based upon principles of risk assessment and risk management, is well established, how OHS issues are strategically integrated into broader organizational risk management and safety management system frameworks has been little studied to date. Understanding how OHS is integrated within a broader risk management framework is important, including potential conflicts and resource availability. Gallagher et al. (2003) noted that to be effective, a health and safety management system should be customized and supported by strong management commitment, effective worker involvement, and program integration. They identify the combination of innovative management and safe place strategies as superior to three other types, with a traditional management combined with safe person approach being least effective. In an organizational case study, Baird (2005) revealed how implementing an OHSM system without management commitment and attention to soft aspects of safety culture resulted in no OHS performance improvement.

Much talked about but hardly ever systematically studied within this disciplinary field is elaboration of the notion of safety culture. Developing sound methodologies for the study of safety culture and the related topic of safety climate and linking these with adequate safety indices, such as behavioral observations and near-hit events as well as more traditional but less adequate measures such as injury rates, is a priority.

1.2.3 Ten generic challenges for OHS research and practice

1.2.3.1 Integrating knowledge

The variety of disciplinary fields and domains identified means that few people can have knowledge of more than a small number and that no one can have expertise across all of them. This means that teams are required to integrate conceptual knowledge and to implement strategic level solutions that are also practical. While there is always likely to be a role for individual expertise, it is increasingly likely that multidisciplinary teams will be required to undertake research and to implement practical solutions in many areas of OHS — less a new notion, more a greater emphasis. One response not only to scarce resources, but also to the complexity of many OHS topics, is to seek to develop and maintain multidisciplinary teams, both for research and OHS practice. The relatively small number of multidisciplinary OHS research units that have been sustained for any length of time within higher education institutions globally illustrates the magnitude of this challenge.

1.2.3.2 Knowledge application

Pure research in many fields may or may not lead to immediate applications. It is highly desirable that OHS research should do so. A problematic aspect of this challenge is that
often it cannot be known in advance which particular line of research will lead to important applications and thus where precious research funds are best spent. A dilemma arising from this problem is that there may be a trade-off between undertaking small packages of applied research and seeking funding for longer-term strategic research for which there may be much less certain applications — a dilemma that is not unique to the OHS field. Gunningham and Healy (2004) argued for a more political approach involving alliances of workers’ organizations, consumer groups, and international nongovernmental organizations through the broader corporate social responsibility movement.

1.2.3.3 Program evaluation
Only a small proportion of OHS interventions are systematically assessed and very few are comprehensively evaluated. For economic as well as safety reasons, it is always important to evaluate attempts to improve OHS in order to determine whether there has been a real effect, or, for example, whether an intervention has been absorbed by performance enhancements. If this has happened, for example, via behavioral adaptation, then it is important to determine the pathways that carry the effect. There is a dearth of studies evaluating the impact of enforcement and advisory agencies’ policy and practices upon workplace-related deaths, injuries, and sickness (for a review of difficulties faced by one jurisdiction in respect of evaluating its OHS policies and practices, see Eriksson, 2004). An important initial step is to develop an adequate methodology for OHS program evaluation. Lindblom and Hansson (2004) described a theoretical framework for evaluating workplace inspections.

1.2.3.4 System complexity
Since Perrow published his original 1984 edition of Normal Accidents, systems have become even more complex and tightly coupled. This increasing complexity, interrelatedness, and vulnerability of large-scale systems, including in some cases being subject to terrorism threats to large numbers of people, is a vital topic to address. Understanding how organizations cope with this type of threat generally requires a systems approach; this involves incorporating business protection with managing large-scale risks.

1.2.3.5 Multiple synergies
Occupational health and safety research often involves studying the effects of a single hazard type or examines OHS issues within a particular type of work location or considers risks to those employed in specific occupations. However, because many people’s working lives are complex and multifaceted, an important challenge is to determine the effects of multiple hazard types upon workers, which might include exposure to toxic substances, management pressure or bullying, various stressors, and physical hazards capable of inflicting traumatic injury. Discovering more about how people learn to cope with multiple hazards, and how these affect their lives, is a challenge for research and practice. Coping strategies, support mechanisms, individual resilience, and having some degree of control are among factors that can help to protect against workplace hazards.

1.2.3.6 Resources
An issue for many areas of research is the availability of resources, not only funding but also requisite levels of expertise or competence among sufficient numbers of researchers. This is likely to be a continuing issue for OHS research. The challenge is likely to require imaginative and creative solutions, for example, seeking diverse funding opportunities, creating openings for OHS researchers, and involving workplace and other agencies in research, including using their expertise and, where possible, involvement in data collection.
(Glendon & Stanton, 2000). A further vital resource is learning from OHS researchers and practices in other jurisdictions to foster and enhance productive collaborative interactions rather than duplicating effort.

1.2.3.7 Displacing risk
As global trade expands through agreements and protocols, an increasingly documented phenomenon is that of increasing regulation in developed countries displacing workers’ risk exposure in these countries to workers in developing countries. This organizational adaptation to OHS regulatory environments parallels the individual-level behavioral adaptation referred to above, and can mean that while efforts of policy makers, enforcers, researchers, and others in one country may appear to bear fruit, a harsh reality is that an OHS problem has merely been displaced (Mayhew, 2004). Arising in part from substantial changes in employment patterns, another example is transfer of OHS risks to unorganized workforces, which often comprise isolated employees, casual staff, or contract workers (Mayhew, 2004). Woolfson (2004) considered such risk transfer mechanisms to be rooted in the structure of modern business. Quinlan et al. (2001) charted the global growth of precarious employment, while Quinlan (2004) reviewed evidence that precarious employment practices have adversely impacted upon OHS and addressed challenges to workers’ compensation that result from changing work patterns. A major challenge is to find mechanisms that can effectively prevent, or at least mitigate, this transfer of risk to considerably more vulnerable populations. Large disparities between legal systems are paralleled by substantial differences in education and managerial practices. Due to cultural and political barriers and the autonomy of legal jurisdictions, as opposed to the relative ease with which many large corporations can shift production between countries, this will be a particularly difficult issue for OHS practice, requiring professional support and political will on an international scale.

1.2.3.8 Ethics and social justice
To an extent associated with risk displacement between jurisdictions are the numerous consequences upon OHS provision of an unequal balance of power between parties, including employer and worker, customer and supplier, and government and individual. These imbalances reflect inter alia increasing economic deregulation, reduced collective representation for workers, and a large percentage of the workforce being self-employed, working in small organizations, or being in insecure employment. While the nature of social and political contexts mean that this issue will always exist to some extent, a major challenge is to determine the extent to which, and mechanisms by which, these imbalances may be attenuated to achieve OHS outcomes that are more aligned with fairness and principles of natural justice. Tombs (2005) reported research evidence that collective workforce participation has significant and measurable impacts upon OHS outcomes, such as injury rates.

1.2.3.9 Triangulating methodologies
While the need for methodological rigor in OHS research is axiomatic, the multidisciplinary nature of OHS research and practice makes methodological triangulation mandatory in any in-depth attempt to understand OHS issues. This may be as true for intradisciplinary research as for interdisciplinary research. For example, while an organization’s safety climate is typically measured by a single self-completion questionnaire, measuring the much broader and more complex concept of safety culture requires a raft of measures from the social sciences (Glendon, 2006). However, a psychometric approach in all but the largest workplaces can be problematic and more appropriate ways of measuring safety climate and safety culture in small organizations have still to be developed.
1.2.3.10 Conceptual and theoretical advances

Much OHS research has been atheoretical or has been undertaken from a perspective that pays minimal regard to theory or conceptual adequacy. Hale and Hovden (1998) noted that for the most part, the study of safety, health, and environment (SHE) seems to have been conducted in something of a theoretical limbo. Exceptions that they noted included Perrow (1984), Sagan (1993), and studies of high reliability organizations (Weick, 1987, 1989; Rochlin, 1988, 1989; Roberts, 1989, 1990). Increasing journal space available for OHS scientific papers and developing more OHS research units could go some way toward ameliorating this shortfall. Given this historical legacy, along with its multidisciplinary nature, a major challenge is to move beyond the purely descriptive and develop adequate and robust theoretical frameworks for advancing scientific knowledge in OHS.
chapter two

Risk models and risk management

2.1 Introduction

Responding to contemporary social pressure for greater personal safety in many spheres, with increased understanding of psychological processes for attributing responsibility for risk and blame, scientists and practitioners have developed a variety of approaches to risk, risk taking, and risk management. Each approach establishes a particular context for risk cognition or risk perception, and has distinct implications for managing risk and for making health and safety (H&S) interventions in the workplace, on the road, and elsewhere. Compared with risk perception, the term risk cognition implies a wider rubric for understanding risk within a psychological context because it implicitly incorporates other features of individuals’ cognitive architecture that influence risk-related behavior, including memory storage and retrieval, learning, and higher order cognitive phenomena, including decision making and problem solving (Glendon, 1987). Hot cognitions can also be incorporated within this rubric, including feelings, moods, emotional states, and traits (Slovic, 1997; Finucane et al., 2000). Otway (1992) noted that, “the term risk perception is technically inaccurate because we cannot really perceive risks. Its use represented a departure from the traditional use of ‘perception’ to refer to the processing of sensory information to apply to the processing of conceptual information” (p. 222, original italics) (see also Chapter 3). In this book we use risk perception when referring to models and approaches that specifically adopt this terminology.

The language of risks and benefits can be used to describe much of the dance of life. All living things take risks, not necessarily consciously, in order to address imperatives (benefits) of survival, procreation, and extending their species domain. In this sense, risk has been integral to human cognition and behavior since our species emerged and in some form to all our predecessors. Successful risk taking conferred survival advantages and is central to many contemporary human activities, including social — particularly sexual — interactions, entrepreneurship, career decision making, travel and exploration, sporting achievements, and trade within and between nations. Our species developed a parallel propensity for risk aversion, or seeking safety, these countervailing forces being salient in many risk debates at all levels. For example, to what extent do parents seek to protect a child while simultaneously allowing it to develop so that it will effectively master its environment? How can workplaces be designed and managed so that H&S is not traded for production? How can road use be regulated in such a way that public demands for
safety are consistent with individuals’ desires to drive as they wish? How can nations trade safely — a potentially risky activity, while simultaneously minimizing risks and maximizing potential benefits?

A challenge for contemporary society, and for those attempting to explain the forces shaping it, is to understand the social nature of risk, how individuals address risk issues, how decisions involving risk are made, and how these processes can be managed to individuals’ and society’s advantage. Major forces characterizing the risk debate include increasing demands for ever greater safety in our lives, and enhancing our inherent tendency to apportion blame to human agency — for example, as enshrined in legislation, through insurance and compensation systems, or via political or psychological processes. Following Wildavsky (1979), Slovic (1993) noted the paradox that as society becomes safer and healthier, concern about risk increases and people have a greater sense of vulnerability — with Kirchsteiger (2005) describing the public as increasingly risk averse as poverty and other threats diminish (at least in developed nations), noting that, “Today’s richest, long-lived, best-protected, most resourceful civilization is on its way to becoming the most frightened and cultivates the vision of a zero-risk society” (p. 32). Hopkins (2005) considered that the notion of a risk society in which society faces unprecedented levels of risk is incorrect, considering that, “we live in a society in which risks are more controllable than ever; hence the increasing demand that they be controlled” (p. xi, original italics). However, can we really know whether we are more frightened than any previous society — or indeed compared with societies in which early death through a host of disease and human agents remains commonplace? We may have developed sophisticated tools and techniques to measure our fear, but still have no valid way of being able to compare our levels of fear with those of earlier generations, or even to assume that the respective risks that we face are in any way comparable with those of previous generations or of contemporaneous societies that face quite different risks. Likewise, whether contemporary risks are more controllable than for earlier generations is also problematic because the nature of risks faced by humankind is changing, and probably more rapidly than for most previous generations due in large part to our own interventions. Comparing risks across time periods is also problematic and there is no unambiguous metric for controllability.

The nature of risk and its derivative concepts is problematic. Hansson (2005) challenged the myth that risk must have a single, well-defined meaning, identifying five (there are more) — an unwanted event; cause of the unwanted event; probability of the unwanted event; statistical expectation value (probability x outcome); and decision made under conditions of known probabilities. The fourth of these is most common (International Organization for Standardization, 2002). Since the 1970s, developments in discriminating between a variety of approaches to risk and related topics have been rapid — leading Horlick-Jones (2005, p. 258) to refer to the sprawling risk literature. Horlick-Jones also noted that in the last 15 years, increasing numbers of professionals have found that their work is articulated in the language of risk. Even before this, during the 1970s and 1980s risk provided a framework for public health and related studies (Taylor-Gooby, 1998). Because each model of risk has different implications for managing risk, it is important to understand the varied approaches and their assumptions and to appreciate which are being used when addressing an issue such as workplace H&S or road user behavior. To unravel some of the complexity inherent in the concept, this chapter describes 12 major approaches to risk. It considers some implications for risk management and, where appropriate, illustrates how these approaches might lead to particular types of H&S interventions.

Two perspectives are evident in considering approaches to risk. First, discipline-based (Althaus, 2004, 2005; Aven & Kristensen, 2005), and second, model-based (Renn, 1992; af Wåhlberg, 2001; Renn & Klinke, 2002). Renn (1992) identified seven basic forms and “integrated approaches” such as social amplification. af Wåhlberg (2001) critiqued three
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approaches, while Althaus (2004, 2005) adopted a discipline-based approach that discriminated between risk identification, risk management, and context disciplines. Risk identification disciplines focus upon image, perception, context, complexity, competing values and shifting moods, emotions, and opinions, and upon how risk is understood, experienced, and created. They include linguistics, the arts, sociology, anthropology, psychology, and history. Risk management disciplines stress substance and policy content, treat risk as a malleable commodity that can be managed but not necessarily eradicated, and offer concrete strategies for measuring and controlling risk. They include mathematics, science, economics, and law. Context disciplines, oriented toward both risk identification and risk management, consider meta-debates on the notion of risk, including moral issues, and include philosophy and theology.

In contrast to Althaus' (2004, 2005) analysis, this chapter considers risk from the perspective of some of the key models of risk that have been proposed. We use the term model rather than theory on the grounds that these represent alternative approaches rather than theories in the scientific sense, as noted by af Wåhlberg (2001). The models are, in general, stand alone in that adherents of one rarely acknowledge the contribution of rival models, although there is evidence for some growing together of social models (Krimsky & Golding, 1992) and at least one interesting attempt to bring together two seemingly disparate approaches — adaptation and cultural theory (Adams, 1995). First order approaches considered here are technical, economic, cultural, and psychometric. Expanded approaches are social constructionist, social amplification, individual differences, and the basic risk perception model. Meta-approaches are political, socio-emotional, adaptation, and evolutionary. Acknowledging assumptions of whichever model or models of risk are adopted can inform decisions about managing risks and making H&S interventions. In a few cases, particularly individual differences, topics are explored in greater detail in subsequent chapters.

2.2 First-order concepts/approaches to risk

These four basic approaches, each originating from an independent disciplinary tradition, have either measuring risk or categorizing risk decision makers as a prime focus. Tenets of these first-order approaches are the most prescriptive and capable of being formally presented, and their methodologies are the most highly developed.

2.2.1 Technical

2.2.1.1 Description of the technical approach
The varieties of technical approach to risk as applied to safety, health, and environment issues have their origins in engineering and the hard sciences. In this approach, examples of which are Grammenco (2004), Kletz (2001a, 2001b), and Lees (1996), risk = probability × magnitude. It assumes rationality, considering risk as being primarily about seeking safety benefits, such that acceptable risk decisions are deemed to be matters of engineering judgment. In seeking objective assessment of risk it is particularly appropriate for identifying hazards and other physical manifestations of risk. Of critical importance is the role of science in establishing levels of evidence and proof in debates about risk. For example, science is increasingly relevant to risk management processes, including identifying, estimating, analyzing, evaluating, and communicating risk issues. Basic risk measurement techniques include inspection checklists, safety audits, and risk assessments (RAs). Derivative forms include probabilistic risk analysis (PRA), fault tree analysis, event tree analysis, Management Oversight and Risk Tree (MORT), and failure modes and effects
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analysis (FMEA). Two main approaches to risk assessment are probabilistic and deterministic (Christou & Porter, 1999; Salvi, & Gaston, 2004). The probabilistic approach evaluates likelihood of hazardous events quantitatively, for example, using fault trees and estimating likelihoods of all initiating events. In the deterministic approach, major incidents are pre-defined and called reference scenarios and their likelihood is not assessed. Risk-reduction methods are evaluated for both approaches. Attempts to harmonize risk assessment and decision-making processes within the European Union (EU) are described by Kirchsteiger and Cojazzi (2000).

2.2.1.2 Risk management and the technical approach

Traditional workplace approaches to managing risk have developed to support and enhance the technical concept of risk as an environmental given that results primarily from human activity. After seeking to identify relevant hazards, the methodology attempts to rate or rank risks according to criteria that first judge the worst possible consequence or harm that could result from that hazard, before estimating the probability or likelihood of that harm occurring. Risk management implications include seeking to measure all risk components and imposing managerial control of risks. Regulatory frameworks, including external legislation and compliance inspection or audit, as well as internal mechanisms such as company policy and rules, generally operate so as to reinforce this approach to managing risk. Renn (1992) noted that technical approaches to risk empower elites to impose their risk management policies on others. The monitoring function operates through some form of behavioral adaptation, principally at organizational level.

Whipple (1992) described the technical approach to risk management as seeking to reduce H&S risks to as small a residual level as possible, and then to declare the process as safe. Whipple maintained, “A major motivation… for using quantitative risk assessments for risk management is that such an approach permits a conceptual separation between the technical factors that determine risk and the political factors that bear on risk management” (Whipple, 1992, p. 346). Highlighting inevitable conflict due to inconsistent values in the social management of technological risk, Whipple noted that there can never be enough resources to deal with all risks.

2.2.1.3 Illustrative interventions

The technical approach has dominated a majority of interventions characterizing attempts to improve workplace H&S, and to a lesser extent, safety in other environments. Because of the extensive and ever-expanding regulatory framework for workplace H&S — at least in Western capitalist cultures, this domain has become a prime testing ground for the technical approach. Behavior modification, or one of its workplace manifestations such as behavior-based safety, in which workers are consigned to follow preset patterns of behavior as a means of reducing accidents and increasing productivity, illustrates one application of a technical approach to workplace risk. This approach ignores implications based on the possibility that workplace behavior that is considered to be “risky” may have individual, organizational, social, or cultural origins. The extent to which workers themselves are involved in developing behavior standards to support such technical approaches to workplace risk may reflect their managerial self-regulatory role. This topic is considered in greater detail in Chapter 3.

2.2.1.4 Where next for the technical approach to risk?

In their discussion of varieties of science, Funtowicz and Ravetz (1992) noted that science is seen by many as part of the problem as well as providing possible solutions to risk issues, reporting, “The great risk problems have to a large extent been created by the practice of
normal, puzzle-solving science and technology” (p. 268). Of the scientific disciplines particularly relevant to risk issues, such as toxicology, epidemiology, ecology, and risk analysis, they observed that compared with the hard sciences, these, “are weaker, technically and socially. They deal with more complex systems, are less well developed theoretically, and historically have tended to lack prestige and resources” (Funtowicz & Ravetz, 1992, p. 268). They also point out that practitioners in these fields tend to be more exposed to public scrutiny and are less well protected by their qualifications. The complexity of many risk problems means that they lie outside any one scientist’s disciplinary framework, thereby rendering them hard to conceptualize as well as to solve. This can be exacerbated by scientists being affected by biases as much as are the public, for example, being overconfident in their risk estimates (Freudenburg, 1992). Freudenburg observed that because system complexity means that it is not possible to identify all possible failure modes, a multidisciplinary approach is needed.

Despite its ubiquity in many spheres, the technical approach to risk has been much criticized. Hansson (2005) observed that the term risk has been in widespread use in various senses for over 300 years, so it should be no surprise that attempts to reserve it for a technical concept introduced 30 years ago result in communication failures. Hansson challenged the assumption that risk severity should be judged according to probability-weighted averages of the severity of their outcomes. PRA estimates the number of induced deaths from a technology, which allows comparisons with health impacts of alternatives so that a rational judgment can be made on their relative acceptability (Cohen, 2003). However, the method falls over when applied to real-life problems because only two factors (probabilities and utilities) are taken into account. Risks do not simply exist, they are taken, run, or imposed and are inextricably linked with personal relationships. In any thorough risk assessment such person-related aspects as agency, intentions, duties, consent, equity, and rights, as well as outcomes and probabilities need to be taken into account (Hansson, 2003). Risk analysts and other experts tend to emphasize the size of risks, while the public more often questions the potential for improbable but calamitous disasters. To communicate more effectively with the public, risk analysts need to deal with social and moral issues that are on the public’s agenda.

Among the myths associated with risk that Hansson (2005) addressed is that if there is a serious risk, then scientists will find it if they look for it. For example, Durodié (2003) considered that because most chemicals have been in use for extended periods there is a considerable amount of data on their effects. However, even quite large health effects can be difficult or impossible to detect in human populations, because in epidemiological studies many effects (of <10%) are indistinguishable from random variations. This means that even in the most sensitive studies, an increase in the lifetime risk of $10^{-2}$ or smaller may be indistinguishable from random variation (Vainio & Tomastis, 1985; Hansson, 1999). There is a gap between what can be detected and what can be accepted — taking benefits as well as risks into account. Thus, risk managers should develop cautious strategies, such as uncertainty (safety) factors. “Science without precaution means acting too little and too late against environmental hazards. Precaution without science means acting with the wrong priorities” (Hansson, 2005, p. 16).

Some texts indicate a certain softening of the technical approach, suggesting that writers in the technical risk field are taking note of, or even beginning to absorb more social aspects of the risk spectrum — see for example, Aven (2003), OECD (2003), and Webb (2003).

### 2.2.2 Economic

#### 2.2.2.1 Description of the economic approach

In contrast with the technical approach, the economic approach takes expected utility (benefit) rather than harm as the central criterion for managing risk. This approach is
derived from mathematical, statistical, and historical components of risk — examples include Bernstein (1996), Sunstein (2002), and Zeckhauser and Viscusi (1990). Economists tend to see hazards as market externalities requiring intervention (Viscusi, 1983). There may be some limited acknowledgment of a cognitive contribution but developmental and emotional aspects are ignored, as are sociological, power, political, cultural, and anthropological notions. Krimsky and Golding (1992) referred to the economic approach to risk as one-dimensional. It implicitly assumes that this approach to risk is universally shared. Its pure form is a type of bounded rationality. Tools and techniques used in this approach include cost benefit analysis (CBA) or utility analysis, and risk–benefit analysis. CBA seeks to compare valuations of benefits and disbenefits of a decision by expressing these as monetary values. It depends on all relevant consequences being valued and determining prices and probabilities objectively.

However, often there is no market for determining values, for example, human lives. In the United Kingdom an arbitrary value of preventing a fatality is assigned and updated annually to reflect inflation — the 2005 figure is around £1 million. However, different sectors may use different human life valuations to reflect possible multiple fatalities — for example, the rail industry. Railtrack’s (U.K.) safety case specified different tolerable levels of risk for different stakeholders. For employees the limit was 1 in 1,000, while for an individual member of the public, for example, at a level crossing or as a rail passenger, the tolerable risk limit was 1 in 10,000 — on the grounds that the risk was imposed rather than voluntarily accepted. While the U.K. Department of Transport uses a figure of £1 million for preventing a (notional) fatality (HSE, 2001a), for the rail industry the HSE accepts a figure of £3.2 million for preventing a fatality (Uff & Cullen, 2001). However, because of widespread concern over safety on the railways (Davies, 2003, p. 20), the HSE has accepted a figure of £10 million as reasonable for installing a train protection and warning system and an additional cost per fatality prevented of £30 million for Automatic Train Protection (Cullen, 2001b). Hopkins (2005) maintained that expenditure figures are decided first, then cost per fatality prevented is calculated, and then this is justified by reference to public pressure, willingness to pay arguments, or political considerations, making an economic case an ex post facto rationalization and not a decision making tool. Hopkins (2005) and Tweeddale (2003) reported on an airline industry case in which risk analysts experimented with different assumptions in order to bring their results within the limits of tolerability.

Decision-making models can be aligned with different approaches to risk. An economic rationalist (expected utility theory) model can be applied when information improves knowledge about the probability of future harm from an agent. People are assumed to be rational, risk averse (prudent), weigh costs and benefits of different potential courses of action, and act to prevent future harm in the face of uncertainty before learning more about a potentially harmful agent (Laffont, 1995; Gollier et al., 2000). This model is most appropriate for well-understood decisions that are encountered frequently — when people can calculate both probabilities and utility values of alternative outcomes.

However, utility theory assumptions do not hold when probabilities are hard to calculate. In these cases, people tend to use heuristics to aid decision making (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981; see also Chapter 3). Prospect theory considers decision making under uncertainty, accounting for some behaviors that are inconsistent with utility theory — for example, that losses are evaluated more strongly than gains are (Tversky & Kahneman, 1992). If a poorly understood risk is low probability high consequence, then people tend to focus on potential harm from negative outcomes, and reject the potentially harmful agent. The certainty effect leads people to treat potential harm from an agent as if it were certain and to avoid the agent at all costs (Conlisk, 1989).
Margolis (1996) expressed options predicted by utility theory and prospect theory as a matrix — the four cells defined by whether costs and benefits are taken into account. Danger consists of the costs of accepting a risk (yes/no) and opportunities refer to whether benefits will be foregone (yes/no) if precautions to avert risk are taken. When both dangers and opportunity costs are taken into account, utility theory can be applied and a decision depends upon weights of costs and benefits, and outcome probabilities — the outcome with the highest expected utility is selected. If neither costs nor benefits enter into the evaluation then the outcome is indifference until more information is available.

Disagreements often arise because one party (e.g., experts) evaluates risk from a supposed balance of costs and benefits, while another (e.g., the public) do so on the basis of costs and benefits to them. If costs (dangers) but not potential benefits are acknowledged, this leads to a better safe than sorry outcome, in which a party avoids a risk while scientific evidence about it is gained — expressed as the precautionary principle (PP) — see Journal of Risk Research (2001, 2002). The fourth cell, in which opportunities (benefits) are considered while dangers (costs) are excluded, is labeled waste not want not, in which a party accepts a risk while learning about it subsequently. Individuals can move between cells in the matrix depending upon risk information available. However, as individuals are generally poor at estimating probabilities (Slovic, 2000), there is a strong tendency to consider risks in terms of their costs (dangers) and benefits and to ignore or downplay probabilities (Margolis, 1996) — see Summary Text 2.1 for an example. An economic rationalist

**Summary Text 2.1 Public Perceptions of MMR Vaccine Risk**

In the United Kingdom, immunization against the highly infectious diseases, measles, mumps, and rubella, is offered to children at approximately 14 months of age as a combination vaccine (MMR). Until the mid-1990s, uptake of this immunization was very high (in 1992 national coverage was 92%), leading to extremely low incidence of these mainly childhood diseases. However, over a few years, journal articles by Dr. Andrew Wakefield and his team, together with anecdotal evidence from some parents and doctors, suggested a link between the MMR vaccine and the incidence of autism. Despite the U.K. Government maintaining that there was no substantial medical evidence to support this link, and that there were significant weaknesses in the evidence suggesting a link, parental concern over the potential risk of autism in their healthy babies led many of them to refuse the MMR vaccine. As a result, by the early 2000s immunization rates in some areas of the country fell below 80%, leading to outbreaks of both measles and mumps in vulnerable groups, including toddlers and university students.

In this situation, some parents placed much greater emphasis on the severity of the potential cost to their families (autism) than the benefits (reducing the likelihood of their own, and others’, children catching potentially life-threatening diseases, such as measles), despite a lack of substantial proof of the danger of autism resulting from use of the vaccine. Many parents thereby adopted the precautionary principle in a way that rational evaluation of available evidence might suggest was inappropriate. However, an anchoring bias (see Chapter 3) might result in a slow reversal of this trend, while in the absence of prospective studies there remains the possibility that a small fraction of the population could be vulnerable to the MMR vaccine.
perspective considers that it is possible and desirable to move public risk evaluations from the precautionary (prudence) location to one of considering both costs and benefits as a result of providing neutral science information (Nelson, 2001).

Geiger (2005) considered that basic risk acceptance patterns found in psychometric and social risk studies can be considered to be utility-oriented attitudes and that risk assessment problems can be adequately treated within utility and decision theory. Geiger’s view is that observed variability in risk attitudes is due to decision makers’ needs, aspirations, their current and past risk exposure, as well as their current and prospective wealth, maintaining that expected utility analyses can also explain inconsistent risk preferences. A more detailed exposition of the economic approach to risk is given by Althaus (2005).

2.2.2.2 Risk management and the economic approach

There are numerous examples of the application of economic methodology, primarily some form of CBA, to risk management issues, particularly on a large scale — where costs and benefits may be most evident. For example, Voorhees (2005) described a CBA of particulate matter control programs in Tokyo, comparing precontrol levels in 1975 with postcontrol levels in 1998. Voorhees considered mortality and morbidity data in respect of chronic bronchitis, cardiovascular disease, pneumonia, chronic obstructive pulmonary disease, asthma attacks, and acute bronchitis, concluding that, “The calculation of avoided health and productivity impacts suggest that pollution control policies successfully prevented a large expense to the society in extra medical care and lost work time” (p. 311). Vrijling et al. (2004) used a mathematical–economic approach to argue for weighing risk reduction in monetary terms against investments needed for additional safety, and included in this approach an estimate for the value of human life to avoid decisions that implicitly attach unrealistically high values to loss of life, basing this value upon present value of net income per capita. They applied their analysis to case studies in Schiphol Airport, air travel in general, road safety, transporting dangerous substances over water, and high speed trains.

Among the most comprehensive set of CBAs is that of Tengs et al. (1995) whose analyses span a broad range of risk issues with three major types of interventions — toxin control, fatal injury prevention, and medical, in the health care, residential, transportation, occupational, and environmental sectors. Tengs et al. concluded that the current ad hoc system of toxin control, injury reduction, and medical risk management, does not rationally prioritize life-saving opportunities and that for all interventions, there is a huge range of cost-effectiveness. Several authors have criticized the Tengs et al. study, for example, Revetz (1999) challenged the validity of the discounting rates selected. Hassenzahl (2005) commented that Tengs et al.’s decision to use cost per life-year saved as a decision rule is not just a normative choice about preference for using this rule, but also includes analytical limitations involved when applying the rule. Hassenzahl (2005) noted that point estimates are arbitrary and that equally plausible assumptions can lead to highly divergent estimates. Thus, selection is based, at least partly, on nontechnical criteria. Decisions based on point-estimate cost-effectiveness calculations can give a false impression of rationality.

Within the framework of developing a European standard generic approach to risk assessment and risk management for different sectors (EC-JRC, 2000), Flüeler and Seiler (2003) considered the possibilities and limitations of a risk-based approach that combines technical and economic models, based around nine case studies of various types of risk. Risk-based regulation (RBR) seeks to apply consistent criteria to various risks to determine tolerable risk quantitatively. Indirect application is the general case — for example, controlling speed limits rather than carrying out a risk analysis for every driver under every set of circumstances. The cost-effectiveness of risk-reducing measures is assessed and risks are lowered to the point at which the costs of the risk-reduction measures are below the
monetarized risk level — that is, “a collective risk of a system is tolerable if at least all measures . . . are taken whose cost-effectiveness is smaller than or equal to the marginal costs” (p. 216). The marginal cost criterion is used to select the most cost-effective safety measures until a target cost/risk ratio is achieved. This differs from a risk–benefit approach in that the aim is not to decide whether to build an installation but to evaluate additional safety measures. The marginal cost approach is utilitarian, which means that some people bear unduly high individual risks. The marginal cost approach can be moderated by an individual absolute risk limit. “Depending on the category, limits of $10^{-5}$ to $10^{-3}$ per year are proposed for individual fatal risks . . . the human capital values for marginal costs are set to . . . 0.6 to 12.4 million U.S. dollars . . . per life saved” (p. 218). Categories are (1) high voluntariness of risk exposure (e.g., dangerous sports), (2) high self-determination and benefit (e.g., car driving), (3) low self-determination (e.g., working conditions), and (4) involuntary, imposed risk exposure with no direct benefit (e.g., local high hazard installation). The authors noted that, “Risk-based regulation is not a substitute for political value judgments; it is not a substitute for politics and policy but a methodical tool into which political judgments may be explicitly incorporated . . . RBR provides a clear separation of analytical results and political value judgments. It makes transparent what risks exist and which risks are — implicitly or explicitly — accepted . . . it forces politicians (and the public) to make . . . value judgments on the tolerability or non-tolerability or risks” (Flüeler & Seiler, 2003, p. 228).

Another example of where technical and economic approaches have been combined is in the general application of ALARP (as low as reasonably practicable) principle in the U.K. nuclear sector (HSE, 1992, 2001) in which ALARP region risks are managed by combining CBA with engineering principles. However, French et al. (2005) observed that CBA may not give clear guidance for cost/risk trade-offs nor for different risk type trade-offs. CBA requires that uncertainties be quantified so that prices can be assigned to variables even if no unambiguous market criteria are available. Costs and benefits arising at different points in time must be discounted to a net present value (NPV). They consider CBA and MAUT (multi-attribute utility theory) as support tools for ALARP decision making, noting problems of pricing; valuing group and individual risk; disproportionality; and discounting. In CBA, decision-maker preferences are determined by the discount rate selected. However, positive discounting rates reduce large future differences to almost negligible present values — unfairly burdening future generations. For this reason, Shrader-Frechette (2000) argued for a 0% discount rate, which accords more with a requirement for long-term protection from nuclear waste. CBA takes little account of different stakeholder perspectives, while MAUT allows stakeholders to make different value judgments and focuses upon potential agreement about conclusions to the analysis. Unlike CBA, decision analysis makes the subjectivity of judgments explicit by separating beliefs and value preferences from expert scientific input before combining and evaluating expected utilities to rank possible actions. MAUT allows problems to be compared from each stakeholder’s perspective.

Risk management implications of the economic approach include assuming that in the long run people will behave rationally, for example, in response to various types of risks. Where this does not occur, insurance cover can be used to transfer risk. Renn (1992) observed, “Economic theory perceives risk analysis as part of a larger cost–benefit consideration in which risks are the expected utility losses resulting from an event or activity” (p. 62). However, as subjective (perceived) utility applies to individuals, aggregating utilities is problematic, for example, leading to outcomes such as siting hazardous facilities close to the poorest communities. This arises from assumptions underlying various risk quantification methods that perpetuate existing socioeconomic relationships, such that in CBA valuations of human life those who are wealthy are deemed to be worth more than those who are poor (Otway, 1992).
Implications for risk management of Geiger’s (2005) model include that assessing low probability catastrophic risks can be expressed as one component of a utility function, and calculating exact costs of risk prevention measures and fair insurance premiums. Geiger acknowledged that many, though not all risk characteristics proposed by the psychometric paradigm (see below) — for example, prior experience, involuntariness of exposure, controllability, and catastrophic potential, do help to predict public responses to risk when analyzed at aggregate level (Marris et al., 1998). A nonexpected utility approach helps to analyze these variables in greater detail.

2.2.2.3 Illustrative interventions
Elements of this approach may be seen in a managerial philosophy that seeks to measure all H&S outcomes in economic terms, including those associated with injury, death, and disease arising from workplace processes. CBA — either explicit or implicit, might be a fundamental driver in making a decision as to whether to introduce a given H&S feature. Costs might include prosecution, fines, restriction of work practices through notices, various forms of work disruption, and trade loss. Perhaps using a crude form of technical risk calculation, managers might assess the downside risk against known benefits of not making a particular safety intervention. Genn (1987) used the term amoral calculator to describe companies (a majority) adopting this approach. Current efforts in a number of jurisdictions to introduce corporate manslaughter legislation represent attempts to shift the perceived balance of risks and benefits to organizations’ management — seeking change through adaptive behavior at this level.

Dorman (2000) provided a comprehensive critique of occupational health and safety (OHS) management and regulation that is based upon an economic approach, maintaining that it is unsound to rely exclusively on economic incentives-based strategies to improve OHS, which despite decades of advocacy, have not brought massive changes to workplace H&S. Dorman identified critical limitations as (1) OHS cost accounting is very inexact, does not accord value to human resources, and resists integration into routine management operations; (2) incentive systems are poorly targeted and often lead to behavior that only meets desired outcomes, resulting in cost-shifting rather than cost reducing; (3) economic incentives don’t address links between OHS and other practices, particularly in the case of precarious employment — where risk factors are higher (the amoral calculator argument); (4) the economic cost of occupational disease — which is much higher than injury costs, and human costs generally elude calculation. Dorman does not regard economic costs as irrelevant to OHS management providing their current limitations are recognized and makes recommendations for improving their potential.

2.2.2.4 Further comments on the economic approach
The economic approach informs many decisions concerning political risk, and while it imposes an arbitrary set of conditions upon decision making applied to risk, it is now widely accepted that many societies do not adopt a Western capitalist worldview and that, therefore, it has inherent shortcomings. Moderators that serve to distort a pure economic rationalist approach include cultural and religious factors as well as broader political issues relating to power relations, historical alliances, and contemporary expediencies, including those that may be labeled as corruption.

Like the technical approach, with which it shares certain characteristics, and with which it is highly compatible, sharing a scientific–rationalist perspective, the economic model has been influential in a number of other approaches to risk. As well as combining with the technical approach — for example, in ALARP, economic style analyses intrude into other approaches to risk, including, psychometric — as with subjective utilities, behavioral
adaptation — as in judging outcomes of different actions, and political — providing input for a wide range of decisions with political implications.

2.2.3 Cultural theory

2.2.3.1 Description of the approach from cultural theory

Cultural theory (CT) adopts an anthropological framework for understanding how groups in society interpret danger and build dis/trust in institutions that create or regulate risk (Douglas & Wildavsky, 1982; Douglas, 1992). Its structural/functionalist approach, in which risk and blame are among the features designed to maintain social structures, uses an organizational/societal level analysis that rejects cognitive/psychological explanations. Cultural theorists have been particularly vehement in attacking psychological approaches (Douglas & Wildavsky, 1982; Douglas, 1985, 1992; Thomson et al., 1990; Wildavsky & Dake, 1990). However, Tansey (2004a) noted that the typology derived from CT is only a heuristic and that Douglas recognized its limitations. It does not preclude psychological theories, for example, regarding how different personality types might gravitate toward one or other of the prototype groups. In seeking to identify different approaches to risk via social and cultural explanation, CT considers risk issues as essentially socially and politically constructed. 6 (2005) observed that CT arose through the neo-Durkheimian tradition — in which cognition is powerfully shaped in semantic content by patterns in social organization.

The CT’s prime methodology is the two-dimensional Grid (degree of autonomy/extent of regulation — social regulation or discipline in the neo-Durkheimian tradition) and Group (degree of incorporation/strength of allegiance — “social integration” or “attachment” in the neo-Durkheimian tradition) dimensions to classify different views of risk, depending on whether a party is high (H) or low (L) on each dimension. The five resultant prototypes are as follows:

1. Hierarchists (HH) or central core who accept established authority, seek to plan/control, and have high social bonding with strong views on norms and behavior; they are risk averse and see nature as robust within limits.
2. Individualists (LL) are entrepreneurial, trendsetters, and risk takers who see nature as robust.
3. Egalitarians (H-group L-regulation) or enclaves are dissenting minorities who are ruled by charisma but have weak leadership; their authority is largely personal; they share adversity, reject or suspect the hierarchical knowledge base, and see nature as fragile.
4. Isolates (L-group H-regulation) are a residual category whose autonomy has been withdrawn by other groups, they are the most victimized, have a fatalist outlook, expect conspiracy, have no respect for the other groups and mock others’ efforts; their isolation frees them and they deride the “cult of safety,” their high-risk lifestyle is an accepted norm; they glorify risk and see nature as capricious.
5. Hermits adopt a central position on both axes and are intellectuals who provide insights that elude the other four groups because of their extreme positions. Adams (1995) proposed this fifth cultural prototype.

The essence of cultural prototypes is that a party’s social position can be used to predict their responses to risk issues so that CT is associated with plural rationalities. Douglas (1992) and Schwartz and Thompson (1990) considered that risk-handling styles corresponded with cultural groups and their associated lifestyles, with different ways of life promoting differing rationalities. Thus the fatalist is characterized by risk acceptance, the hierarchist by procedural risk management, the individualist by entrepreneurial risk taking, and the egalitarian
by risk aversion. A simple illustration of the five roles described in cultural theory is given in Summary Text 2.2. However, because cultural prototypes represent social aggregates, they cannot predict how people come to be in their cultural roles. While empirical data suggest that cultural prototypes are related to individual attitudes toward risk, values, and worldviews (Buss et al., 1986; Wildavsky & Dake, 1990) the theory cannot predict how individuals or groups that are mixtures of prototypes will behave. Renn (1992) considered that two dimensions were too simplistic to represent social complexity.

Extending the basic grid/group model, 6 (2005) noted that CT must predict how cognitive styles will differ for many individuals between contexts — the mobility hypothesis (Rayner, 1992). An individual’s primary location is their long-term position in relation to major institutional forces (e.g., labor market, housing market, public services, key suppliers of goods/services, peers/colleagues, friends/acquaintances, religious institutions, and family). Contexts are also important (e.g., shopping, working, worshipping, relaxing, and playing). Secondary locations may involve conversations in which another party frames an issue differently and a person may change their mind about an issue that undermines (part of) an existing frame, perhaps temporarily (see Chapter 6 on attitude change). The key question is — how much mobility can there be? 6 used privacy risk to identify five basic frames and to hypothesize about the existence of three more and the range of mobility between frames. To do this 6 extended the classic CT matrix to suggest that extremes connect along the diagonals and that it is easier to move between some positions than others.

2.2.3.2 Risk management and cultural theory

Rayner (1992) pointed to the large disparity between the considerable influence of cultural theory’s principles and its very limited practical application. The normal risk sequence assumes that an individual perceives a hazard and then, via rational and emotive cognitive processes, interprets this as a risk. This leads to attempts at risk communication and risk management efforts to mitigate the hazard or to ameliorate potential harm. In this model the perceiver is a passive agent in the face of a hazard and conventional risk management is reactive. Cultural theory on the other hand assumes an active perceiver — not an individual, but an institution or organization driven to select risks to manage (Douglas, 1985). Cultural theory indicates that it is the social attributes of the cultural group that determine which risks are selected and which are avoided (Douglas & Wildavsky, 1982; Rayner & Cantor, 1987; Wynne, 1989; Thomson et al., 1990). Rayner (1992) observed that, “Whatever objective dangers may exist in the world, social organizations will emphasize those that reinforce the moral, political, or religious order that holds that group together” (p. 87). However, people seek trust, liability, and consent rather than freedom from danger.

In cultural theory, risk management is the proactive proximate stimulus and the institutional structure is the ultimate arbiter of how risk is understood. Management strategies include coping and adaptive behaviors in response to risk. Risk communication emphasizes creating shared meaning and trust rather than information transfer. A risk management implication of cultural theory is that because group attitudes differ, risk information operates differentially. Therefore identifying relevant community group/social environments is critical to predicting likely responses to risk issues and risk communication. Rayner (1992) considered how different parties conceptualized risks in respect of nuclear plants. Utilities focus on investment risk, state public utility commissions are concerned about economic risks (e.g., rate of return from plant), while public interest groups focus almost entirely on H&S risks. These lead to different ways of conceptualizing the problem — either the need for the plant (consent), or who pays for it (liability), or management of the technology (trust). Cultural factions create alternative risk management regimes.
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Summary Text 2.2 A Risk Illustration

An example of how the behavior of one group, in this case drivers, can involve risk for another group, in this case residents living in a particular road, is provided by a story in the first author’s local newspaper (The Gold Coast Sun, October 20, 2004). The story, fronted by the headline, “Speed turns school road into deathtrap,” reveals several aspects of risk and provides examples of the five prototypes described by cultural theory. It recounts how concerned residents consider that, “Speeding drivers have turned a road outside a local high school into a deathtrap.” It was reported that the road had, in recent years become a popular shortcut for drivers, and the issue was brought to a head when a car, being driven by a teenager, crashed into a resident’s garden in the early hours of the morning, coming to rest a meter from the bedroom in which her two young grandsons were sleeping. One of the children was profoundly disabled and wheelchair bound.

As well as destroying three trees and a fence, the crash wrote off the resident’s uninsured car — which she claimed not to be able to replace. The driver of the car was taken to hospital in an ambulance. The resident, Janet Knitschke, was reported to have said that in the 4 years that she had lived there, traffic had increased phenomenally, to the point where it was now allegedly a speedway, nearly 24 h a day. “It seems to get busier every month, and the traffic faster, she said.” Racing motorists were seemingly oblivious to the fact that children could run out from their homes on one side of the road, while on the other side was a school. Cars are supposed to do 40 kph during school days drop-off and pickup times, yet it was claimed that most did not adhere to this limit. At other times, Janet Knitschke reported, many do 80 or 100 kph, instead of the signed 60 kph. It was reported that the family of the young man who crashed into her car did not want to know, while the police had advised her that it was a civil matter.

Janet Knitschke was concerned about the safety of other residents and did not want one of her family to be killed. She was intending to distribute a petition requesting traffic calming measures to be installed in the road amongst residents and parents dropping children off at school. A local councilor, Peter Young, was reported to have said that he would refer the petition to council’s traffic officers when he received it. He maintained that speeding traffic was a problem all over the city and that it was a difficult problem to address as drivers were often unaware of their speed. He suggested that parking the council’s speed awareness trailer, which displays the speed of approaching cars in very large format, in the street for a period might help the situation.

Salient points from this example can be reconstructed by considering the roles of the players in this local drama in terms of cultural theory, which in this example is used to deconstruct a relatively small road traffic incident in which no-one was killed.

The resident victim: Janet Knitschke can be characterized as a typical Aussie battler, without the resources either to insure her only means of independent transport or the wherewithal to replace it. Once personally affected by this road speed risk, she sought action to try and remedy the situation, and while her response is closest to egalitarian in nature, she is likely to be really up against it.
The car driver: Seemingly acting as an individualist risk taker, he is portrayed as showing no evident concern or of taking responsibility for his actions.

The car driver’s family: Probably also adopting an individualist stance in support of their close relative and not accepting responsibility for his behavior.

The police: While there is little information on their role in the incident, from the newspaper report, their response appears to be typically hierarchist. While they might bring charges against the driver, they have no rules to help the resident whose property was destroyed.

The local councilor: Peter Young acknowledged the speeding traffic problem in this road as a particular instance of a citywide problem and indicated that he would take action once he received the petition, and also suggested a possible (short-term) solution to the problem in this road. His approach is also typically hierarchist, although in this case he is seeking a risk management remedy.

The sleeping children: While they may have no direct or active role in the drama, their evident vulnerability and proximity to the crash that precipitated the story might assign them as isolates by default. Their only voice is that vicariously assumed for them by their grandmother.

Other residents: The extent to which they see their interests as being in common with Janet Knitschke’s could be critical in respect of getting an outcome that would be to their advantage. While insufficient information is available to ascribe a role to them definitively, they are most likely to share the resident victim’s egalitarian orientation.

The journalist: How the story came to the attention of Valerie Jones we don’t know from the account, but she clearly identified a local interest angle, as the story was on page 5 of a substantial weekly newspaper and was accompanied by a color photo showing Janet Knitschke at her damaged property. She is closest to the hermit role, by showing insight and compassion in reporting the story.

Parents of children at the school: As with the other residents, the extent to which sufficient of their number see their interests as being in common with Janet Knitschke’s could be critical in respect of getting the outcome that she is seeking. Insufficient information precludes definitive role assignment.

Other drivers: It may be assumed that unless something that other drivers using this road will notice in their environment changes, then their behavior will not change and that in this role they will also be individualists. While the council’s speed awareness trailer might have an impact, it is presumably in demand in many places, so that its use in one location precludes its use in all other locations. Deployment of this trailer is a political decision, perhaps dependent upon the strength of arguments of local councilors and city council traffic officers.

2.2.3.3 Illustrative interventions
This approach to conceptualizing risk is reflected in attitudes and behaviors of broad social groupings and the theory can make few if any specific predictions in respect of workplace hazards. The hierarchy is best represented by large corporations and governments, which
seek to plan and control workplace agendas and the political and economic environment in which production occurs and hazards are created. Individualists are driven by desire to be free to exploit resources of all types — human, capital, and natural, for example, in pursuit of entrepreneurial activity. Through appropriate political processes the agendas of these two groups usually reach some mutual accommodation as to a large extent each relies upon the other for its existence — entrepreneurs require market systems for trading, and governments need traders to supply the economy that is their political lifeline.

The groups on the other diagonal represent external challenges to the established order. While Greenpeace represents a well-known moderate face of egalitarianism, the extent of demonstrations and violent disruptions at global trade talks since the late 1990s may be a harbinger of a more militant challenge. To members of this group, greater trade globalization threatens their core egalitarian values because it is perceived as the haves increasingly benefiting at the expense of the have-nots. However, threats from isolate groups increasingly achieve headline status and terrorism risk has been amplified through media and political commentary, at least in part to serve controlling interests of powerful parties. What greater symbolism could there be in opposition to the hegemony of international markets, than the destruction of the physical fabric of the World Trade Center in New York by a small group of isolates using machines developed as critical adjuncts to capitalist trade? Repeated instances of such events as occurred on September 11, 2001, have the potential to destabilize markets, disrupt trade, and challenge the current economic order.

2.2.3.4 Further comments on cultural theory
Tansey (2004a) anchors the work of Douglas and other CT theorists in a century of sociological thinking, criticizing commentaries that have taken cultural theory out of context (Boholm, 1996; Sjöberg, 1997, 1998a; Rosa, 1998). Tansey pointed out that ontological differences exist between two approaches to social theories of risk. The first is agent-centered, derived from rational utility approaches that focus upon individuals using heuristics to make cost/benefit calculations of different actions. Here individual rationality is fixed and social production of safety is subject to traditional scientific method. In contrast, sociocultural approaches emphasize social context, institution, and culture as exerting the strongest influence upon risk perception (RP) and social action. Such approaches recognize that societies cannot function efficiently and that risk issues are bound up with constant conflict over the legitimacy of power relations. Cultural theory can be used to explore this framework.

While not without its shortcomings, for example, its low explanatory value for observable phenomena (Bloor, 1995; Bellaby, 1999), CT can contribute to understanding why risk is special in human experience and the roles it can play in the micro-politics of human relations. Douglas considered risk to be inherently political and to be concerned with issues such as holding people accountable, blame, and fortune. Part of the power of cultural theory is that it can characterize key social groups and their attitudes and values in respect of a wide range of issues. When extreme representations of these values translate into behaviors that can threaten the established order, then hierarchies may begin to understand that their worldview is very different from those of other groups.

2.2.4 Psychometric

2.2.4.1 Describing the psychometric paradigm
Arising partly out of their critique of Starr’s (1969) revealed preference (quasi-economic) approach to risk, the psychometric (expressed preference) paradigm is most associated with the Centre for Decision Research in Eugene, Oregon — see for example, Fischhoff et al. (1978, 1981), Slovic (1992, 2000), and Slovic et al. (1979, 1986). Basic tenets of
this approach are that situations produce RP, RP dimensions can be measured, and that RP is a subjective cognitive (within the head) phenomenon — for both experts and lay people. Siegrist et al. (2005) declared the psychometric approach to be the most influential model in the field of risk analysis. An early and consistent finding is that perceptions of experts and lay people differ on several risk dimensions. Any risk, including social risks, can be included within the psychometric paradigm — and ratings for any risk, including imaginary ones, can be constructed. To Starr’s key risk acceptance mediator of voluntariness, the psychometric approach added several more, including familiarity, novelty, degree of control, chronic-catastrophic potential, immediacy of effect, severity of consequences, equity, trust, and level of knowledge to self and to science. Every hazard has a unique risk profile on these dimensions, many of which are highly intercorrelated (e.g., voluntary, controllable, and well known). However, perceived risk is neither correlated with perceived benefits nor with voluntariness, but with dread and severity of consequences (Fischhoff et al., 1978). While the psychometric model emphasizes novelty and dread as primary dimensions, later work stressed affect as a determinant of perceived risk (Loewenstein et al., 2001).

Psychometric researchers also developed ideas from prospect theory by considering heuristics and biases used by lay people in estimating risks, such as availability, overconfidence, and desire for certainty (Slovic et al., 1979). These biases resulted in some risks being underestimated and others being overestimated. For example, while disease takes 15 times as many lives as do traumatic fatal events (accidents), the public perceives them to be of roughly equal likelihood. In considering the typical methodology used within prospect theory, Slovic et al. (1982) and Slovic (1986) noted that asking people about their value for risk is problematic because they can give conflicting accounts, depending upon question framing. Summary Text 2.3 is a dramatized illustration of the framing bias. As one means to overcome this methodological bias, Slovic and colleagues argued for multiple methods (triangulation).

The methodology is questionnaire based and uses factor analysis as the prime statistical technique to derive primary and secondary RP dimensions. A fundamental assumption is that RP is multidimensional and can be measured by scales that reflect risk characteristics that are important in shaping RP (McDaniels et al., 1995). Otway (1992) observed, “perhaps the only time that nothing but risk is being ‘perceived’ is when respondents are filling out a risk perception questionnaire” (p. 223). One consistent finding is of two main dimensions — labeled variously as unknown risk, and dread — and up to nine sub-dimensions. However, the number of dimensions differs between studies, and so there is no universal psychometric model as yet. Otway (1992) suggested that cognitive dimensions of risk are not innate structures but artifacts used to represent data, which vary depending upon the methodology used to construct them. The psychometric model does not make predictions or attempt to explain why people experience risk in these dimensions. Events with high signal value, or signal potential, such as Three Mile Island (TMI) are high on both unknown risk and dread dimensions. This approach measures attitudes, perceptions, and affect in relation to risks, but not risk-related behaviors. Numerous risks have been studied using this approach, including radiation (Slovic, 1996), adolescent smoking (Slovic, 1998), drug use (Slovic, 2000), railroad hazards (Kraus & Slovic, 1988), food hazards (Sparks & Shepherd, 1994), and nuclear waste (Slovic et al., 1991). The psychometric approach has been used for different purposes, including evaluating risk communication about electromagnetic fields (MacGregor et al., 1994), studying differences between genders and races (Flynn et al., 1994), assessment of skill (Greening & Chandler, 1997), and demographic influences (Savage, 1993).

While some psychometric studies have apparently demonstrated that the public does not have a particularly adequate representation of different risks (Lichtenstein et al., 1978), Elvik and Bjornskau’s (2005) summary of ten studies, including Lichtenstein et al. (1978)
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Summary Text 2.3 An Example of Framing

Sir Bernard Woolley recalls. . . He asked me to drop in on him in the Cabinet Office, to discuss the situation. He was most interested in the party opinion poll, which I had seen as an insuperable obstacle to changing the Prime Minister’s mind.

His solution was simple: have another opinion poll done, one that would show that the voters were against bringing back National Service.

I was somewhat naïf in those days. I did not understand how the voters could be both for it and against it. Dear old Humphrey showed me how it’s done.

The secret is that when the Man In The Street is approached by a nice attractive young lady with a clipboard he is asked a series of questions. Naturally the Man In The Street wants to make a good impression and doesn’t want to make a fool of himself. So the market researcher asks questions designed to elicit consistent answers.

Humphrey demonstrated the system on me. “Mr Woolley, are you worried about the rise in crime among teenagers?”

“Yes,” I said.

“Do you think there is a lack of discipline and vigorous training in our Comprehensive Schools?”

“Yes.”

“Do you think young people welcome some structure and leadership in their lives?”

“Yes.”

“Do they respond to a challenge?”

“Yes.”

“Might you be in favour of reintroducing National Service?”

“Yes.”

Well, naturally I said yes. One could hardly have said anything else without looking inconsistent. Then what happens is that the Opinion Poll publishes only the last question and answer.

Of course, the reputable polls didn’t conduct themselves like that. But there weren’t too many of those. Humphrey suggested that we commission a new survey, not for the Party but for the Ministry of Defence. We did so. He invented the questions there and then:

“Mr Woolley, are you worried about the danger of war?”

“Yes,” I said, quite honestly.

“Are you unhappy about the growth of armaments?”

“Yes.”

“Do you think there’s a danger in giving young people guns and teaching them how to kill?”

“Yes.”

“Do you think it wrong to force people to take up arms against their will?”

“Yes.”

“Would you oppose the reintroduction of National Service?”

I’d said “Yes” before I’d even realized it, d’you see?

Humphrey was crowing with delight. “You see Bernard,” he said to me, “you’re the perfect Balanced Sample.”
found that, even if absolute numbers of fatalities are not always correctly perceived, public
perceptions of differences in fatality risk between different modes of transport are broadly
correct. An important factor is how the scales measuring both estimated risk and per-
ceived risk, are constructed. Elvik and Bjørnskau’s study, which found a strong positive
correlation between perceived and actual differences in fatality risk between modes of
transport, strongly supported this general finding. They also found that, more than older
drivers, younger drivers perceived their higher crash risk relatively accurately, while older
male drivers were less likely than were older female drivers to accurately perceive their
higher crash risk — a finding supporting Andersson (2005).

While cultural theorists perceive a substantial difference between their approach and
the psychometric paradigm, Slovic (1992) considered the psychometric model to be a vari-
ant of the broad social approach to risk. As with other social approaches, Slovic (2000)
acknowledged that risk is socially constructed and that worldviews of experts and lay
people are instrumental in determining individuals’ responses to risk (see also Buss et al.,
noted, “perceptions of risk… within the psychometric paradigm may have their roots in
social and cultural factors” (p. 190). Among several papers considering the divergence
between expert and lay perceptions of risk, Kraus et al. (1992) noted that lay people’s intu-
itive toxicology tends to be consistent with their political views and that scientists’ risk
assessment methodology is viewed with suspicion by the public.

2.2.4.2 Risk management and the psychometric approach

In analyzing risk perception demographically using the psychometric approach Slovic
(2000) considered that RP appears to be associated with individuals’ power to influence
decisions about hazards and that defining risk is an exercise in power. While cultural theory
would ascribe such power to individuals as accruing through their institutional roles, the
focus of the psychometric paradigm is at individual or aggregate demographic level. Thus,
Slovic reported that about 30% of white males perceive all risks to be very small and that this
subgroup accounts for the gender differences found in several studies (see also Gustafson,
are more involved in creating, managing, controlling and benefiting from technology and
other activities that are hazardous” (p. xxxiv). Slovic (1997) noted that judging risks to be
small, which is characteristic of white males, tends to be associated with a constellation of
conservative values, including being disinclined to share decisions more democratically.
Slovic considered this to be evidence of a socio-political explanation — relating to power,
status, and trust, rather than being biologically based. A recurring message in the psycho-
metric literature is how to involve the public in risk decision making (Fischhoff et al., 1979;
Slovic, 1993, 1997), a theme common to some other approaches to risk.

The psychometric approach has contributed to understanding how policy makers
weigh risks and benefits of a range of decisions and the amount of intuition in such policy
making, as well as the role of cognitive biases (see Chapter 3). Psychometric research-
ers have critiqued the economic approach to valuing life (Slovic et al., 1976), and have
challenged some of the assumptions of expected utility theory (Slovic et al., 1977). They
have also described some of the limitations of traditional risk assessment, such as extrapolating inappropriately from dose–response relationships in animal studies, failure to estimate synergistic effects (e.g., chemicals and workplace stressors), and not accounting for particularly sensitive individuals in calculating exposure limits (Slovic, 1986). Slovic (1997) noted, “the public’s reactions to risk...can be attributed to a sensitivity to technical, social and psychological qualities of hazards that are not well-modeled in technical risk assessments” (p. 279). Slovic (1997) identified nine ways of expressing mortality risk, observing that the one selected by a risk assessor (i.e., framing) can make a risk appear to be larger or smaller. Psychometric researchers have also indicated how to improve the reliability of technical methodologies, for example, by including a greater range of items in fault tree analysis, de-biasing decision makers through warning about potential problems, and decomposing hazard scenarios into component events to improve estimates of individual event probabilities (Slovic et al., 1976). A psychometric approach has also been used to categorize technological hazards (Hohenemser et al., 1983).

2.2.4.3 Illustrative interventions
Because of the psychometric paradigm’s cognitive approach, behavioral interventions are primarily inferred through insights gained through survey or experimental work. One example is Slovic et al. (1978) who considered the problem of persuading motorists to wear seat-belts in the era prior to widespread seat-belt legislation. They pointed to conflicting perceptions between public policy officials (experts), who see the total road injury picture in statistical terms, and the driving public, who consider only their own likelihood of being killed or injured in a crash. The solution was to seek to change public perceptions so that drivers could be encouraged to consider their injury–crash risk over the whole of their driving lifetime, rather than the very low perceived probably of injury during any given trip — which was reinforced after each experience of a crash-free trip (see also Kunreuther, 1992). That this risk issue is less straightforward than appears here will be revisited when the approach to risk through behavioral adaptation is addressed. One implication of this approach is that it is possible to change risk perceptions by seeking to adjust people’s perceptions of the location of a hazard on one or more risk dimensions — for example, by appropriate risk communication.

2.2.4.4 Further comments on the psychometric approach
While a psychometric approach could be used to determine relevant attitudes or perceptions of a particular group — for example, of workers or consumers to a particular set of hazards, its ability to explain phenomena at any other level of analysis is circumscribed by its conceptual basis and methodology. Siegrist et al. (2005) suggested that a stable structure exists that can describe individual differences in RP as well as hazard dimensions. While it might serve as an adjunct to understanding specific cases in respect of hazards in particular workplace environments, robust decision making in respect of hazard control would need to be based upon additional criteria, including systematic hazard assessments, as well as social and cultural factors.

While like the other first-order approaches to conceptualizing risk the psychometric approach is circumscribed by its methodology, it is also comprehensively and systematically defined. The amount of recycled material in later papers may indicate that the psychometric approach is approaching the limits of its contribution to the risk debate — a suggestion also made by Otway (1992). While it has increasingly acknowledged a social context, it remains essentially two-dimensional (Glendon, 1987), although multilevel modeling (Langford et al., 1999) and three-dimensional analyses (Siegrist et al., 2005) can be used to expand the scope of the psychometric paradigm. After some 30 years of detailed
empirical research and theory development, as a result of influences from cultural theory, the psychometric paradigm appears to be moving closer to social approaches, as well as developing links with the socio-emotional framework (see Section 2.3.2).

2.3 Expanded/developed approaches to risk

2.3.1 Social constructionism

2.3.1.1 Describing the social constructionist approach
To an extent this approach is common to all social conceptualizations of risk, which share the central notion that rather than being an objective entity capable of quantification and measurement risk is a socially constructed phenomenon. Klinke and Renn (2002) identified realism vs. constructionism as one of five controversial issues in risk management. The social constructionist approach informs and is closely associated with the social amplification of risk framework (see Section 2.3.2). Cultural theory may be seen as a prototypical form of social constructionism. Insofar as it acknowledges a social basis for the phenomena that it studies, the psychometric paradigm genuflects to this approach. Social constructionism considers risk to be continually created, re-created, and constructed — see, Johnson and Covello (1987), McKenna (2001), and Walters and Frick (2000). The risk context is complex, nonlinear, and organizational. Because it is based upon perceptions and assumptions, risk is viewed as being unavailable to full rational or objective analysis. Thus, risk assessments constitute mental constructions, and can only be valid with the framework of the social group performing them (Klinke & Renn, 2002). While for many technical experts, the constructivist position seems absurd, constructionists regard the realists position as naïve or imperialist (Klinke & Renn, 2002).

Tansey (2004b) described the social constructionist position as one extreme of the social action continuum, which suggests that life is unconsciously scripted by external social structures. At the other extreme, the individual is considered to be sovereign and social life is the aggregate of individual attitudes and values. This end of the continuum would be more characteristic of the psychometric, basic risk perception model, or individual differences approaches (see Section 2.3.3). The neo-Durkheimian tradition, from which cultural theory (CT) springs, considers both extremes to be problematic (Tansey, 2004b).

2.3.1.2 Risk management and the social constructionist approach
Risk management implications of this approach involve recognizing the nonlinearity and nonrationality of risk, as well as the complexity of decision making and a political requirement to negotiate reality. However, acknowledging that workplace risk is a constructed phenomenon might appear incongruous or even insulting to workers who face real hazards in their daily work, which renders problematic incorporating tenets of this approach into risk management as commonly practiced. As with cultural theory, while social constructionism may have its attractions as a theoretical position, its use as a basis for practical guidance on workplace H&S issues is problematic.

2.3.1.3 Illustrative interventions
In contributing to understanding workplace H&S, this approach might encourage parties within a workplace to appreciate how risk, culture, economics, political structures, and other key elements of the other’s environment shape their approach to hazards and to potential approaches to safety interventions. How hazards are conceptualized from another’s perspective can be better appreciated by going beneath the surface and probing basic assumptions and perceptions. This points to a pluralist agenda acknowledging that within
a workplace parties’ interests may differ and that cultural processes guiding attitudes and behavior are critical to the context in which H&S can be improved.

2.3.2 Social amplification of risk framework

2.3.2.1 Describing the social amplification of risk framework (SARF)

This approach, which along with cultural theory and social constructionism, is the third of the trio of mainstream social approaches to risk that considers risk to be a social construct and as a property of a hazard or event (Kasperson et al., 1988; Kasperson, 1992; Renn et al., 1992; Kasperson & Kasperson, 1996; Pidgeon et al., 2003). As components of a dynamic process, initial risk notions and ideas percolate through society to have second and subsequent order impacts, or ripple effects. It posits that people and organizations can act like amplifier stations for risk messages that will ripple through society and have different effects — including economic, judicial, and social. The SARF provides a basis for understanding interplays between the domains of science, politics, economics, the media, and social attitudes toward relative risks and benefits associated with a wide variety of issues. In classifying perspectives on risk, Renn (1992) identified SARF as the approach that could integrate all others recognized at that time.

Typical of social models of risk, a starting point for SARF is to critique both the technical and economic approaches, Kasperson (1992) indicating that SARF grew out of a desire and demand for expanded approaches to risk. The technical approach was considered to be too limited by focusing only upon probability and magnitude dimensions, Kasperson asserting that conceptualization of risk must be more complex than this. Kasperson et al. (1988) stated that, “Risk is a bell-wether in social decisions about technologies” (p. 178). They maintained that traditional economic approaches such as CBA and risk–benefit analysis ignored higher order impacts of technologies, thereby greatly underestimating the variety of adverse effects on risk events. These authors described the approach thus — “The social structures and processes of risk experience, the resulting repercussions on individual and group perceptions, and the effects of these responses on community, society and economy compose a general phenomenon that we term the social amplification of risk;” so that “social amplification provides a corrective mechanism by which society acts to bring the technical assessment of risk more in line with a fuller determination of risk” (p. 179, original italics). Kasperson (1992) described it thus: “The concept of social amplification of risk is based on the thesis that events pertaining to hazards interact with psychological, social, institutional, and cultural processes in ways that can heighten or attenuate perceptions of risk and shape risk behavior” (pp. 157–158).

The two main stages in risk amplification are (1) transfer of information about risk, and (2) social response mechanisms. Factors affecting social amplification include the volume of information, the degree to which information is disputed, the extent of dramatization, and symbolic connotations of the information (Kasperson et al., 1988). The social amplification phenomenon can act both to amplify and to attenuate risks — in cultural theory an analogous process may be manipulation by group leaders as part of the context within which group members appraise risks. An example of the social amplification effect is TMI, an incident in which no one died, yet which changed irrevocably attitudes toward and the face of nuclear technology in the United States and elsewhere. Repercussions of the TMI incident included stricter regulations for nuclear technology, considerable public opposition to nuclear power, reduced global operation of nuclear power plants, and less directly, to increased public concern about other complex technologies, such as chemical processing and genetic engineering, which could even be quantified through psychometric methodology. At the
other extreme is the social attenuation effect, also identified in psychometric studies, in which everyday risks, such as indoor radon, smoking, driving without seat belts, or carcinogens in food, are underestimated. While risk attenuation may be functional to the extent that it helps people to cope with the multitude of risks that they might encounter, it also results in under-response to such risks. A task for SARF is to explain or predict why certain risks are amplified or attenuated. Psychometric methodology could assist.

Agents of amplification or attenuation include scientists, risk management institutions, media, activist organizations, opinion leaders, peer and reference groups, social networks, and public agencies. Examples of research using SARF include Beedie and Bourne (2005), who provided an illustration of the social amplification of risk via the media and its role in the development of a blame culture. Hill (2001) used examples of moral panic and media violence to show how the media, politicians, and antiviolence campaign groups become social amplification stations that manipulate risk events to control information flows to meet their aim of creating a safer moral environment. Bennett (2005) used Kasperson’s (1992) risk amplification framework and Peters’ (1999) research into scientists’ interactions with journalists to explore the relationship between the paper’s author and a journalist. Bennett concluded that the journalist and the scientist acted as amplification stations and that the journalist’s representation of the research (Bennett, 2003) involved selectivity and construction — as did the scientist’s research.

2.3.2.2 Risk management and the social amplification framework

Within SARF, Pidgeon et al. (2003) distinguished between risk management and risk issue management. Both amplification and attenuation effects serve to confound conventional risk analysis. Risk management occurs for both individuals and organizations as agents managing the risks in their respective environments. For individuals, managing risk involves inter alia, signal filtering and decoding, information processing, and attaching social values to information. As in cultural theory, interactions take place within the social and cultural group to interpret and validate signals, formulate appropriate behavioral intentions, and engage in group actions to accept, ignore, tolerate, or change the risk (Kasperson et al., 1988). Interpersonal exchange can enhance individuals’ risk cognitions and act so as to exclude conflicting information. Four major risk response pathways are proposed: heuristics and values — to simplify risk evaluation and shape responses; social group relationships — to influence member responses, and perhaps to polarize views; signal value — which if high could trigger higher order impacts; stigmatization — which could create aversion to certain environments.

For organizations, risk management implications of this approach include that risk constructs can be amplified by organizations, government, media, and other agencies, for example, by selectively releasing scientific or other information. Because it involves learning and social interaction associated with risk experiences, risk management must take account of this dynamic quality. High information volume can mobilize latent fears about a risk, an effect that can generalize to similar events or products. Debates among experts can heighten public alarm about facts relating to a risk, raise concerns as to whether hazards are really understood, and decrease official spokespersons’ credibility. Because media reports tend to focus on dramatic events, media coverage can increase the dramatization associated with particular risks. Kasperson et al. (1988) identified impacts of the social amplification of risk upon organizations as including business and financial losses, regulatory constraints, organizational changes, litigation, increase (or decrease) in physical risk, sabotage or terrorism, and loss of public confidence. Examples of events with potentially high signal value include scientific disputes over the validity of epidemiological studies — as occurred over the MMR triple vaccine — which can indicate to the public that the experts
do not understand the risks and the resignation and successful prosecution of corporate senior executives, which could indicate that they cannot be trusted and that risks are being concealed — as has happened in several notorious corporate scandals and collapses.

Analogous with hazard classification according to individual or group risk perceptions in the psychometric approach SARF researchers have modeled a 128-hazard database described by Kasperson (1992), who identified the seven major categories given below:

1. Biocidal hazards, producing traumatic injury, death, or serious health impacts
2. Persistent delay hazards, which are toxic and have serious health effects
3. Rare catastrophes, which include airplane crashes and building collapses
4. Life-threatening common killers, including smoking and road vehicle crashes
5. Global diffuse hazards, which include ozone depletion and global warming
6. Natural hazards, including flood, drought, earthquakes, and tsunamis
7. Radiological hazards

Kasperson (1992) developed a causal model to show the social amplification process involving physical consequences, risk perception, media coverage, social impacts and public responses, as well as summarizing SARF empirical and theoretical studies to that date.

2.3.2.3 Illustrative interventions

Targeted use of scientific information is increasingly important in the workplace and other domains — for example, epidemiological evidence on relative risk factors relating to a given disease, or the safe level of exposure to a substance. However, while scientific principles and research may be held as paramount criteria for judging the relative degree of hazard or safety of a given course of action, science always occurs within a social and political framework and like all aspects of society is driven largely by the agendas of those controlling this framework. There is iteration between social needs, as promoted by powerful pressure groups, and scientific endeavor, for example, updating information on workplace hazards and the likelihood and magnitude of their potential impact upon the interests of management, workers, and other parties.

Marsden and Attia (2005) considered the role of the media in amplifying terrorism risk, which they referred to as media contagion, by providing publicity for suicide bombings (see Nacos, 2002; Gould et al., 2003). Noting the absence of current media guidelines for reporting suicide attacks, they argued for extending accepted media guidelines for reporting suicides to cover suicide bombing. These include no extensive or repetitive reporting, eschewing sensational headlines that focus on events as suicide bombings, avoiding simplistic explanations, not providing how to descriptions, not presenting suicide bombing as a tool to accomplish certain ends, not glorifying suicide bombing nor its perpetrators, and not focusing on perpetrators’ positive characteristics. Etzersdorfer and Sonneck (1998) noted that when applied to suicide deaths on the Vienna subway system, these recommendations resulted in an 80% decrease in such deaths. Marsden and Attia noted that within the context of a highly fragmented, globalized, and politicized media, it would be naive to believe that such guidelines would be universally applied. However, where there is political will and editorial ability they argue the case for trialing such guidelines.

2.3.2.4 Criticisms of SARF

Rip (1988) criticized the lack of sociological analysis in the original presentation of the SARF, arguing that it was largely based on individual responses to risk signals and that it failed to take account of social aggregation processes. Rip suggested including reinvention of hazard signals by organizations. In a later representation of SARF, Kasperson (1992) included micro- and macro-levels as part of the risk amplification process.
While considering that the SARF may be perfectly valid, af Wåhlberg (2001) argued that it is not possible to falsify the SARF, nor is there anything in SARF that could generate a hypothesis that would predict any particular outcome. He noted that, “the vagueness of social amplification is its most outstanding feature” (p. 242). Rip (1988) noted that many of the terms used in SARF are exchangeable, af Wåhlberg observing that within the SARF a reaction can go either way (be amplified or attenuated) at any magnitude so that the model cannot predict anything. af Wåhlberg considered that SARF has many redundant features — for example, signal value is a circular construct and has no use as a theoretical tool. “How do we explain the strong reaction of the public to a phenomenon? By saying that the phenomenon has strong signal value. How do we know that a phenomenon has high signal value? By the reaction from the public. Until a way of measuring signal value is proposed that does not involve people’s reactions, the concept is circular, useless, and redundant” (af Wåhlberg, 2001, p. 244).

2.3.3 Individual differences

2.3.3.1 Individual differences and risk-taking behaviors

This approach, inter alia, suggests that, as with personality traits or dimensions (see Chapter 5), individuals differ in their risk-taking/thrill-seeking propensity (Zuckerman, 1979; Wilde, 1994, 2001). Sensation seeking (SS), age, and gender are among the main individual difference variables to be studied in respect of risk-taking behavior. The personality trait of SS is characterized by the extent to which an individual seeks out novelty and intensity of experience (Arnett, 1994). Zuckerman (1979) suggested that some people have a physiological need for heightened arousal, which drives them to seek ways of increasing their degree of stimulation. Actual behavior may be studied, but more often reported behavior and risk attitudes are measured. The methodology includes questionnaires, for example, to study reported behavior, experiments to test hypotheses, and more rarely, field studies to observe actual behavior.

Some researchers (Yates, 1990, 1992; Yates & Stone, 1992) have treated risk taking as a purely cognitive rational decision problem involving identifying, storing, and retrieving risk information. Possible gains from risk taking as well as emotional aspects have been ignored by many researchers, as is how expectations about the future affect present decisions. Trimpop (1994) argued for adding emotions, an optimal level of arousal, and preconscious appraisals to cognition to explain risk motivation.

Buck’s (1980, 1985) prime theory stressed the importance of emotions in motivating behaviors. If, “applied to . . . risk taking behavior, prime theory would suggest that the initial stimulus is already experienced on a basic physiological–emotional level, and leads to autonomous, automatic bodily responses” (Trimpop, 1994, p. 142). It can also account for differences between risk seekers and risk avoiders in response to stimuli, because subjective emotion conditioning determines whether either risk-seeking or risk-avoiding behavior will be engaged. Frijda (1986, 1988) developed nine “laws of emotion” to account for ways in which people automatically respond to events and to explain the influence that emotions have on people’s behavior. Trimpop maintained that these should be moderated by individual differences.

Mastering dangerous and difficult tasks is a motivator for risk taking that is partly considered in achievement motivation (need for achievement, or n-Ach). Risk seekers and risk avoiders are differently motivated, both intrinsically and extrinsically. Dweck and Leggett (1988) proposed that individual differences were reflected in helpless and mastery cognition-affect-behavior patterns. Mastery-oriented people are similar to high n-Ach individuals, sensation seekers, and those desiring personal control. Individuals displaying the helpless pattern tend to strive for activity-oriented goals and are risk avoiders.
Piët (1987) provided the example of stuntmen seeking mastery and control by overcoming danger and challenge.

Locus of control (LoC), originally conceived by Rotter (1966), has generated a number of scales adapted for particular behaviors including health outcomes (Calnan, 1988; Schank & Lawrence, 1993), safety (Jones & Wuebker, 1993), risk (Rohrmann, 2002), and driving (Montag & Comrey, 1987). Montag and Comrey found driving internality to be negatively related, and driving externality to be positively related to involvement in fatal injury crashes. Trimpop (1994) noted that, “With the desire for risk taking counterbalanced with the desire for mastery and control, people seem to be involved in a constant readjustment and adaptation process” (p. 179).

Partly because it provides perhaps the greatest opportunities for displaying behavioral variation among everyday activities for a large proportion of the population, driving has been a prime area of field research into individual differences, as well as experimental work into individual differences in risk taking. Gender differences have consistently been found to be associated with driving violations (Groeger & Brown, 1989; Parker et al., 1992a), unsafe driving behaviors, speeding and dangerous thought patterns (Harré et al., 1996), vehicle headway distances (Evans & Wasielewski, 1983), and attitudes toward speeding outcomes (Parker et al., 1992a), with males consistently demonstrating more risky attitudes and behaviors in respect of driving (Clément & Jonah, 1984; Groeger & Brown, 1989; Jonah, 1997; Begg & Langley, 2001; Boyce & Geller, 2001; Jonah et al., 2001). Yagil (1998) found that more than men, women believed that traffic laws should be obeyed and that women were more willing to accept the legitimacy of road rules and to abdicate personal decision making, for example, in respect of exceeding signed speed limits. In reviewing links between SS and risky driving, Jonah (1997) noted that SS had consistently been found to be higher in males than in females, while for both sexes, SS increased until around age 16 before subsequently declining with age. However, independently of age, sex, or driving experience, Parker et al. (1995) and West et al. (1991) found that self-reported lack of thoroughness in decision making was associated with increased driving crash risk, which was partly mediated by faster driving speed. This suggested that decision making is an individual variable and its role in risk behaviors requires further study beyond cognitive biases that are assumed to be universal (see Chapter 3).

The relationship between SS and risky driving has been studied since the 1970s. Arnett (1994) observed that driving provides a SS thrill for some individuals, while Zuckerman (1979) suggested that high-sensation seekers could drive riskily to achieve optimal personal arousal, while low-sensation seekers attempted to lower their level of arousal and avoid driving (and other) risks as much as possible. There is evidence for a relationship between SS and risky driving, including a preference for fast driving (Zuckerman & Neeb, 1980; Clément & Jonah, 1984), close following, and driving less carefully (Heino et al., 1996). Compared with sensation avoiders, sensation seekers appear to be involved in more vehicle crashes — for example, Heino et al. (1996) finding that the proportion of sensation seekers that had been involved in at least one crash (57%) was more than twice as high as the proportion of crash-involved sensation avoiders (24%). There is also evidence that SS moderates the way in which drivers respond to perceived risk (Jonah, 1997). Age and gender are major sources of variance in SS, with males and younger individuals being higher in SS than females and older people are (Heino et al., 1996; Zuckerman & Neeb, 1980). This topic is explored further in Chapter 5.

Trimpop summarized evidence for a genetic influence on risk-taking behavior — for example, Fulker et al. (1980) found that SS was related to risk taking (Zuckerman, 1979) with a heritability coefficient of 58%. Zuckerman (1994) argued that certain monoamine neurotransmitters underlie individual differences in SS. For example, dopamine is involved in motivation to explore the environment, providing positive arousal and reward associated
with novel and intense stimulation. Similarly, norepinephrine provides arousal associated with novel stimuli and amplifies reactions to them, while serotonin inhibits behavior if potential threats are encountered. The enzyme monoamine oxidase (MAO), levels of which are partly genetically determined, is involved in regulating these transmitters, and in several studies has been found to be consistently lower in high-SS individuals than in low-SS individuals (Zuckerman, 1994; Jonah, 1997). Zuckerman found that compared with low sensation seekers, high sensation seekers also have lower levels of norepinephrine — suggesting that high sensation seekers require greater levels of arousal (e.g., through risk taking) to achieve the same level of production of this neurotransmitter.

2.3.3.2 Risk management and individual differences
Risk management implications include targeting subgroups (e.g., young male drivers) within a population to maximize the impact of risk communication or other intervention strategies.

2.3.3.3 Illustrative interventions
Mandatory safety features seek to protect risk seekers and risk avoiders alike — despite their different fundamental risk motivations. Risk seekers and risk avoiders are likely to seek out activities to match their respective motivations. Success for risk takers will reinforce their behavior as intrinsic reward. While errors or injuries are more likely to result from faulty risk assessment than from risk seeking, in applying this approach to workplace hazards affecting safety critical tasks, it could be useful to know the extent to which an individual can be characterized as a risk taker or as having a more cautious approach. There is an extensive literature on personality and accident involvement in both occupational and nonoccupational settings (see Clarke & Robertson, 2005; Chapter 5).

Jonah (1997) argued that the body of research literature on risky driving, SS, and biological differences suggests that risky driving, at least to some extent, is genetically determined. He suggested that if high-SS drivers can be reliably identified, then certain prevention measures could be implemented to reduce the incidence of risky driving. One option would be for a screening measure that could reliably identify high-sensation seekers applying for a driving license so that individuals in this group could be required to complete an educational program designed to deter them from using driving as an arousal mechanism. Jonah suggested that these people could be encouraged to seek sensation through voluntary pursuits such as risky sports, in which they are less likely to endanger others as a result of their risk-seeking behavior. Other measures could be used to identify high-risk drivers on the basis of personality characteristics known to be associated with collision risk, with educational programs again the recommended mechanism for seeking to change aggressive or otherwise risky behaviors associated with these characteristics.

2.3.4 Basic risk perception model

2.3.4.1 Describing the basic risk perception model (BRPM)
As the psychometric approach is most associated with Paul Slovic and his colleagues, cultural theory with Mary Douglas and others in the sociological/anthropological tradition, and the social amplification of risk framework with Roger Kasperson and his followers, so is what has been termed the basic risk perception model (BRPM) (af Wåhlberg, 2001) is particularly associated with Lennart Sjöberg. The BRPM incorporates and expands on psychometric dimensions and explains more variance in RP (Sjöberg & Drottz-Sjöberg, 1994). This extension of the psychometric approach (Sjöberg, 2000a, 2002a) incorporates features such as attitudes, fear, worry, risk sensitivity, trust, lifestyles, and worldviews
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(Sjöberg, 1992, 1993, 1995, 1996a, 1998a, 1998b), and moral values (Sjöberg & Drottz-Sjöberg, 1993). Sjöberg (2002b) regarded the psychometric model as insufficient for understanding risk perception and dimensions extracted using BRPM methodology appear to be more stable than those from the psychometric approach. The methodology is similar but BRPM studies tend to use larger and more representative samples and the individual is the response unit rather than response means as in the psychometric approach. Proponents of the BRPM argue that the psychometric model is weak when seeking to account for variations among individuals (Gardner & Gould, 1989; Sjöberg, 1996b, 2002b, 2004), the typical average figure of variance accounted for being in the order of 20%. For intra-individual variation among hazards, in contrast with variation among individuals for a given hazard, few published studies exist — exceptions include Marris et al. (1997) and Siegrist et al. (2005). Sjöberg (2002b) argued that the power of the psychometric approach is low or lower at the inter-individual level of analysis.

Sjöberg (2002b) found that worldviews, as suggested by Buss and Craik (1983), and general value dimensions systems were ineffectual in accounting for RP. Neither worldviews, nor CT, nor group/grid dimensions came out well in explaining RP from this study. Dake (1990) and Wildavsky and Dake (1990) reported stronger correlations than found by Sjöberg (2002b). Sjöberg (2003a) compared three distal approaches to risk perception, one of them being CT (Douglas & Wildavsky, 1982), using scales derived by Dake (Wildavsky & Dake, 1990). Sjöberg formed indices (three items for each) to measure six core CT concepts — hierarchy, egalitarianism, individualism, fatalism, group, and grid. From this survey, which was broadly representative of the Swedish population (N = 797, response rate 66.3%), Sjöberg (2003a) found that neither general nor personal risk ratings correlated strongly with worldviews and that CT was not supported. Peters and Slovic (1996) described their low correlations between CT scales and RP as strong. In the United States, similar scales have been found to account for 10% of explained variance, but only 5% in Europe (Sjöberg, 1997, 1998a; Brenot et al., 1998). Sjöberg (2003a) reviewed arguments over the most appropriate measure of effect size for such studies.

In a separate study, Sjöberg (2003a) measured four CT dimensions across the five Nordic countries and related to these the perceived risk of genetic engineering. The strongest relationship was between perceived risk and CT for low values of egalitarianism — a group of low egalitarians who were extremely low in perceived risk accounted for the relationship. Risk deniers (low-risk raters) were particularly low in egalitarianism, low in fatalism, and high in individualism. They tended to be male — as with Flynn et al. (1994), who found that white males tended to give low risk ratings across the board compared with other groups. Risk alerters (high-risk raters) were particularly high in egalitarianism, as well as being high in hierarchy and low in individualism. Egalitarianism most clearly related to perceived risk, and there were weak but consistent relationships between perceived risk and some other CT dimensions. Correlations between CT dimensions and perceived risk were largely due to a group of risk deniers (15% of respondents) and a smaller group of risk alerters.

Sjöberg (2003c) argued that antagonistic agents who create risks deliberately require new approaches to understanding risk perception. Addressing the risk of terrorism, Sjöberg (2005) investigated two dimensions — dread and new risk, using four classes of explanatory concepts (1) reasons for riskiness in the world in general; (2) characteristics of the perpetrators of 9/11; (3) reasons for and interpretations of the events; (4) personality — tendency to suspicion. Perceived risks were personal and general (Sjöberg, 2003b). As did Fischhoff et al. (2003), Sjöberg (2005) found a clear difference between personal and general risk — gender, age, and educational level were related to perceived risk, but none strongly nor consistently. Women gave higher risk ratings than men did, as did older respondents and those with a lower level of education. However, demographics only accounted for about 5% of the variance in perceived risk. Dread was strongly and consistently related to
perceived risk, but new risk was not. The best block of explanatory concepts was suspicious thought patterns and reasons for a risky world (i.e., cognitive factors), while background data and the psychometric model dimensions (dread and new risk) added less than 10% of explained variance. The large difference between personal and general risk suggested that people perceived a high degree of control (Harris, 1996). Up to 60% of RP of technology and environment risks can readily be explained (Sjöberg, 2000a, 2000b). Other possible factors include overall attitude, trust in those responsible for managing terrorism threats, and uncertainty as to how to assess those risks (Sjöberg, 2001).

2.3.4.2 Criticisms of the BRPM
Sjöberg’s critique of cultural theory (Sjöberg, 1997, 1998a) has been challenged (Slovic & Peters, 1998; Tansey & O’Riordan, 1999; Tansey, 2004a, 2004b), with Marris et al. (1998) among others claiming that CT is not intended to explain RP and that it is a misrepresentation of the cultural model to assume that it can. Tansey (2004b) pointed to a deep methodological disjuncture with respect to the use of questionnaires as a way of operationalizing cultural theory concepts. Some CT proponents consider that CT archetypes do not work well with this approach to RP and so high correlations are not to be expected. Reasons include weak attitude–behavior relationship (see Chapter 6 for further discussion of this topic), biases arising from power relations in survey implementation, generality of risks that people are required to rate, and the plethora of variables — irrespective of whether or not they are relevant to a respondent’s social context (Tansey, 2004b). The construct validity of survey items might also be an issue. Despite these potential limitations, Tansey (2004b) noted that 60% of Sjöberg’s (2003a) correlations are significant, indicating that the survey does reveal coarse differences in individual reactions to certain risks.

While questionnaires are one of a number of tools for data collection, analysis of survey data requires an inductive leap to speculate about causal pathways. Intensive qualitative methods could be used to follow up clusters of respondents, including focus groups, participant observation, and interviews, to reveal complexity of risk dimensions (Marris et al., 1997). A multi-method approach to focus on specific risks within specific social contexts would be more consistent with the anthropological tradition from which CT is derived and could reveal the extent to which RP is the product of the politics of a particular social context. Alternative approaches include qualitative case studies (Tansey & O’Riordan, 1999), improving measures of cultural bias (Peters & Slovic, 1996), or cross-cultural replications of Dake’s scales (Brenot et al., 1998).

Like the psychometric approach, the BRPM does not make predictions or attempt to explain why people experience risk in these dimensions. It is more political than the psychometric approach, but is subject to most of the same limitations. These include that it studies reported behavior (e.g., via questionnaires) not actual behavior, does not explain why risk is perceived in the way revealed, and mixes internal (to individuals) and external (environmental) factors (af Wåhlberg, 2001).

2.3.4.3 Risk management and the BRPM
Risk management implications of this approach include seeking to control risk by manipulation of broad agendas to influence risk discourses.

2.3.4.4 Illustrative interventions
Applying the BRPM to workplace hazards might offer opportunities for expanding psychometric assessment of parties’ risk perceptions to include other features of this approach. It might be used in conjunction with a social constructionist approach to aid understanding of another party’s position. For example, Sjöberg (2002c) cited an earlier study in which the
views of a sample of politicians on risk and its mitigation were compared with those of a sample of the general population. While perceptions of risk and risk mitigation priorities of the two groups were very similar, the politicians misperceived public risk perceptions, basing their mitigation priorities on their own RP rather than on what they believed the public’s RP to be. Sjöberg et al. (1998) observed that politicians had tripled their legislative initiatives on risk issues in the span of three decades. Reviewing the frequent finding that experts consistently rate risks about which they have some expertise lower than do the public, Sjöberg (1999b, 2002c) argued that responsibility rather than knowledge was the prime explanation as to why experts rated some risks as very low. This could parallel perceived control over risks at an individual level.

2.4 Meta-approaches to risk

2.4.1 Political

2.4.1.1 What constitutes a political approach to risk?

The political approach to risk probably has the greatest number of links with other models (Althaus, 2004, 2005). For example, Tansey (2004b) observed that social life is political at every level. One implication is that a unique mix of factors influences political risk in its various forms. In one sense this is probably the least well defined of the approaches considered in this chapter; no universal set of principles can readily be applied to describe it. The concept of political risk awaits definitive form. Political risk perception may be characterized by, inter alia, information overload, conflicting goals, values and constituencies, chronic fear of failure, and inappropriately attributing superhuman qualities to political agents.

Althaus (2004, 2005) characterized the political approach to risk as involving both risk identification and risk management components and as being at the confluence of risk models derived from other disciplines. Noting that the political science literature did not reflect risk as central to political theory or practice, Althaus distinguished an outside-in approach to political risk from an inside-out approach. The former considers political problems derived from technical, scientific, or natural origins as being externally imposed and deals with how they are handled politically. The alternative inside-out approach, reflecting respective descriptions by Sundakov and Yeabsley (1999) and Waring and Glendon (1998), characterizes all political activity as having potential for disaster or opportunity, so that political life is continually facing and managing uncertainty. Outside-in refers to the substance, and inside-out is concerned with processing political risk.

 Whilst maintaining that political risk has existed for some considerable time, Althaus (2004) attributed the absence of a clearly articulated position in political science debates as explaining why writers in the sociological (e.g., social constructionism) and anthropological (e.g., cultural theory) traditions have challenged political scientists to develop a political approach to risk. Althaus (2004, 2005) explained that political risk could be conceptualized in two ways. First as managing external threats, such as public health scares, global warming, genetic engineering, and natural disasters — the outside-in approach. The other approach is the process of how politicians assess and confront uncertainty — an inside-out perspective, including the criteria and institutions used by political actors to decide and assess polities and actions. This approach also involves distributing benefits within a community and incorporates a moral component involving individual and social concerns. Political risk is both power and policy focused. Althaus (2004) viewed political risk as, “the application of knowledge to uncertainty in an attempt to order the randomness of uncertainty and thus try to control it” (p. 93).
Political risk interfaces with technical risk. For example, Hiskes (1998) argued that the status of risk has been fundamentally transformed by the rise of modern technology and urged greater democratization through more deliberate participative risk politics. Hiskes considered risk to be an “emergent” phenomenon that is interconnected and collective in nature and not reducible beyond group level: “life in modern technological societies cannot be reduced solely to the actions or decisions of individual persons. Risk is the product of our lives together, and to fully understand risk’s emergent character is to realize that most of the efforts to either explain risk or cope with it within an individualistic political framework are doomed to failure because they do not acknowledge the “togetherness” of our risky present” (p. 13, original italics). Risk is elaborated as a political construct, involving conflicting interests and power relations that are inherent in many modern technological risk choices. With respect to risk, Hiskes (1998) considered political concepts of community and communal responsibility, consent, authority, rights, responsibility, identity, and political participation.

While in the technical approach to risk the role of science is not problematic, the political approach recognizes that science and policy differ in some crucially important ways. Regulatory activity is one of the main arenas in which risk politics is played out. Hellstrom and Jacob (2001) noted that policies for managing risks in environmental and public health areas are inseparable from how those risks are understood within a regulatory context. Scientific knowledge and methods help to define issues that are considered by risk policy makers, the questions that are asked, and the range of policy responses. In turn, regulatory policies within political and social contexts influence topics for scientific study, the frameworks adopted and how scientific uncertainties are investigated and presented. Noting that science mixes with political discourse in various ways, Hellstrom and Jacob argued for dissolving boundaries between science and policy. Althaus (2004) noted that while science provided risk problems only politics could offer solutions.

The economic approach to risk often appears adjacent to the political. For example, welfare economics — concerned with need and moral status, can be framed in terms of risk. Tait (2001) distinguished between interest-based and value-based responses to risk. Interest-based conflicts are restricted to specific issues, and can be resolved by providing specific information or compensation; value-based conflicts are rooted in normative beliefs and are more difficult to resolve. Interest-based motivations display economic or instrumental rationality (Hargreaves Heap et al., 1992). Tait (2001) associated canonical rationality with a hard science approach to risk analysis with the postmodern concept of plural rationality, which she considers as driving social science advances. In her analysis Tait conflates various social approaches to understanding risk, including social constructionism, post-structuralism, and the risk society approach — which she sees as sharing an emphasis on the knowledge claims of different lay and expert groups. However, others considered that the rational actor paradigm continued to dominate both hard and social science approaches to understanding and managing risk (Wynne, 1996; Jaeger et al., 2001; Horlick-Jones, 2003, 2004, 2005). Jaeger et al. (2001) reviewed scientific positions and theoretical approaches to risk. Furthermore Horlick-Jones (2005) found that the distinction between interest-based and value-based lay attitudes toward risk issues was problematic, as reasoning processes were more complicated than suggested by this model, arising from a wider framing of topics than typically used by technical experts, as determined through a focus groups study (see Peets et al., 2001).

Rifts and tensions between experts and lay people, identified and quantified through psychometric methodology, and further elaborated though SARP, can be explored further using a political framework. Horlick-Jones (2005) observed that lay groups tend to include a much wider range of considerations in their everyday rationality, which Molotch (2003) described in terms of busy brains simultaneously seeing in all directions because they are
hard-wired that way — providing a link with the evolutionary approach (see Section 2.4.4.1) and also human factors (see Chapter 4). Horlick-Jones (2005) noted that for protest groups, linked issues driven by moral outrage and a sense of unfairness could coalesce into a seemingly single instrumental risk issue — for example, anticipated noise from a proposed new road. Wynne (1992) considered that disagreements between experts and lay people over risk issues could be accounted for by differences in framing issues. Lay people evaluate the downside of risks through invoking a wide framing of topics that reflect personal experiences, local contextual issues and knowledge, which arise from interacting with others (Grove-White et al., 1997; Kerr et al., 1998; Irvin et al., 1999).

Horlick-Jones (2005) considered an important issue for study to be the various informal modes of reasoning that may inform people’s actions when engaging with risk issues. Understanding this sphere of interaction and associated micro-politics can help us to understand why risk is special to human experience and social relations, which also means that its evolutionary origins are likely to be critical. "The growth in importance of the technical discourse of risk in professional practice creates an increasing number of situations where the micro-politics of contingency overlaps with formal audit controls, so raising important questions about the informal character of risk reasoning by experts and lay people alike" (Horlick-Jones, 2005, p. 268). In arguing that risk issues bring out inherent aspects of social relations in certain forceful ways, Horlick-Jones (2005) maintained that the ambiguity inherent in social interactions creates conditions for a rich micro-politics, which cannot be explained by a risk society approach (Beck et al., 1994).

Within a broader social framework, Taylor-Gooby (1998) noted that political elements include, “static levels of upward social mobility among the bottom two income deciles and widening income and wealth inequalities in many societies. These forces change the ways in which the risks that concern social policy scholars are perceived both by those who are objectively most and by those who are least at risk, change the meaning and value of many people’s coping strategies, and change the political climate within which claims for collective programs to manage individual risk can be legitimated” (p. 305). The poorest people are likely to live in areas of greater environmental and technological risk and secure work with the greatest health and safety risk. Reflecting the social position of groups identified within cultural theory, Taylor-Gooby (1998) observed that, “qualitative work on savings, housing risk and over-the-counter drugs... suggest that in fact fatalism is a much more nuanced, intelligent and active style of coping than is sometimes suggested” (p. 306).

Terrorism is not a new threat to society and organizations, according to Shrivastava (2005) who described it as a form of war with roots in historical, economic, cultural, and ideological conflicts. Harm or vulnerability resulting from terrorism can be physical, economic, political, perceptual, or ecological, and can be widespread across individuals, organizations, and nations. Consequences can include deaths and injuries, economic/financial losses, environmental damage, psychological trauma, and disturbing media images (Atran, 2003). A crisis can be large scale in terms of damage, perceived loss of control, social breakdown, and need for protection. Shrivastava (2005) characterized key elements of terrorism crises in terms of preconditions, which can involve a variety of ideological, social, and economic triggers. Causes are often multiple and interacting, including structural conditions such as poverty and political repression often with cultural and religious influences. Terrorism is an organizational phenomenon involving financial networks, planned activities, global coordination, and communication. Its genesis can lie in failures of corporate, government, military, charity, and intelligence organizations. Individual factors may include psychological, stress, personal incentives, and complex motivations. Resolution requires understanding underlying conflicts, contestants’ positions, and interests. Kushner (2003) and O’Connor (2004) urged examination of political and other causes that terrorists
represent, while Nyatepe-Coo and Zeisler-Vralsted (2003), and Shrivastava (1993) noted that business organizations face special challenges. Business costs include security, business continuity, asset duplication, and dealing with uncertainty.

2.4.1.2 Risk management and the political approach

Horlick-Jones (2005) considered the lay–expert interface in the management of risk. Risk professionals may consider lay people as irrational in their views on risk issues, while lay people can become frustrated by experts’ apparently narrow and technical approach (Wynne, 1996; Horlick-Jones, 2004). However, both groups use, “emergent logical forms that reflect a range of situational considerations” (Horlick-Jones, 2005, p. 266). Horlick-Jones (2005) stressed that professionals’ risk reasoning has much in common with that of lay people, although each accounts for their reasoning and actions in different ways. The increasing technical discourse of risk in professional practice creates more situations where the micro-politics of contingency overlaps with technical audit controls and practices. “The rise of the “risk management society” (Horlick-Jones, 2003) may provide new resources with which agents can account for a diversity of practices” (Horlick-Jones, 2005, p. 269). In describing political risk management, one might be hard pushed to improve upon the long-established principle of politics being the art of the possible. The risk assessment inherent in all political decision making could characterize this as the application of practical wisdom to any set of circumstances.

At societal level, risk management is manifested through social policy, which is concerned with distributing certain risks, calculating probabilities of certain types of harm, and comparing alternative strategies for managing those risks for particular groups within the population (Taylor-Gooby, 1998). Social policy is concerned inter alia with risks associated with poverty, unemployment, disability, need for medical or social care, debt, homelessness, lack of insurance cover, divorce, family breakdown, delinquency, and crime victimization. Rather than using methodologies from other risk areas (e.g., technological), it is important to use more qualitative methodologies to probe people’s risk awareness, coping strategies, the extent to which they perceive personal responsibility to bear the risks and the extent to which they consider the taxpayer should assist. Research using interview and focus group data has compared public perceptions with actual incidence of risks such as family breakdown, unemployment, rent or mortgage arrears, need for long-term care, need to spend down savings or capital assets, and adverse side effects from over-the-counter pharmaceuticals. Because many people do not, or are unable to, plan ahead on the basis of actuarial likelihoods against such risks as inadequate retirement income or need for long-term care, assumptions about individual rationality in RP that are implicit in the design of social policies may be problematic. Taylor-Gooby (1998) considered the desirability of applying the PP in social policy risk management.

Proposing a mixture of public policy and market-based initiatives to strengthen public accountability, engaging other stakeholders, defining regulatory regimes, and public interest objectives, Flyvberg et al. (2003) addressed the issue of public participation in risky projects and proposed ways of dealing with accountability. Flyvberg et al. argued for broad public involvement early in a project as part of the planning process to prevent interest groups capturing the decision-making process. Mechanisms suggested include citizen juries, public hearings, and scientific and extended peer review, most of which already exist in some form. The authors examine difficulties commonly experienced by megaprojects, their main concern being with downstream risks created by infrastructure projects and management of those risks. Using Beck’s (1992, 1999) analysis as a starting point, their intention is to make risk society less risky. Noting that the State is in potentially conflicting roles when caught between promoting risky projects and serving the public,
the authors’ aim is for consensus on such issues as economic performance, environmental sustainability, and safety. However, Genus (2005) suggested that the search for consensus may be less helpful for making decisions about risky projects than for developing means for airing and clarifying areas of dispute.

Kirchsteiger (2005) considered that more deregulated trade, political integration, and centralization of decision making means that economic and political control is becoming centralized at higher and more global levels. Focusing on chemical process industry risks, Kirchsteiger observed that decision makers have taken responsibility for risk management (RM) away from individual stakeholders to science-based government programs involving only a selection of stakeholders (e.g., scientists, engineers, industrialists, health specialists, managers, media, government officials, and opinion leaders), often failing to build trust and acceptance of the decision-making process. Greater openness in exchange of information in some industrial sectors exists as it is realized that a major incident in one organization can affect public confidence in the whole industry, for example, civil aviation. Kirchsteiger argued that measures aimed at reducing risks to acceptable levels should be rational, transparent, accountable, targeted, consistent, and proportional (costs/benefits), and that risk assessments should balance benefits and risks.

Maintaining that RM, including the PP, is based largely on politics rather than science, Kirchsteiger (2005) noted that RM varied across industries and countries due to differing perceptions, attitudes, and values toward risks in different social contexts. Value-based criteria used or proposed include incertitude, ubiquity, persistency, reversibility, delay effect, and potential of mobilization. Risk characterization is a systematic summary of information about a risk that addresses needs and interests of policy makers and other affected parties. RM strategies include reducing disaster potential, reducing disaster probability, increasing resilience, assuring model completeness, emergency management, implementing the PP, developing substitutes, reduction and containment, public participation, and confidence building. A RM priority could be precaution and developing substitutes if ubiquity and persistency are relevant and science-based assessments are weak (Horlick-Jones, 1998). Kirchsteiger (2005) argued that RM should not assume that a scientific or technical model of a risk alone would allow trust and acceptance to be built. Without diminishing the role of scientific assessment, a participatory approach to RM would involve all stakeholders early in the process of characterizing and assessing risks, integrating the risk assessment (RA) phase with RM.

Althaus (2004) considered that politics tended toward risk resolution (RR) rather than RM, the difference relating to perceived eradication. In the case of RR, risk is understood as confrontation with uncertainty, requiring a decision for progress to be made. Risk is thereby perceived to have been handled, dissipated, or eradicated — at least for the time being. RR thereby extends beyond RM, which is associated with ‘massaging’ or controlling risk. Politics uses wisdom from other disciplines to synthesize a political response to risk resolution.

2.4.1.3 Illustrative interventions
Kirchsteiger (2005) outlined 15 examples of international organizations operating in the field of chemical process safety. These include the European Commission under Directive 96/82/EC (Seveso II Directive) on control of major-accident hazards, which aims to prevent major accident hazards involving dangerous substances, and mitigating consequences to people and environment if these do occur. In 1993, the International Labor Organization adopted the Convention concerning Prevention of Major Industrial Accidents, which required ratifying states to formulate a coherent national policy for protecting workers, the public, and the environment against major industrial incidents. The International Program
on Chemical Safety establishes a basis for the safe use of chemicals through evaluating chemical risks to human health and the environment, methodologies for evaluating hazards and risks, preventing and managing toxic exposures and chemical emergencies, and developing human resources in these areas. Since 1988 the Organization for Economic Cooperation and Development (OECD) has had a comprehensive program relating to chemical accident prevention and preparedness of response as part of the Environment Program. The UN Economic Commission for Europe has a Convention on the Transboundary Effects of Industrial Accidents, which aims to build national capacity and strengthen international cooperation in preventing and preparedness for industrial accidents capable of causing transboundary effects.

Kirchsteiger (2005) described the Seveso II Directive, which was prompted by the Flixborough (1974) and Seveso (1976) disasters — culminating in Seveso I, followed by Bhopal (1984) and Sandoz (Basle, Switzerland, 1986), which resulted in massive pollution of the Rhine. Excluded from Seveso II are nuclear safety, transportation, and temporary storage of dangerous substances, as well as their transportation by pipelines. Far from being harmonized, criteria, tools, and methods for assessing industrial risks are very different across EU member States, mainly for historical reasons. Problems of differing approaches to RA arise in transnational operations. However, in arguing for more harmonized RA to improve cost-effectiveness, and increase cross-national understanding, Kirchsteiger (2005) revealed his own political agenda thus, “This would promote a transparent decision-making process in which all stakeholders can more easily be involved and thus increase public acceptance of technological risks” (p. 49). How public and other stakeholders would be involved is not explained, nor why greater acceptance of technological risk is necessarily a good thing. Kirchsteiger argued for a political evolution toward greater transparency and freedom of information, and to public participation in decision making, again without suggesting the mechanisms that would be involved, or how to overcome likely barriers to this approach. He considered that the greatest long-term changes in international safety management practices will arise from transparency provisions to involve a wider public being involved in decisions that could affect their safety and health — already the intent of many international agreements on industrial safety management — raising a further political issue of why many are not already being implemented.

Within an organizational context, risk issues are also politicized. Some decades ago Dalton (1959) pointed to the organizational politics of safety rules that demonstrated the capacity of risk to be used to achieve certain ends, while Jackall (1988) identified a politics of blame in organizational settings. In terms of modes of practical reasoning used by people in everyday situations, Horlick-Jones (2003) showed that people needed to account for risk-related activities in ways that make sense and that show them in a morally acceptable light. Because it lacks a definitive context, while workplace hazards can be incorporated within a political risk framework, this approach does not provide a well-defined contribution for assessing or managing everyday OHS risks.

2.4.1.4 Further political risk model development

Hovden (1998) noted that in a global, liberalized economy, utility models seem to gain superiority over alternative models of decision making — for example, precaution or democratic processes. While traditional risk analysis and risk management are components of scientific rationality, alternative risk management strategies proposed by Klinke and Renn (2001) include the following:

- Risk-based or risk-informed (if enough knowledge of key parameters)
- Precautionary or resilience based (if high uncertainty or ignorance)
- Discursive (if high ambiguity)
Hovden (2004) considered the importance of influencing the political agenda on risk issues thus, “Risk management is about power, conflicts of interests, and political influence. This conflict perspective is usually hidden” (p. 638, original italics).

Hovden (2004) developed a two-dimensional risk management model to describe the scope and variety of the field, which excluded everyday risks such as crime, vehicle-related and occupation-related injuries — which he considered to be accepted and absorbed by society through standard means. Hovden’s risk-vulnerability (vertical) axis ranges from macro-level national security risks incorporating those relating to political, military, economic, ecological, social, and technical events, to individual safety, including meeting personal protection needs, personal coping, and feelings of security. His hazard-threat (horizontal) axis covers events from those that are unintended at one extreme (from natural catastrophes to human errors), to deliberate events at the other, including terrorism, sabotage, crime, and self-destructive behaviors. A third time-based axis can be added to represent the relative time period over which different types of events and their corresponding risk vulnerabilities can unfold.

Hovden (2004) described some findings from a Norwegian governmental report (Norway: Ministry of Justice, 2000) highlighting the increased vulnerability of contemporary society to infrastructure risks. Noting that responsibility for societal risk management was scattered around many ministries and control bodies, the report recommended splitting responsibilities for controlling risk and vulnerability from operational aspects of risk management at all levels. Hovden (2004) cited the U.K. HSC/HSE construct as representing the broadest scope for a government risk management regime, although this body only deals with occupation-related risks and has also lost the component that addresses rail system infrastructure risk. Noting that a response to Beck’s (1992) risk society seems to be the audit society (Power, 1997), Hovden (2004) regarded a key political issue to be what should be government controlled and what by markets? Part of the political dimension of risk management is that, as with most aspects of political life, left wing parties are more in favor of political control of regulatory institutions, while right wing parties prefer to trust the market to regulate. In the Norwegian case, two different change strategies operated in parallel. The first, proposed by the Commission, is top-down, whereby a single ministry is responsible for control of and response to all society’s high-risk activities and vulnerability issues. The second is more a bottom-up or muddling through approach, in which each sector operates pragmatically, for example, through reorganization and merger with no overall strategy. Hovden (2004) considered that combining the two approaches should offer optimum security.

2.4.2 Socio-emotional

2.4.2.1 Describing the socio-emotional approach to risk

A variation on the technical approach to risk is that risk = hazard + outrage — Sandman (1987, p. 21). This paradigm rejects a cold cognitive approach, regarding RP as a cognitive side effect of fear (Joffe, 1999), identified as a fundamental human emotion by several authors (Izard, 1991; Ekman, 1992; Plutchik, 1994; Oatley, 2004). Fear (of an event or outcome) generates risk attitudes, which produce RP. In contrast, within the psychometric paradigm the dread concept, which is close to fear, is identified as one of the key dimensions of RP, but not as an underlying construct except in the sense that other sub-dimensions are associated with it. Hovden (2004) considered that fear may create more risks than the threat that originally caused the fear. Being more broadly based than most approaches to risk the socio-emotional paradigm provides a deeper analysis by including sociological and anthropological as well as psychological — particularly psychoanalytical, social identity theory, and attributional-components. It is also developmental, concerned with how we
acquire/learn to fear certain things. Dunn (2003) described research showing that while two year olds ask questions mostly about where people are or what they’re doing, by three years of age most of their questions are about people’s inner states. Other research shows that children talk appropriately about emotional states like fear and happiness months earlier than they talk appropriately about cognitive states like remembering or knowing. In the child’s emotionally charged world, in which emotions are the scripts for relating, many of their interactions with siblings and parents are characterized by intense emotion (Dunn, 2003).

Maturity occurs when our fears are reconciled with reality (Joffe, 1999). This approach adopts a unified approach to risk at an individual level. The origin of responsibility and blame as RP agents are explained in terms of self-protection, for example: If I experience risk/fear, then someone else is to blame or Others are in greater danger than I am. Linking with a social constructionist paradigm, Dorn and Brown (2003) suggested that rather than considering risk taking as the product of stable personality factors — as in an individual differences framework, a shift of focus is required toward understanding risk as a discursive phenomenon. Within such a paradigm it is possible that risk taking results from momentary changing perceptions involving interpretation of external events and internal emotions designed to assign culpability for hazards (Dorn & Brown, 2003).

Within the socio-emotional tradition, Palmlund (1992) used a social drama and risk evaluation context to argue for an alternative approach to risk than is suggested by risk quantification, risk as a purely management issue, and risk communication as a means of changing views. Palmlund’s approach is based on social interaction, emotions, power, and uncertainty. Risk interaction is founded in social anxiety and the human need to exert control. Competing views of reality in pluralist society are played out through social drama, particularly via the mass media. “Social controversies over technological risk have their roots in fear of death and in fear of losing control over reality” (Palmlund 1992, p. 200).

Palmlund (1992) related deaths from modern technologies with the drama of ancient ritual sacrifice — similar to the ritual cleansing function described in cultural theory. Various audiences exist — including those who are threatened and their representatives, producers, and users of the technology. Criticizing the dominant technology can lead to social punishment — as for whistle-blowers. Citizenry is also an audience, although one that is mainly passive in the face of political power, unless threatened by a particular issue. Risk bearers and risk generators are usually distinct competing parties. Other roles include: risk bearer’s advocate, risk researcher, risk arbiter, and risk informer (e.g., media). Palmlund maintained that these six generic roles in risk scenarios corresponded with the universal functions of drama. The scene within which action takes place is also important, linking this approach with the political arena. Palmlund (1992) considered that, “Risk is a code word that alerts society that a change in the social order is being requested. . . . Every reference to risk contains a tacit reference to safety. And our need for safety and security is related to our need for control. Conflicts over risk are processes played out over time, where anxiety is contrasted with security, and where perceptions of chaos and risk are intermingled with perceptions of order and certainty” (p. 206).

Also within this tradition is Beck, who in cultural theory’s terminology, is an egalitarian, seeing nature as fragile in the face of numerous threats (Beck, 1992, 1999; Beck et al., 1994). His position is consistent with the socio-emotional approach (p. 49) by considering the driving force in an individualized risk society to be fear (p. 74). In the tradition of learned helplessness, he considers that where there is no escape, people no longer want to think about risk, so that hysteria becomes indifference. Of mostly well-educated, informed, affluent people, he noted that they, “are afraid, feel threatened and organize themselves in order not to let the only possible test of their realistic-pessimistic visions of the future even happen” (Beck 1992, p. 52). Referring to the scapegoat society, Beck considered that,
“Affliction by hazards need not result in an awareness of the hazard; it can also provoke the opposite, denial from fear” (Beck 1992, p. 75, original italics). As a form of self-protection, Beck further argued that, “the possibility of denying and trivializing the danger grows with its extent” (p. 75, original italics). Thus, the, “process of becoming aware of risks is . . . always reversible” (p. 75, original italics). As an example, Beck noted that while, “The threat from nuclear weapons . . . does not change. The perception of it fluctuates wildly” (p. 75). Thus it is, within the risk society, “handling fear and insecurity becomes an essential cultural qualification,” and that, “it comes to be demanded of the individuals that they cope with fear and anxiety” (p. 76, original italics). While Beck (1992, 1999) attempted to explore foundations for institutional change to open up the political to enable societies to deal better with risk, he maintained that reflexive modernity had not yet been achieved (Beck, 1999). This circumscribes the extent to which risks can be managed within a risk society framework.

Critiques of Beck’s risk society framework include Hopkins (2005), who maintained that it is not obvious that modern society is now more fearful than previous societies (fear is part of being human and has always been part of our make up). However, Hopkins’ critique focuses upon substantive components of Beck’s thesis rather than on the processes that Beck describes. Hopkins regards that a more apt description would be blame society, although he is similarly critical of CT. Hopkins ascribes contemporary public anger more to the fact that science has been able to reveal the underlying nature of many risks, meaning that causes are more readily attributable than in previous eras. Therefore, an assumption is that because it is theoretically possible to keep many (or most?) risks in contemporary society under control, people assume that we should do so. Rather than risk-aversion being predominant, argued Hopkins, it is rather the presumption that someone somewhere must be culpable, and which results in public anger — and political response. Conflating fear and risk acceptability, Kirchsteiger (2005) noted that fear of technological risks has existed (at least) since the industrial revolution with varying responses since then. He considers that the highest risk acceptance levels were in the 1950s, with a nadir in 1986 as a result of the Chernobyl, River Rhine poisoning, and Challenger disasters.

2.4.2.2 Risk management and the socio-emotional approach

Palmlund (1992) dismissed various attempts to describe risk controversies in chronological stages as failing to take account of the symbolic nature of risk controversies. She considered a drama-based alternative in terms of three acts, which paralleled the risk management process. The three types of dramatic breach are (1) sudden (e.g., Bhopal, TMI, Seveso, and Chernobyl) — where risk constitutes deviation from an expected pattern, (2) from science in response to social threats (e.g., Thalidomide) — which generates the full risk drama sequence, (3) political (e.g., ozone depletion and global warming), which is a less abrupt breach, again resulting in the full risk sequence drama. The significance of the breach is the degree of upset to the prevailing order and social dramas represent a desire to return to the prevailing order. “The plot in social dramas over technological risk reflects two opposing impulses in modern, industrialized society: the celebration of technological progress as against the protection of the health, safety, and property rights of individuals” (Palmlund, 1992, p. 209).

Palmlund (1992) identified criteria for determining whether a risk will be adopted for social controversy. Different actors may view the nature of a drama differently — for example, risk bearers may consider themselves to be part of a tragedy, while social elites may define the same drama as melodrama, in which no one is really to blame — varying accounts of the collapse of Barings Bank, described by Waring and Glendon (1998) illustrate these divergent perspectives. In the case of tragedy there is dénouement, catharsis, resolution, and closure, while melodrama may only repress underlying conflict. Palmlund
(1992) argued for inclusion of human emotions in the reality of risk, “In studies of risk perception, risk evaluation, and risk management, we should . . . accept the relevance of emotive statements as well as positivist assertions” (p. 211). While technological trappings have changed, we are biologically little changed so that, “in our social adjustment to risk, reproducing patterns of social interaction that have been carried down through generations. Our interest in social controversy over technological risk may well be a reproduction in modern settings of earlier generations’ anxiety, pity, and excitement surrounding the sacrifice of individuals to further the strength of the group” (Palmlund, 1992, p. 212), which also links this approach with the evolutionary stance (see Section 2.4.4). Hovden (2004) observed that anxiety relates to uncertainty and cannot be addressed by traditional risk management approaches.

2.4.2.3 Illustrative implications
With a prime focus upon individual emotions, this approach could yield novel and hitherto unappreciated workplace applications. It could be aligned with a culturally oriented approach to understanding workplace hazards in which the role of the group and identification of individuals with the workplace and with other groups is given greater prominence than in technical or psychometric approaches. In addition, this approach allows for the influence of emotions as a legitimate factor in appreciating how hazards and safety are perceived. Because of its broadly based rubric, appreciating the benefits of enhanced understanding of workplace safety that could be provided by this approach requires an insightful triangulated methodology. Managing emotions in the workplace might require a framework such as that espoused by Goleman (1995, 1998).

2.4.3 Adaptation

2.4.3.1 Adapting to risk
While the four first-order approaches are essentially static conceptualizations of risk, second-order approaches begin to imply that process is involved in understanding the nature of risk, most evident in SARF, which incorporates some elements of feedback. Feedback is central to adaptation to environmental risk. Adaptation can occur at both individual and aggregate (e.g., group, organizational, community, and nation state) levels.

Risk cognition during driving has a separate history from occupational risk cognition although, because driving is part of many occupations, they are not mutually exclusive. Of risk cognition models forwarded to explain the basis on which people decide how to drive, two have dominated the field. One of these is risk homeostasis theory (RHT) — also referred to as risk adaptation, risk compensation, or behavioral adaptation. We use these terms interchangeably. Researchers most associated with this approach are Adams’ risk thermostat (1985, 1988, 1995) and Wilde’s target risk (1976, 1982, 1994, 2001), although its origins can be traced back some decades (Gibson & Crooks, 1938; Taylor, 1964). Probably no attempt to model driver behavior has met with such fierce opposition as RHT — see for example critiques by Elvik (1999), Evans (1991), Graham and Weiner (1995), Haight (1986), Huguenin (1982), McKenna (1985), and O’Neill and Williams (1998).

Risk compensation maintains that drivers have a preferred (target) level of subjective (perceived) risk that determines risks that they take while driving. Overall level of road users’ risk is determined by the aggregate of each individual driver’s target risk and commensurate behavior. Behavioral consequences from risk compensation are that if a safety measure is introduced, for example, a blind bend in a road is straightened, or an in-vehicle safety feature such as air bags or an advanced braking system (ABS) is installed, then being aware of such features, drivers compensate either by driving faster or in other ways so as
to maintain their target level of risk. Conversely, if an intervention increased the level of objective danger for vehicle drivers — for example, if train drivers were urged to approach a level crossing at higher speeds to reduce the likelihood that car drivers would be tempted to drive across the railway tracks just before a train arrives (an example presented at the Third International Conference on Traffic and Transport Psychology, Nottingham, September 2004), then to maintain their target level of risk, drivers would compensate by driving more carefully. Pfafferott and Huguenin (1991) found that behavioral adaptation occurs in some, but not all situations of road safety improvements. Trimpop (1994) cited evidence of homeostatic effects in various sports as protective gear improves to reduce the rates of some injury types, the risk shifts to other injury types.

Contemporaneously with Wilde’s initial formulation of risk compensation, Näätänen and Summala (1976), and Summala and Näätänen (1988) rejected the notion that risk was a determinant of driver behavior and proposed that drivers’ preference was for zero collision risk. Fuller (2005) reported studies suggesting that 95% of drivers are uncomfortable with driving at a speed at which they rate the probability of crashing as greater than zero. Debate raged between these apparently incompatible approaches about the role of risk in explaining driver behavior.

The main protagonists in the RHT/zero-risk debate rarely forwarded alternatives to their positions. Hoyes and Glendon (1993) maintained that there was sufficient empirical evidence that behavioral compensation could occur in the face of changes to objective environmental risk factors. Problems included determining conditions under which compensation could occur, pathways through which behavioral compensation occurred, and factors determining response type — either through behavioral adjustments (e.g., speed changes, more or less overtakes, increased or decreased attention), mode migration (using alternative transport such as walking, bus, or train), or avoidance (e.g., not making a particular journey because of adverse weather) (Stanton & Glendon, 1996). Jonah (1997) suggested that, rather than being a general phenomenon among all drivers, risk adaptation is mainly pursued by those drivers who are attempting to optimize their risk level and the potential rewards from those risks — that is, high sensation seekers. He postulated that, more than low SS drivers, high-SS drivers will adapt their behavior to engineered improvements designed to enhance road user safety — for example, speed limit warning devices or driver fatigue monitoring alarms.

Heino (1996) considered the RHT, zero-risk, and the threat-avoidance models, all three of which attempt to formalize psychological processes underlying driving behavior. The approach to risk in these cases conceptualizes risk as either a quantity to be controlled (RHT, Wilde, 1982), or as something to be avoided (zero-risk, Näätänen & Summala, 1974, 1976), or as feedback in a learning-theory approach to driving (threat-avoidance, Fuller, 1984). A major difference between RHT and zero-risk is that subjective risk threshold refers to a perceived magnitude, while target risk refers to a desired quantity. In RHT, accepted risk is assumed to be a major determinant of driving behavior. In the zero-risk model risk is more of a disturbing factor to be eliminated as soon as possible. In the threat-avoidance model, although risk is not a variable, it is assumed that drivers opt for zero risk. The approaches differ in respect of the implicit model applied by road users for resolving decision problems involving risk. In RHT people tend to optimize the risk they incur in traffic, in zero-risk theory they seek to maintain safety margins, akin to satisficing decision rules, whereby behavior is acceptable as long as the threshold of the subjective risk monitor (acceptance standard) is not exceeded. Behavioral compensation in this model only begins when perceived risk exceeds the threshold. In the threat-avoidance model, risk acceptance mostly means coping with threat.

Heino (1996) suggested that RHT and zero-risk could be complementary rather than conflicting. In RHT, target risk is seen as a relatively stable component of driving style.
In the zero-risk model risk seems to be primarily related to short-term traffic risk and to resultant momentary fear reactions. While "zero risk" seems inappropriate for referring to normal driving, Heino suggested that zero fear might be a more appropriate term. Heino considered RHT in terms of utility maximizing functions that bring various factors into play: "because road user behaviors are the outcomes of a utility maximizing motive that is not directed towards the control of risk per se, there is no sensible rationale for risk constancy as a purpose to be achieved on its own. It must instead be considered to be a by-product of behavior directed towards a reasonable purpose, that is, to maximize the overall expected utility associated with driving (Janssen & Tenkink, 1988)" (Heino, 1996, p. 111, original italics).

From a task difficulty perspective Fuller (2005) considered that feelings about risk could inform driver decision making. However, subjective risk relates not to collision risk, about which Fuller agrees with Näätänen and Summala's (1976) zero-risk formulation, but to the difficulty of the current driving task. Fuller cited evidence showing that subjective risk shadows driving task difficulty, while estimated crash risk remains substantially lower than both these judgments. He concluded that risk homeostasis is a special case of task difficulty homeostasis, which occurred only when a driver is close to the limit of their driving ability. Most of the time, Fuller argued, drivers drive well within their capability, in accordance with the zero-risk hypothesis.

Within the risk adaptation framework, Trimpop (1994) developed risk motivation theory (RMT) to explain risk-taking behavior thus: "Risk taking is any consciously, or non-consciously controlled behavior with a perceived uncertainty about its outcome, and/or about its possible benefits or costs for the physical, economic or psycho-social well-being of oneself or others" (p. 9). Seeking a holistic description of risk-taking behavior, RMT — which is based upon at least 14 psychological theories, enhanced RHT by suggesting that target risk levels are constantly adjusted according to individuals' risk perception and that risk taking is affected by personal and environmental factors (Lopes, 1987). RMT postulated the following four points:

1. Multiple target levels of risk exist that require constant compensation so that optimal risk level is never reached
2. Emphasis is on individual motivational processes rather than collective behavior
3. Emotional and physiological processes are part of evaluating risk-taking behavior
4. Activity oriented rewards (desire for risk) are added to goal oriented rewards (risk tolerance)

The notion that risk can be arousing is not new. For example, Fischhoff et al. (1987) suggested that exposure to risk could bring benefits, such as arousal and emotional experience, which should be included in the benefits side of the equation. To RHT, which is a utility theory incorporating positive psycho-physiological experiences of risk, arousal, challenge, curiosity, and their respective intrinsic rewards, Trimpop (1994) argued for adding intrinsic pleasures of risk taking. Trimpop argued that neither Fuller's (1984, 1988) threat-avoidance model, involving drivers avoiding hazards after perceiving them, nor the zero-risk model, involving a regulatory subjective risk monitor, accommodated either risk taking as thrill seeking, or individual differences, or consequences of feedback.

In RMT, while personality determines a person's target level of risk, situational variables determine momentary fluctuations, and risk-taking behavior results from the interaction. RMT differs from other utility models such as prospect theory by taking into account physiological/emotional costs and benefits as well as conscious/cognitive costs and benefits, the former being more heavily weighted. Waring and Glendon (1998) proposed a similar model. The methodology of studying risk taking within an
adaptation framework includes questionnaires, physiological measures, and an emotions checklist.

2.4.3.2 Adaptation and risk management

Implications for managing risk on the basis of risk compensation or behavioral adaptation center upon manipulating four sets of utilities. These are expected costs and benefits arising from relatively risky and cautious behaviors, echoing the expected utility approach. Accepting a behavioral adaptation approach within the workplace is antithetical to a traditional risk management approach in which risks are identified, assessed, analyzed, evaluated, and where necessary, controlled. Assumptions underlying this sequence are that implemented controls will effectively change behaviors so that people are safer as a result. A critical factor in resolving this issue concerns the amount of freedom that workers have to exploit introduced safety features and thereby potentially compensate for them. For example, providing additional protection for fire-fighters that enables them to withstand greater heat for longer periods could result in them taking greater risks by going deeper into fires and staying in fires for longer, thereby negating at least in part, the additional protection provided (Ash & Smallman, 2003). The human body is susceptible to severe effects from exposure to intense heat within around 15 min. Practical resolution requires the possibility of behavioral compensation to be taken into account in the risk analysis sequence.

Managing risk at an individual level from the adaptation framework is based on the premise that as risk taking is inherent in humans it cannot be eliminated, but it can be channeled. A traditional approach to managing risk from the technical viewpoint — safety courses, can have reverse effects to those intended — for example, more subsequent injuries (Lund & Williams, 1985). Trimpop (1994) explained that teaching danger-coping strategies to young drivers could increase subjective safety, which could lead to less actual safety, and argued for early training in risk perception and for generalized incentives that motivate for safe performance to reduce injury rates. Incentives should be appropriate — for example, giving extrinsic rewards for behavior that is intrinsically rewarding can reduce intrinsic pleasure (as in being paid for sex). Trimpop (1994) also urged continual changing of rewards and ensuring that they are genuinely rewarding. He noted that fame incentives to reduce (or increase) target risk have been shown to be effective, while fortune or pain incentives tend to be ineffective. Social reward incentives could be more powerful than financial incentives. Workers need to be actively involved in workplace safety so as to address their natural level of risk taking.

In comparing the RHT, zero-risk and threat-avoidance models, Heino (1996) noted that the most important difference between the three models is the predicted effect of safety measures on driving performance and crash involvement. The zero-risk model would predict that crash countermeasures that increased perceived risk would have the largest effects on safety. The threat-avoidance model would predict effects from a range of possible interventions, for example, road environment improvements and driver motivational effects. RHT would predict that only motivational effects that impact on target risk would have an effect. In a series of studies, Heino found evidence for RHT and that people aimed for an optimal risk level, which may differ between situations (Lopes, 1987), while zero-risk was inappropriate for normal driving. Heino found that direct and immediate rewards work best, depending also on the cost to the driver of the behavior change. For example, seat belts make no difference to journey time, whereas reduced speed does. According to RHT, even if the rewarded behavior changes, some other behavior could also change, resulting in no net safety gain. It is the desire for greater safety that has to be changed. Risk taking seems to be socially reinforced and social norms don’t promote cautious driving (Job, 1990). Rewarding crash-free driving should work better than punishing crash involvement. The threat
of punishment works best with the already converted (De Waard & Rooijers, 1994). Heino concluded that incentives (prospective rewards) are more effective than actual (post hoc) rewards.

The economic approach to measuring behavior change is also evident at an aggregate level, as the methodology of RHT and its derivatives frequently seek to demonstrate costs and benefits of an environmental change within a population or jurisdiction, even if those costs and benefits cannot be readily quantified. Adams (1995) provided an example of risk adaptation at community level, revealing that the U.K. road traffic fatality rate for children declined over a 20-year period because parents no longer allowed their children to walk to school because of traffic dangers. Ridgewell et al. (2005) also found that in response to a perceived increase in traffic and assault risks and because of car culture and social practice, more and more parents drove their children to school rather than allowing them to walk or cycle. However, this practice also revealed a trade-off that resulted from conflict between safety and health issues, because being driven deprived children of health benefits of exercise that previous generations had derived, and contributed to the contemporary obesity epidemic in a number of developed countries. These authors documented increasing patterns of driving children to school in several countries. They also noted the self-perpetuating nature of this behavior change, as increasing numbers of parents drive their children to school, this increased the traffic risk for those who continued to walk or cycle (for another illustration, see Summary Text 2.2). To begin to reverse this trend, the authors argued for ensuring that bus routes and timetables are geared to serving needs of children traveling to and from school, upgrading and ensuring security of walkways and cycle routes, and in the longer-term consideration of parental time constraints and relative locations of schools with respect to residential areas and traffic planning within communities.

2.4.3.3 Illustrative interventions

Wilde (1994) lists the features of effective incentive programs as follows:

- Managerial vigor — continually remind people of the program; give feedback on its progress
- Reward the bottom line — for outcomes (e.g., no injuries) rather than behaviors
- Reward attractiveness — “Incentive programs can be expected to be the more successful the more they widen the utility difference between the perceived benefit of not having an accident and the perceived disadvantage of having an accident” (Wilde, 1994, p. 194). Smaller awards have greater flexibility, can be handed out more often, and are less likely to lead to underreporting (one of the few negative aspects of incentive programs)
- Progressive safety credits — like compound interest
- Simple rules — that everyone can understand
- Perceived equity — rewards should be perceived as just and not cause resentment among those not rewarded
- Perceived attainability — to encourage everyone to participate
- Short incubation period — delayed rewards/penalties tend to be discounted and are therefore less effective in shaping behavior than are immediate rewards
- Rewarding group as well as, or even instead of, individual performance — thereby reinforcing peer pressure not to have an injury
- Operator participation in program design — people are more likely to achieve goals that they helped to define, and the rewards are more likely to be valued by those involved in the program
Prevent injury underreporting — generally only minor injuries go unreported, but see also the use of smaller rewards

Reward all levels of the organization — supervisors and middle managers as well as shop-floor workers, to increase cohesiveness and pervasive safety orientation of the organization

Whether to supplement reward with safety training — could consider adding information on specific behavior that will help to avoid injuries, distinguishing between someone’s ability to be safe (e.g., through training), and their willingness to be safe (e.g., through incentives)

Maximizing net savings vs. maximizing benefit/cost — decide the primary goal in advance

Research component — incorporate evaluation to determine its short-term and long-term feasibility and its best possible form. Distinguish between incentive, which is a preannounced gratification, and reward, which can be post hoc

Compared with workplace programs, it is more difficult to use peer pressure to improve driving through incentive programs. Enforcing speed limits could result in crash-injury migration. Good options might include reduced license fees or insurance rate reductions, although the issue of insurance incentives is complex: “increases in workers’ compensation payments for injuries may increase the rate of workplace accidents” (Wilde, 1994, p. 201) (Worrall, 1983). Government interventions could include altering the life of a valid license and encouraging insurance companies to use incentive schemes (Wilde, 1994, pp. 201–202). While insurance companies have the greatest facility to widen the utility gap for drivers between having and not having a crash, thereby lowering their target level of risk, whether insurance companies are motivated to reduce crash rates is problematic. And, “to offer people protection against the consequences of risky behavior encourages risky behavior” (Wilde, 1994, p. 205). The public generally does not push hard for higher road safety — road vehicle crash rates reflect the trade-off between desire for mobility and safety.

2.4.4 Evolutionary

2.4.4.1 Describing the evolutionary approach

Representing a unique historical legacy, the evolutionary approach is the only one that logically cannot be derived from any other. This approach, for example, as espoused by such authors as Nicholson (2000) and Williams (2002), seeks explanation for risk behaviors within cognitive and emotional development throughout human evolution and can thereby identify the rationale for our limited comprehension of many contemporary risks. Risk has become a concept of interest within the evolutionary community relatively recently. The journal Evolution and Human Behavior ran two special issues on risk in 2002 and has carried more recent articles on this topic. In the evolutionary approach, according to Daly and Wilson (2002), “Risk is typically operationalised as outcome variance in some proximal currency (such as money or calories), and appropriate response to risk is construed as a matter of maximizing expected returns in some more distal currency (“utility” in economics, fitness in biology) which is nonlinearly related to, and usually less directly measurable than, the proximal currency” (p. 1). Daly and Wilson explained that few problems in nature present people or other animals with choices for which probabilities and payoffs are precisely known — that is, the basic components of risk perception or risk assessment. The evolutionary approach suggests that natural selection has equipped animals (including humans) with expectations based on past experiences, such that decision making under uncertainty (or risk) relies on evolved psychological and physiological processes. These
processes enable decisions to be made such that gains, such as calories or mating opportunities, can be set against potential losses, such as injury or death. The common currency in the decision-making process is expected fitness, which enables an organism to weigh quite different costs (e.g., assessed probability of death or injury) against likely benefits (e.g., access to food or mating opportunities). Thus the term risk can serve an integrating function by encompassing both uncertainty and peril as well as payoff variance. Daly and Wilson maintained that an evolutionary approach could hold the key to interdisciplinary synthesis in the social and biological sciences. A selection of evolutionary studies is described here, along with some possible implications for understanding risk in other disciplinary contexts.

The language of economics frequently finds voice in scenarios driven by an evolutionary hypothesis. For example, Wang (2002) used a series of hypothetical life–death problems as well as real reproductive and parental decision problems to study how people used risk distributions — that is, variations in expected payoffs, to maximize the likelihood of reaching a goal and to minimize the likelihood of falling below a minimum requirement. It has been known for some time that people will make sacrifices for close relatives and it is maintained that this is associated with the extent to which they share common genes — which can be represented as a coefficient of relatedness. Wang concluded that humans are sensitive to variations both in expected payoff and reproductive fitness, such that the higher degree of relatedness between a decision maker and the object of the decision, the greater risk the decision maker would be willing to take in respect of the other. In cases of uncertain kinship, the expectation is that a person will seek relevant information to reduce uncertainty — for example, an adopted child will search for information about its natural parents, or a father may seek confirmation that a child is genuinely his. An evolutionary framework could thereby be critical to social issues such as kinship and community.

An evolutionary model could also help to unravel some issues concerned with individual differences in risk taking. For example, it has been maintained that men are more risk-prone than women are because throughout their evolutionary history men have had to engage in higher levels of intra-sexual competition (Fetchenhauer & Rohde, 2002). These authors found that compared with women, men had more positive attitudes toward risks and were more short-term oriented, and that the likelihood of being a victim of various negative events (e.g., car crashes, violent crime) correlated with a (potential) victim’s risk attitudes and short-term orientation. Related to risk-proneness is the individual difference of forward planning, and it has been suggested that for those living in an unstable and uncertain environment, it could be adaptive to discount the future consequences of one’s behavior. For example, for someone facing a lengthy term of imprisonment it might be seen as worth risking their life to try to escape. Thus, short-term orientation is likely to be negatively related to the stability of one’s social environment. For example, Hill et al. (1997) found that higher risk taking was associated with degree of perceived unpredictability and skepticism about one’s personal life expectancy. Fetchenhauer and Rohde (2002) suggested that short-term orientation could be the prime mechanism for individuals becoming risk-takers at a behavioral level. Discounting other possible explanations for the link between negative outcomes, attitudes, and orientation, they concluded that men were more likely to be victims of negative events because of their more positive risk attitudes and their greater short-term orientation. They maintained that the influence of short-term orientation on risky behavior is mediated by risk attitudes. While these authors did not investigate reasons why individuals might differ in their level of short-term orientation or risk attitudes, variability in risk attitudes has been found to have a heritable component (Miles et al., 2001), while environmental factors are also likely to play a part (Hill et al., 1997; Wilson & Daly, 1997; Chisholm, 1999).
An evolutionary perspective might also shed some light on how certain aspects of the social amplification of risk might operate and could also challenge some assumptions of a social constructionist approach. After studying 736 news stories from middle-ground newspapers in eight different cultures over a period of three centuries, Davis and McLeod (2003) suggested that the relative stability of category rankings over time and place could indicate that the content of sensational news is not socially constructed, but rather that the categories that emerged from their study corresponded with major themes in evolutionary psychology. These environmental features would have been important to our ancestors’ ability to pass on their genes, and include: food acquisition, parasites, altruism, predators, cheater detection, reputation, violence, reproductive strategies, and treatment of offspring (Gaulin & McBurney, 2001; Palmer & Palmer, 2002). Davis and McLeod proposed that, like gossip, sensational news stories could trigger an adaptive tendency to attend to categories of information that could increase reproductive fitness.

Intellectual criticism of sensational news stories often centers upon their emotional impact or appeal to people’s base instincts. However, Davis and McLeod (2003) maintained that the common themes and rankings of such stories suggested that they could reflect human universals. Their correlation of 0.70 between news story rankings over six 50-year time periods indicated that the same general topics emerged in news prevalence over time. The 12 categories that emerged were: murder/physical assault, robbery/vandalism, accidental/natural injury/death, altruism/heroism, suicide/self-inflicted injury, abandoned/desolate family, harm to child/ren, sexual assault/rape, taking a stand/fighting back, reputation, marital/courtship anomalies, and a miscellaneous category. The authors maintained that the emotional impact of these stories provided critical information to readers about their world, which could be explained by reference to an environment of evolutionary adaptiveness, in which such information could have survival value. While animal attacks on humans were of insufficient frequency to form a separate category, when such attacks did occur they were often front-page news. Davis and McLeod ascribed such salience to the importance of predators for our ancestors. This evidence suggested that rather than being socially constructed on the basis of particular time periods or cultures, sensational news stories serve a more basic human desire for certain kinds of information. Findings from psychometric studies about the judged likelihood of certain types of event might usefully be reinterpreted in the light of such findings, as they could reflect attention to knowledge that could be critical to human survival, for example, by increasing human reproductive fitness. Of the selected medium, the authors suggested, “The emergence of newspapers and, with them, sensational news may simply reflect a technological change in the manner in which certain categories of information are transmitted” (p. 216).

While emotions are human universals, culture acts to interpret and provide a social context for emotional expression (Oatley, 2004). Because risk cognition exists in all cultures, it must have an evolutionary basis. Evidence for this assertion comes from psychometric studies that have found very similar dimensions and patterns of risk perception, for example, in Norway (Teigen et al., 1988), Poland (Goszczynska et al., 1991), France (Karpoweicz-Lazreg & Mullet, 1993), Italy (Savadori et al., 1998), China (Lai & Tao, 2003), and Switzerland (Siegrist et al., 2005). Early hominid survivors must have derived advantages from being able to perceive certain types of risks/threats better and behaving more appropriately than their less successful peers. Risk cognition is based upon hard-wired drives so that attitudes and behavior in relation to risk are more appropriate to prehistory (e.g., with the result that we are more naturally afraid of snakes than of traffic). Risk cognition is based upon the hunter-gatherer brain, which can, for example, comprehend immediate threats of temperature extremes but cannot readily appreciate global climate change. Similarly we have evolved to readily understand small-group behavior, but not global behavior, or personal
hatred, but not fundamentalism (Williams, 2002, p. 228). Williams characterizes this as brain lag — the perceptual and intellectual discrepancy between what our brains have evolved to cope with and survival threats posed by the modern world.

When people take risks in contemporary contexts, behaviors that once had survival value might no longer do so. Thus, young males’ risk taking in sports, driving, or substance abuse could be viewed as contemporary reflections of past generations’ demonstrations of mating prowess. In some contexts such behaviors may still be perceived as demonstrating fitness, although underlying factors may be complex. However, an evolutionary approach can also help to elucidate some aspects of social and sexual relations in respect of risk taking. For example, from a framework of costly signaling theory Farthing (2005) used 21 scenarios as a basis for males’ and females’ evaluations of the attractiveness of risk takers compared with risk avoiders as potential mates or same-sex friends. Farthing found that both females and males preferred heroic physical risk takers as mates, with females having a stronger preference. However, for nonheroic physical risks, such as risky sports, both sexes preferred risk avoiders above risk takers as mates. For same-sex friends, males preferred nonheroic physical risk takers, while females preferred risk avoiders. Farthing concluded that insofar as nonheroic risk taking by males is a costly signal, the signal is directed more toward other males than toward females. Preference for risk takers was also positively correlated with reported self risk taking. Both sexes underestimated the opposite sex’s preferences for drug-risk avoiders.

From a cultural theory perspective, Tansey (2004a) considered that the concept of risk has emerged relatively recently. However, this is only true from a purely linguistic perspective, and ignores the (unprovable) certainty that preliterate societies’ activities were concerned with risk, which is implicit within a CT approach. The concept of risk and associated behaviors must have existed in some forms for much longer. Trimpop (1994) argued that risk taking is inevitable in any changing environment, because change represents uncertainty about the future. Risk taking was essential in human evolution, and therefore has physiological and genetic predispositions, as well as an intrinsic reward mechanism. Risk taking would be needed to acquire resources, while faulty risk assessments could lead to extinction — which could in part have been responsible for the fate of related hominid species. Trimpop considered that risk taking for mating could have involved fighting, while the great variety of threats would make adaptability through risk taking important for survival. Sex differences in risk taking could be explained by different evolutionary imperatives. “Any organism genetically programmed to take an optimal amount of risk, has...a great advantage and is more like to survive and to have more offspring” (Trimpop, 1994, p. 39, original italics), and, “humans...are equipped with evolutionary advantageous genetic risk taking programs” (p. 42). Optimal risk taking is determined by a combination of environment and an individual’s abilities (Buss, 1988).

Toda (1980) and Frijda (1988) described the emotional and evolutionary basis for risk-taking behavior while Cooper (1987) undertook this task for thinking and using heuristics, arguing that an optimal balance between rational thought and emotions would confer survival value. As the product of objective probability and evolutionary biology, subjective probability is the means by which we judge the likelihood of all events, including those involving risk. It was probably unimportant to their survival that our ancestors were not proficient at calculating probabilities accurately. From this perspective, the discovery that humans are poor at calculating objective probabilities, as demonstrated by methodologies developed by the economic and psychometric approaches, is trivial from the point of view of human survival. To this extent the evolutionary approach is consistent with a universal or archetypal form of social constructionism — in so far that only those risks that were important to survival needed to be attended to, and thus only certain risks were constructed as part of humans’ day-to-day reality.
Turkheimer (1991) argued that combining evolutionary concepts with situational and individual differences helped to gain a full understanding of the relationship between risk taking and personality. These patterns are likely to be rooted in older brain areas — those linked to survival and reproduction as common to all organisms. However, as societies and cultures diverged, base levels for risk taking and risk perception would be likely to vary widely (Dawkins, 1976). Jonah (1997) reminded us that both high and low sensation seekers make important contributions to species survival, Zuckerman (1983) noted that, “The biological value of a Columbus to the species is incalculable, but for every Columbus, there must be more cautious types who stay at home and keep the books, make the star charts, codify the laws, and plant the crops” (p. 38). With the surface of the Earth now effectively completely discovered concern has been expressed about the avenues that remain for those individuals with very high risk-taking, sensation seeking, and adventure needs. Will there be sufficient opportunities for them to explore and develop their particular motivations for the great benefit of human kind, or might their particular needs be frustrated and turned against others in society?

Trimpop (1994) argued that from an evolutionary perspective, emotions have survival value and that, “emotions are genetically programmed motivators for risk taking behavior” (p. 139). Similarly, Toda (1980) considered that emotional motivations are often far more important than are material ones. Toda (1980) maintained that emotions developed to lead individuals to making correct decisions in primitive environments, while analytical abilities developed later to supplement automatic action patterns. Basic feelings, such as anger, surprise, or fear, focus attention onto a stimulus and prepare the body for flight or fight. Emotional expression became essential for social interaction and for competition within and between species. Basic emotional expressions are common to all cultures, while more sophisticated emotions and appraisals may be culture specific. Buck’s (1980, 1985) prime theory on the importance of emotions in motivating behaviors could also be seen as critical to evolutionary survival. However, while risk taking might be necessary for effective learning, in reality at school and in work environments people tend to be punished for making errors and so learn to overcome their evolutionary emotional stance and become more risk averse.

In addressing the issue of what controls risk-taking behavior, Trimpop (1994) considered that, “inherent motivation to gain influence, mastery and control over one’s environment…is the necessary and advantageous counteragent to risk taking from an evolutionary standpoint” (p. 161). It is thus likely to be genetically controlled and intrinsically reinforced, and can be, “result, cause, motivator, and inhibitor of risk taking” (Trimpop, 1994, p. 161). Contrasting motivations — curiosity and the need to meet basic needs vs. security seeking must have evolutionary roots. Averill (1973) suggested that biological seeking for personal control had evolutionary benefits, for example as a way of reducing uncertainty in an unstable environment. This would serve to reduce stress and anxiety, even if the control was only perceived.

2.4.4.2 Risk management and the evolutionary approach
Trimpop (1994) argued that if risk taking is genetically determined, and is an evolutionary stable behavior, then it is not logical to attempt to reduce errors and accidents by preventing people from taking risks. However, this stance ignored the point that most risks to which people are exposed in contemporary society are very different from those that faced our ancestors. Thus a strong argument could be made to limit people’s exposure to involuntary risks and to those hazards that cannot be directly perceived by our senses. Beck (1992) noted that many risks are increasingly out of humans’ perceptual range (e.g., radioactivity, many toxins, and atmospheric pollutants). Beck (1992) considered that the, “spell of the invisibility
of risks can also be broken by personal experiences” (p. 53), and that, “The latency phase of risk threats is coming to an end. The invisible hazards are becoming visible” (p. 55, original italics). However, “the end of latency has two sides, the risk itself and public perception of it. It is not clear whether it is the risks that have intensified, or our view of them” (p. 55, original italics). However, Sjöberg (2002c) challenged this notion, noting that humankind has always faced many risks and disasters caused by invisible agents, such as viruses.

While evolution equipped humans with the ability to identify and avoid harmful substances that were evident in our ancient environment, for example, the emotion of disgust evolved to reject toxic substances (Rozin et al., 2000), many contemporary hazards are beyond our perceptual capacity. Risk management implications of the evolutionary approach include finding ways to enhance risk cognition, for example, seeking to render hazards that are hard to perceive, more concrete, or manifest. Thus silent hazards such as ionizing radiation might be made visible using appropriate technology. Chapter 4 outlines means of enhancing human capacity or overcoming human limitations by using machine technology (see Summary Text 4.11 and Summary Text 4.12). Long-term threats to health such as smoking could be represented in short-term ways, for example, by using technology to speed up the ageing process as a dramatic illustration of its adverse effects.

A more fundamental risk to be managed concerns that arising from evolved human proclivity to deny the humanity of those outside our immediate social group (Shermer, 2003; Oatley, 2004). As Oatley (2004) noted, “Those emotions persisting from previous phases of our evolution that are directed antagonistically to those outside our community are the most dangerous in our repertoire. They are the emotions of contempt, hatred, and disgust. We inherit their legacy along with our capacity to love. Their most baleful expression is war” (p. 91). Managing such potentially large-scale risks is a major challenge for contemporary society.

2.4.4.3 Illustrative applications
As far as applications of this approach for safety interventions are concerned, its main contribution may be its ability to identify fundamentals of human behavior that are superordinate to culture. For example, hierarchy appears to be hard-wired and therefore universal, as does individual competition (e.g., for promotion within organizations) (Nicholson, 2000). Human motivations include asserting ourselves against others in conflicts over status and power (in extremis, greed), loss avoidance — which can lead to fear, ego maintenance (belief in control, self-confidence), attachment and affiliation to others as belonging and recognition needs, as well as hard-wired gender and other individual differences (Jenkins & Oatley, 1996; Goldberg et al., 1999; Oatley, 2004). We also have an inbuilt mechanism for detecting cheating in others; however, because this is a universal it is also readily manipulated by those with the will and skill to do so. Recognizing these and other human fundamentals in seeking effective safety interventions can help to breach some of the barriers that may be imposed by more recent (in evolutionary terms) cultural artifacts. An evolutionary perspective helps us to understand that while comprehending immediate and obvious hazards may be relatively easy for us, appreciating the complexities of how we interact with the myriad of possible hazards that confront us is beyond our cognitive range.

2.4.4.4 Links with other models
af Wåhlberg (2001) noted that RP could be defined either as cognition, or as a personality trait, or as behavior, any of which would be consistent with an evolutionary approach. Links between RP and behavior have generally been neglected — for exceptions see Crisp and Barber (1995) and Weinstein and Nicolich (1993). af Wåhlberg (2001) considered that RP research and theory must be linked with evolutionary theory and that culture is also
derived from evolution. He considered that personality, cognition, and behavior must be grounded in evolutionary theory to be a real explanation of the phenomena (Cosmides & Tooby, 1994). “To explain a certain psychological make-up, we must find the uses to which it was put in the beginning” (af Wåhlberg, 2001, p. 247), which could then give rise to new insights and even predictions.

An evolutionary framework also links with the political approach because contemporary politics must deal with many of the legacies of human evolution. For example, status maneuvering within small social groups, which for our ancestors was probably an aspect of maintaining social order over countless millennia, within the context of modern day power imbalances and numerous sanctions often available to those in power, this once-functional social control mechanism can become a means for chronic social repression or, in extremis, genocide. Similarly, antisocial emotions (Oatley, 2004) that could once have served to preserve in-group integrity against out-group threats, take on a very different perspective within the context of our contemporary capacity to produce, and use, weapons of mass destruction against other groups. These are among the biggest challenges for managing risk at many levels within society, also implying links with behavioral adaptation, again from individual to inter/national political level. While in the long term, behavioral adaptation is practically synonymous with evolved behavior, inherent lags in our ability to develop means of countering the wide range of contemporary risks that we face, make our ability to understand the origins of our emotions and the limitations of our cortical function to moderate them fundamental to finding ways of reducing risks of widespread human suffering.

The evolutionary model is also highly consonant with a socio-emotional approach, particularly insofar as we have developed as a social species. MacLean (1990, 1993) has postulated three major stages for human evolution, each represented by a physiologically distinct area of the brain. In evolutionary and developmental terms, the oldest part of our brain includes the corpus striatum, which is common to birds, reptiles, and mammals and whose circuits control basic life routines. These include establishing a home base, patrolling and defending territory, forming social groups and hierarchies, greeting, mating, flocking, migration, and daily routines (Oatley, 2004). Associated emotional circuits involve escape from danger and fighting — the traditional fight or flight response. Risk cognition at this level is likely to be based on autonomic responses associated with the type of activities listed above. The next layer within the brain, the limbic system, developed in mammals but not in reptiles, and its circuits are associated with infant care, intraspecies vocalization, and play. The limbic system drives emotional as well as social behaviors, so could be considered as the seat of emotions for all mammals. Risk cognition in this socio-emotional center is likely to be focused on protection of close family and social group in the face of real or imagined threats. The final layer is the cortex, which is most developed in primates and in humans comprises around 80% of the brain’s volume. As the organ of cognition or reason, the cortex is involved in such human activities as planning, tool-making, imitation, and advanced language (Donald, 1991). It also expands our social network beyond immediate family so that we can recognize individuals within larger social groups, in the case of humans this group size is approximately 150 (Aiello & Dunbar, 1993; Dunbar, 2003). The cortex could serve a dual function in respect of risk cognition, on the one hand acting as an executive filter in respect of threats interpreted by lower brain centers, while also generating its own repertoire of threats and responses arising from its unique functions. While these functions may be theoretically distinct, in reality they are almost certainly confounded.

Panksepp (1998, 2001) maintained that emotions are generated in the limbic system and that neural circuits associated with each emotion generate a particular state of consciousness, which is probably shared with other mammals, including happiness, fear, and
anger. Panksepp maintained that each of these basic states of consciousness was associated with a particular action category — for example, continue activity, escape, or fight, that were shaped by evolution to meet recurring situations, in these examples progressing an activity, sensing danger, or preparing for confrontation. Limbic system circuits are relatively fixed and can powerfully affect our cognitions. In infants, while powerful, emotions are wordless — as in all other mammals and in our prelinguistic ancestors. The emotions that drive some of our actions may also initially defy description, but our cortical language centers can subsequently attach labels to these archetypal features, as in I was afraid, or I was angry, or indeed I took a risk. The language of risk is thereby superimposed upon the emotional substratum. For example, within the limbic system the amygdala performs a rapid initial appraisal to detect whether some external event presents a threat, and induces fear — the low road (LeDoux, 1997). This can result in physiological responses that include blood pressure change, stress hormones release, and the startle reflex, as well as behaviors such as flight, fight, or immobilization. The longer route, via the cortex (the high road), takes longer and results in more detailed analysis of the event.

2.5 Further discussion

Proponents of the various models described above tend to adhere firmly, if not sometimes rigidly to their own approach, resulting in controversy and acrimony within the field of risk cognition and risk management. The evolutionary paradigm in particular, while gaining increasing numbers of adherents, remains highly controversial. There has been talk of reconciling at least some of these approaches within a grand unified theory of risk. However, development of our understanding of what risk is, and what are valid approaches to risk still has some way to go for this to occur. At this stage of our conceptualization of risk, it is important to continue to investigate the diversity inherent in risk-related reasoning as it can reveal what is important about risk for human experience. Risk management implications of subscribing to a single approach would have similar problems. If there is fundamental disagreement about the nature of risk and its cognition then we cannot hope to have a clear set of principles for managing risk. In a workplace or indeed any context, managing risk depends upon the particular models of risk adopted, which in turn rests upon how risk is conceptualized. In any case the nature of risks that are considered by the various approaches tend to be substantively different, with each discipline retreating to its respective comfort zone by considering risks that suit its particular level of analysis. This chapter has shown that each approach could have some potential contribution to make to enhance understanding of hazard risk and to improving health and safety.

Improved guidelines for action can be developed by acknowledging that risk can be conceptualized at different levels — individual, group/community, organizational and societal — as well as through the viewfinders of different disciplines. Horlick-Jones and Sime (2004) observed that discipline-based boundaries represent significant hurdles to reconciling social and material dimensions of the hybrid nature of risk. How risk is conceptualized needs to be explicit and transparent. How this is done is likely to depend upon an individual’s disciplinary background and contemporary circumstances, which are also likely to determine preferred strategies for managing risk. While several authors (e.g., Hovden, 2004) have pointed to the greater vulnerability of contemporary society to technological risks, past societies have been more vulnerable to other types of risk — for example, disease pandemics, which modern society can at least (so far) find ways of combating. However, whether the requisite medical technology can be successfully applied could depend as much on politics as upon scientific advances. From an historical or evolutionary perspective it is more likely to be the type of risks and our perceptions of them that have changed.
A major challenge for managing and minimizing workplace hazards is selecting an appropriate combination of approaches. Our own approach is to acknowledge the multifaceted nature of risk, to propose that a multidisciplinary approach is required to understand risk, and to urge that risk management needs to be sufficiently broadly based to take account of individual differences and the sociopolitical environment, as well as more traditional components. The model proposed by Klinke and Renn (2002) is considered in Chapter 12.

It seems that increasingly research into risk cognition and risk management uses a combination of approaches, or else moderates a preferred approach with input from another — representing a softening of boundaries between discipline-based approaches. Some of the risk dialogue has tended to critique another discipline purely on the basis of its level of analysis (e.g., sociology of psychology), while being blind to the fact that another discipline has a unique contribution to make to understanding risk.

Authors from various traditions, including the psychometric and SARE, as well as the political and risk society approaches, argue for greater democracy and public participation in decisions involving risk. However, in most cases the processes and mechanisms for such participation are problematic in respect of their form and equivalence in various jurisdictions. This issue, whether within workplaces or as part of a wider community, is at the kernel of many risk debates.
chapter three

From sensation and perception through motivation and behavior

How sour sweet music is
(William Shakespeare, Richard II)

This chapter deals with some of the processes and mechanisms through which humans interpret their environment. Knowledge of these processes is essential in order to understand the characteristic ways in which we think and behave. The chapter first describes the process of perception relating to objects, events, and other people. Given the wide variety of competing stimuli in the environment, the process of attention is considered in relation to why particular stimuli draw attention and others are ignored (selective attention) and how attention is maintained over time (sustained attention). The ways in which stimuli are interpreted also affects how we understand why events occur (attribution) and how we are compelled to act (motivation). Implications for designing safer environments and motivating people to behave safely are considered throughout the chapter.

3.1 Introduction

The study of perception focuses on how people discover what is going on around them from data that are registered through the senses. A distinctive feature of our central nervous system is its great capacity to store parts of previous perceptual inputs and to interpret new perceptions within a meaningful framework. Embracing these features, cognitive psychology treats individuals as active agents seeking to make sense of their environment in order to adapt successfully to it and to satisfy personal needs. Our perceptual system processes and interprets a vast array of stimuli before committing a selection of these to memory. Interpretation and selection of stimuli is influenced by our genetic inheritance and by our experiences (Held & Hein, 1963). Perception occurs when stimuli are evaluated by individuals’ unique perceptual structures. Although Mowbray and Gebhard (1958) identified five distinguishable physical human senses or sensations: vision, hearing, taste, touch, and smell, contemporary science acknowledges a more extensive repertoire (see Section 3.2). The cognitive approach focuses on how this information is processed by the brain. Important cognitive processes include attention, which determines how stimuli are processed, and attribution, which affects how causality for events is ascribed.
These processes affect how people choose to act or behave. The objectives of this chapter are to:

- Describe and explain basic sensory and perceptual processes
- Reveal some of the complexity of human perception
- Examine processes of attention and vigilance, considering implications for safety, including design of warnings
- Describe and explain attributions
- Examine attributional effects and their role in safety
- Consider the behavioral approach to motivation
- Evaluate the contribution that behavior modification has made toward improving workplace safety
- Assess the role of motivation in relation to safety

3.2 Sensation and the human senses

As Matt and Ned Roach were getting ready for work at Mt Kembla mine, their big black dog did something that he had never done before: he stood in front of them and howled continuously. At a house nearby, Mrs Hunt had dreamed a warning not to let her son go into the mine. Because of their dog’s behavior, Matt and Ned Roach did not go to the mine that day. Mrs Hunt’s two sons, Percey and William, and her husband, also called Percey, did and all three were among 96 killed in a massive series of explosions, which also left 152 injured in Australia’s worst mining disaster on July 31, 1902.

Piggin and Lee, 1992; Brown, 2002; Ryzman, 2002

Why was a dog’s insistent and unusual behavior taken as a sufficient warning for two men not to attend work — a decision that would have had financial and other consequences if it would have been a normal working day? Why did Mrs Hunt, on the basis of her dream, not insist that her husband and sons stayed home that day? Are humans programmed to believe that some animals have a sixth sense, while our own forebodings are too unreliable to be heeded? After all, if none of the other mine workers or their family members had dreamed about a mine disaster the previous night then could this one instance merely be ascribed to coincidence? People frequently dream about disasters and unfortunate events, yet rarely do these coincide with similar events in real life, so we generally assume that the predictive value of our dreams or waking fears of danger approximates to zero. However, experiments on extra sensory perception (ESP) carried out since the 1930s have shown a consistent and reliable effect in the domain of image transference, albeit one that cannot yet be explained by mechanisms currently known to science. It has been pointed out that if comparable results had been obtained for the effectiveness of a drug then that drug would have been produced and marketed as an effective product (Matthews, 2004). However, because the rationale for ESP is currently unknown and possible pathways for any such effects are opaque, research funding is difficult to obtain to explore it further and the mystery remains. The link between perception and motivation is illustrated by the consistent finding that discovering evidence for the paranormal is much more likely if you believe that it exists — and are therefore motivated to find such evidence (McCrone, 2004). Controlled experiments by skeptical psychologists (O’Keeffe & Wiseman, 2005) typically fail to find evidence for those claiming extra sensory powers.
It is possible that we are only at the threshold of understanding the nature of human and animal sensation and perception, and that future research into the chemistry and functioning of the brain will reveal hitherto unknown pathways that could facilitate a rich variety of perceptual activity, of which at present we are mostly unaware. In the same way, the traditional notion of intelligence went unchallenged for over 80 years, until Howard Gardner’s classic text (Gardner, 1986) revealed not one but seven types of intelligence, a number that has since been added to by Goleman (1995, 1998) and others. It is now widely accepted that the concept of human intelligence (and much more is also being discovered about intelligence in many different species of animal) should encompass a wide variety of possible forms that can adequately reflect the considerable range of human behaviors. It is more than possible that our notions of what constitutes perception will undergo a similar revelation in the years ahead.

The traditional view of the process of sensation is that we receive information from the external environment through receptors in the eyes, ears, nose, and mouth as well as via touch receptors in the skin. Information on the body’s internal state is received by different types of receptors (proprioceptors): the kinesthetic sense, concerned with motor functions, is located in muscles, tendons, and joints and provides information about the activities of these tissues; the vestibular sense, located in the ears, gives information about the position of the body and its component parts. Sensory organs act as temporary reception centers for energy, which is passed to the brain by nerve impulses. The notion that there are only five senses, attributable originally to Aristotle, is at odds with current scientific knowledge (Durie, 2005). However, while our knowledge of the big five is relatively well understood, some of these can be subdivided, while the catalog of what constitutes part of our sensory system can be extended to other modalities. Thus, vision can not only be divided into light and color, for which the well-known respective receptors are rods and cones, but cones can also be divided into three types, each being receptive to either red, green, or blue. So, is vision best described as a single sense, or as two, or perhaps as four? Similarly, taste can be divided into four or possibly five separate components, each represented by an area of the tongue, while olfaction might be represented by at least 2000 receptor types. Touch can be divided into light touch and pressure, with different receptors operating for each mode. Even hearing, as loss of this modality tends to occur unevenly across the range of sounds otherwise accessible to the human ear, could potentially be subdivided into a few or perhaps many categories.

Beyond the traditional five and their subcomponents, pain can be identified as a separate sense, which can be subdivided into cutaneous, somatic, and visceral types. Separate temperature receptors exist for heat and cold, while mechanoreception has at least balance, proprioception (joint position) and kinesthesia components, and arguably more. Interceptors enable us to sense our own blood pressure, lung inflation, bladder stretch, stomach extension, and a variety of others. There is no final agreement on how many senses humans have or about how they should be divided. However, there is reasonable agreement that at least ten basic senses can be identified and that most of these have subdivisions (Durie, 2005). It is possible that others will be discovered and that more will be revealed concerning their physiological mechanisms. However, to some extent the number of senses that we can identify is much less important than how the information that they transmit is combined and processed as perception. Implications for how humans sense various hazards, for example, relating to health, through the body’s proprioceptors could be considerable, while much has still to be discovered about the neural mechanisms that interpret (perceive) sensory data from multiple sources as part of risk appraisal. Despite the diversity of the human senses, the most commonly researched areas relate to the visual and auditory senses in relation to implications for safety.
3.2.1 Vision

People with normal color vision are capable of distinguishing between hundreds of different colors or hues (think of the color charts that you study when deciding what color to paint a room). Color can, therefore, be used to help to distinguish between different controls, displays, and action signals. The British Standards Institution (BSI), in collaboration with industry, has adopted standards for the best use of color in coding systems. Color codes are used to denote different types of fire extinguishers. Color is also used to distinguish between different conditions, for example, industrial and medical gas cylinders, traffic signals, and electrical wiring. Color may be used to denote differences between pipework in work locations, while different colored helmets may be used to distinguish separate gangs of construction site workers. On an aircraft carrier, personnel performing different functions are distinguished by the color of their apparel while on action stations — when correct actions and effective teamwork are critical (see Chapter 8). However, beyond about five different colors, confusion may occur, particularly when individuals are under stress (see Chapter 7). Research has shown that people associate different colors with different hazard connotations (Wogalter et al., 1998), with red most associated with danger. This information is used in the development of hazard warning systems (see Section 3.4.3).

Color can also be used to help create feelings and moods or to represent a variety of conditions. For example, people are supposed to feel a greater sense of warmth in a situation where red predominates, compared with a situation in which blue prevails. A number of psychological effects are attributed to color, some of which are shown in Summary Text 3.1. In today’s world, our eyes have to cope with many colored charts, diagrams, and screen graphics. Cones in the retina respond best to red, green, and blue light. The sensation of yellow is created when the cones that capture red and green are equally and simultaneously activated or stimulated. A strong yellow light tends to undermine the strength of red and green cones, leaving blue cones with the primary responsibility for controlling vision. As there are fewer blue cones than red or green cones, the response of the blue cones is inferior in controlling vision and thus performance is below optimal. (For a more detailed review of vision and performance, see Megaw, 1992). Visual efficiency is much lower when the red, green, and blue cones are all fully operational. Significant adaptation by the eyes to the color yellow leads to changes in the appearance of other colors, so that yellow may be a poor choice in many situations. However, while yellow has a poor contrast on a white visual display screen, yellow writing on black background can provide an optimal contrast.

For people with some defective color vision, red, orange, green, and brown colors generally pose the greatest difficulty, although those affected may remain unaware of their deficiency until an obvious error of judgment is made. Although very few people are completely color blind (seeing only white, black, and shades of gray), Megaw (1992) noted that between 6 and 10% of males and between 0.5 and 1% of females have some color discrimination deficiency. The most common form of deficiency is confusing red with green and yellow with blue. However, particular colors on certain backgrounds can be a problem for those with normal color vision. Color vision defects can be due to genetic factors or disease. Where effective performance on a job depends upon a certain level of color discrimination, appropriate tests may be used to diagnose color abnormalities.

It has been known for some time that age can affect visual performance. In one study it was found that participants aged 50–60 required illumination in the range 100–400 lux to perform as well as younger participants (aged 20–30), who functioned with illumination in the range 2–5 lux (Bodman, 1962). For a dramatic illustration of this effect, see Green (2004b). Thus, a worker’s age may be important when designing visual tasks. Another problem with increasing age is reduced ability to focus on objects at different distances.
### Summary Text 3.1 Some Psychological Attributions of Colors

<table>
<thead>
<tr>
<th>Color</th>
<th>Positive attributions</th>
<th>Negative attributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Happiness, optimism, strength, dynamism, passion, warmth</td>
<td>Anarchy, the devil, blood, anger, explosiveness, death, war, debt</td>
</tr>
<tr>
<td>Orange</td>
<td>Communication, organic, warmth, ambition, cheerfulness, richness, generosity, receptivity</td>
<td>Malevolence</td>
</tr>
<tr>
<td>Yellow</td>
<td>Cheeriness, enlightenment, youth, sunshine, intelligence, action</td>
<td>Cowardliness, treachery</td>
</tr>
<tr>
<td>Brown</td>
<td>Organic, strength, earthiness, compactness, health, utility</td>
<td>Vulgarity, barrenness, impoverishment</td>
</tr>
<tr>
<td>Green</td>
<td>Nature, fertility, prosperity, life, hope, stability, security, calmness</td>
<td>Decay, mould, envy, jealousy, immaturity</td>
</tr>
<tr>
<td>Blue</td>
<td>Spirituality, devotion, justice, rationality, tranquility, contentment, hygiene</td>
<td>Melancholy, darkness, doubt, discouragement, depression</td>
</tr>
<tr>
<td>Purple</td>
<td>Royal, loyal, power, truth</td>
<td>Lust, decadence, mourning, secrecy</td>
</tr>
<tr>
<td>Black</td>
<td>Impenetrability, distinction, nobility, elegance, richness</td>
<td>Death, sickness, despair, denial, evil, sin</td>
</tr>
<tr>
<td>White</td>
<td>Purity, refreshment, perfection, infinite wisdom, truth, refined, delicate, peace</td>
<td>Blankness, absolute silence, void, ghostliness, surrender</td>
</tr>
<tr>
<td>Gray</td>
<td>Autonomy, neutrality</td>
<td>Indecision, fear, monotony, dirt, coldness, depression, age</td>
</tr>
</tbody>
</table>


For example, the eyes of an operator typing text at a computer keyboard move between the written material on the manuscript and a visual display screen, if the respective positions of the screen and manuscript are at different distances from the eye, then the eye needs to accommodate rapidly. With increasing age, the ciliary muscles in the eyes deteriorate, creating a long-sighted effect, whereby the nearest point at which the eye can be sharply focused moves further away. The heavy load on the ciliary muscles can account for eyestrain experienced by visual display unit (VDU) operators (Oborne, 1995). Perceptual deterioration is one reason why older people are generally slower than younger people at using software such as word processing (Davies et al., 1991) even where they have comparable typing speeds (Glendon et al., 1994) and competency at a range of other tasks, for example, driving (Davies et al., 1992). A measure of drivers' visual attention and
Summary Text 3.2 Recommendations for Auditory Warning Signals

- Use sound frequencies between 200 and 5000 Hz — where the human ear is most sensitive
- When sounds must travel long distances (>300 m) use sound frequencies below 1000 Hz — because high frequencies are absorbed in travel
- Use frequencies below 500 Hz when signals must bend round obstacles or pass through partitions
- In noise, use signal frequencies different from the most intense noise frequencies to reduce masking of the signal
- Use a modulated signal to demand attention — intermittent beeps (1 to 8 per sec) or warbling sounds that rise and fall in frequency
- Use complex tones rather than pure tones to differentiate from other sounds


3.2.2 Hearing and vibration

The ears convert noises received as sound pressure waves into electrical patterns, which as nerve impulses are decoded and measured by the brain’s auditory cortex. Sound waves vary in frequency, measured in Hertz (Hz). Sounds sensed by a normal young adult range from a low of 20 Hz to a high of 20,000 Hz. Sound below 16 Hz is called infrasound. For maximum effectiveness, auditory warning signals should be designed in accordance with the criteria shown in Summary Text 3.2. Different messages can be transmitted by different types of tones, as in the case of a telephone system. The quality of the tone enables people to distinguish between different human voices. Sounds can help airline pilots to steer a steady course. For example, a continuous 1020 Hz tone can be heard when the aircraft is on the planned course, but any deviation is indicated by different sounds. Different sound and voice modifications are associated with different degrees of urgency (Edworthy & Hel-lier, 2000), allowing auditory warning systems to be designed (see Section 3.4.3). Sounds with little or no quality of tone are called noise, frequently described as unwanted sound. The ear’s sensitivity to sound intensity varies with sound frequency. Sound intensity is measured in decibels (dB). The range of audible noise levels is shown in Summary Text 3.3. Matthews et al. (2000) summarized effects of noise on task performance. Summary Text 3.4 gives examples of adverse and beneficial effects of sound, while Summary Text 3.5 indicates ways of reducing noise as part of a risk management program. Hearing loss can result from the combined effects of long-term exposure to noises that people encounter every day, such as those generated by loud music or motor vehicles. Normal aging is also associated with hearing loss. Evidence on the role of noise in injury causation, summarized
Chapter three: From sensation and perception

Summary Text 3.3 Noise Levels and Environmental Conditions

<table>
<thead>
<tr>
<th>dB</th>
<th>Example of noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>Pain threshold</td>
</tr>
<tr>
<td>130</td>
<td>Pneumatic chipper</td>
</tr>
<tr>
<td>120</td>
<td>Loud automobile horn</td>
</tr>
<tr>
<td>110</td>
<td>Inside underground train</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Average traffic on street corner</td>
</tr>
<tr>
<td>70</td>
<td>Conversational speech</td>
</tr>
<tr>
<td>60</td>
<td>Typical business office</td>
</tr>
<tr>
<td>50</td>
<td>Living room</td>
</tr>
<tr>
<td>40</td>
<td>Library</td>
</tr>
<tr>
<td>30</td>
<td>Bedroom at night</td>
</tr>
<tr>
<td>20</td>
<td>Broadcasting studio</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Threshold of hearing</td>
</tr>
</tbody>
</table>

(db stands for decibels, a logarithmic measure of sound intensity)


Summary Text 3.4 Examples of Adverse and Beneficial Effects of Sound on Human Performance

Both intermittent and continuous noise can have detrimental effects on behavior. For example, Crook and Langdon (1974) found that aircraft noise impacted on a group of school children in the ways listed below.

- Increased fidgeting, irritability, tiredness, and headaches among pupils
- Disruption of lessons
- Reduced teacher satisfaction and increased irritability and tiredness

Nemecek and Grandjean (1973) found that percentages of workers in a landscaped office reported that they were distracted by noises from conversations (46%), office machinery (25%), and telephones (19%). Similar problems were revealed in a study by Waller (1969). Noise in the environment interferes with sound reception and decoding because of masking — which weakens the perception of a signal in the form of speech or sound from an auditory system. Some sound may have positive effects. For example, Fox (1983) found beneficial effects of background music in the work environment, such as reduced absenteeism and turnover, improved timekeeping, and productivity.
Summary Text 3.5 Examples of Noise Reduction Methods

- Sound absorbent material around noisy machinery
- Sound absorbing wall and floor materials
- Cover noise source (e.g., using hoods)
- Arrange plant and equipment to create screens and to reduce reflected sound level
- Isolate workers from noise source
- As a last resort provide comfortable personal protective equipment (PPE)

by Smith and Jones (1992), remains inconclusive. However, results from one study indicated that some self-reported everyday errors by people living in a high aircraft noise area were higher than for a comparable group in a quieter area (Smith & Stansfield, 1986).

While noise is sound transmitted through the air and detected by the ear, it is vibration when transmitted through a solid and detected by the body. Sound at the low end of the range is also felt as vibration. Levels of vibration experienced by vehicle drivers who drive on rough ground can cause structural damage to the body. In a study of 371 tractor drivers who frequently drove over rough ground, those who operated for long periods reported stomach complaints and spinal disorders, particularly in the lumbar and thoracic regions (Rosegger & Rosegger, 1960). Thalheimer’s (1996) review of effects of whole-body vibration in the workplace revealed an array of adverse health effects. International guidelines, introduced in 1997, seek to reduce workers’ vibration exposure to acceptable levels (International Standards Organization, 1997). Prolonged exposure to high-frequency vibration is also likely to cause injuries. This is common among workers who use handheld powered equipment such as road drills, stone breakers, and chain saws. Intense vibration can be transmitted to an operator’s fingers, hands, and arms, producing effects such as intermittent numbness or clumsiness and perhaps damage to bones, joints, or muscles as well as restriction of the blood supply (as in vibration induced white finger). Prolonged rest is the only cure for all or some of these symptoms, although they can reappear if the worker is again exposed to the vibrating stimulus. Vibrating structures can also produce motion sickness and headaches, as on board a ship. A vibrating source can also provide useful information. For example, a particular combination of noise and vibration from a car engine can inform the driver that something is amiss. Effects of vibration on human performance and well-being are complex — for details see for example, Sherwood and Griffin (1990), Griffin (1992), European Committee for Standardization (1996), Thalheimer (1996), and Yao et al. (1998).

3.3 Perceptual organization and interpretation

With such a rich and diverse array of sensory receptors, the process of interpretation, or perception, involves much more than simply processing external and internal stimuli. It involves a variety of cognitions, including learning and memory, as well as problem solving, decision making, and language. Perception and its associated cognitions comprise complex patterns that the brain continuously interprets to enable us to make sense of our world — including dangers that we face. Perceptual information, almost always from multiple modalities, is combined to produce patterns that we can understand and act upon where necessary. This includes how we perceive warnings and use that information as a
motivator to action. For example, in his classic study of a gypsum mine, Gouldner (1955) described how experienced miners were able to identify subtle cues that presaged a roof collapse: they referred to the supporting timbers as speaking to them, which would give them time to evacuate.

Still to be fully understood is the phenomenon of synesthesia, experienced by some people, in which sense modalities that are traditionally considered to be separate, become fused in various ways — up to 40 possible combinations have been identified, and it seems that this fusion of the senses occurs particularly in the limbic system (Cytowic, 2002), identified in Chapter 2 as the seat of the emotions. Synesthesia is considered to result from cross-wiring in the brain that links different senses. Our perceptual system is designed to interpret multisensory inputs simultaneously, which can be challenged by such phenomena as the Stroop Effect, which confuses the visual sense by presenting the words for various colors in colors that are different from the word itself (e.g., the word green is written in the color red), which take longer to read. The McGurk Effect confuses visual and auditory modalities, and is typically demonstrated by the sound of someone saying one thing while a video seen simultaneously shows their lips saying something else — as in watching a poorly dubbed foreign language film. Alsuisi et al. (2005) found that concentrating on a secondary task could reduce the McGurk Effect so that important information could be attended to, which would be of survival benefit if a person was in real danger — such as the miners in Gouldner’s (1955) study. The location of synesthetic effects deep within the brain suggests that this capacity could be shared at least with other mammals, and quite possibly that this mode of functioning was relied upon to a much greater extent by our ancestors than most of us are capable of. The ability to sense danger using a combination of sensory modalities has important survival value, although because the nature of our environment has changed radically this phenomenon now has more curiosity than survival interest.

Cytowic (2002) considered synesthesia to be a normal brain process that is displayed in only a small number of people. It has been suggested that humans are all born with synesthesia but that most of us lose the ability as our brains develop and mature, so that only around one in 2000 adults can experience this phenomenon (Mondloch & Maurer, 2004). One such person, a musician, was reported on by Beeli et al. (2005), who described the musician as using her synesthetic sensations in the complex task of tone-interval identification. In this individual, each of around ten tone intervals (e.g., minor third, major seventh) was consistently associated with a different taste, the effect being unidirectional — that is, the musician did not hear the tone when exposed to the corresponding taste, evidence according to the authors of a synesthesia-cognition cascade. Beeli et al. suggested that synesthesia could be used to solve cognitive problems. It has been known for some time that people have different preferred sense modalities, the most common being visual (seeing problems pictorially for example), with affect (feelings and emotions), and verbal (thinking in words) also common, while other sense modalities, such as taste or smell were much less common (Bandler & Grinder, 1979). An interesting illustration of how one well-developed sense modality may be confused by another, is given in Summary Text 3.6, while Summary Text 3.7 gives an example of how our visual sense can be readily fooled.

3.3.1 Organization

After concentrating on relevant stimuli, we organize the incoming information. When people watch a safety film, the soundtrack and visual images are complementary and help the audience to organize the messages. Repetition of a message, as in advertising or a safety campaign, also contributes to perceptual organization. However, this can be difficult in circumstances where the stimuli are ambiguous or difficult to grasp. Thus, people tend to make their world more understandable by emphasizing stability and constancy.
Summary Text 3.6 Seeing is Believing

Many years ago, a renowned speaker presenting the Royal Institution Christmas Lecture in London wished to illustrate the way in which our senses combined to provide important information about our external world. To do this, he introduced an expert wine taster and placed two glasses of red colored wine on the bench. Being invited to sample the wine in the first glass, the wine taster went through his usual routine of studying the look of the wine, and then its aroma, before finally tasting it. One sip was sufficient for the expert to quickly identify the wine’s characteristics and within a short time he was able to locate almost the precise vineyard in which the grape had been grown. Suitably impressed, the audience applauded this man’s genuine expertise and knowledge of his subject. The speaker then presented the wine taster with the second glass and the same procedure was followed. However, on this occasion the wine taster was clearly puzzled and took several sips from the glass before eventually admitting that he could not identify the wine, but that it was acceptable to the taste, without being a “classic wine.” The speaker then dropped the bombshell by asking the wine expert if he considered Chablis to be a classic wine. The wine taster immediately knew that he had been duped by the tasteless red coloring that had been added to this glass of famous white wine. Not only the expert, but also the audience had been fooled into thinking that this was genuinely a red wine and once the incorrect branch for identifying a wine had been entered, it seemed that there was no way back. From the very start of the exercise, the expert’s visual sense had locked his perceptual processing into the category “red wine.” The short discussion that ensued focused upon the importance of the initial visual impression given by a wine and the point had been ably demonstrated.

Summary Text 3.7 Fooling the Visual Sense

The capacity to manipulate how sensory information is organized and interpreted by an audience is demonstrated in the stage show magic of the classic illusionists. For example, in the 1800s, the famous French magician Robert Houdin performed an illusion that involved juggling three balls, whilst telling the audience a story — which varied, but always included a theme on the number three, such as the moon, sun, and earth. During the telling of this story, whilst the juggling movement of three balls was constant, Houdin would progressively place the balls, one at a time, into his pocket; finally, he would clap his hands, and the three balls, which the audience perceived he had been juggling continuously throughout the story, would appear to have vanished into thin air! (Axworthy, 2005).

Constancy is illustrated in situations where objects are perceived as stable (e.g., in size) despite significant changes in the stimuli reaching our senses. Thus, a person who is close to us rather than distant produces a larger image on the retina, but we make allowances for the differences and we still see a normal sized adult. Likewise, we make adjustments for variations in effects produced by light on different surfaces, seeing color as we expect it
to be, rather than how it is. For example, sunlight coming into a room with a white ceiling and a blue carpet may make the ceiling appear blue from the reflected light. However, because of the constancy effect we still see the ceiling as white. Under certain circumstances constancy does not hold good, so that what we see appears to be quite different from what we know to be true. In such circumstances, illusions occur as errors of perception. For example, when we see the moon near the horizon, it looks larger than when we see it high in the sky, even though the moon produces the same sized retinal image in both cases. One explanation for this illusion is that the perceived distance to the horizon is judged to be greater than that to the zenith and it is this greater perceived distance that leads us to see the moon as larger at the horizon (Holway & Boring, 1941).

Illusions of movement arising from stationary stimuli are not uncommon. For example, an isolated stationary light in an otherwise dark visual field appears to wander after observing it for a while. This autokinesis effect is often encountered in flying (Hawkins, 1987). There are numerous reported cases of mistaken identity of lights, such as a pilot circling round the wing tip light of the aircraft to identify it. There are also examples of illusions arising from moving stimuli. For example, when you look out of the carriage window of a stationary train and see another train moving off from an adjacent platform. The perception that your own train is moving is the illusion of induced movement. Another common illusory problem experienced in visual flights relates to evaluating the relative altitude of approaching aircraft and the subsequent collision risk assessment. At a distance, an aircraft appears initially to be at a higher level but may eventually pass below the level of the observer. Mountains at a distance appear to be above the aircraft, but are eventually seen well below it. Two aircraft separated by 1000 ft may appear to be approaching each other’s altitude, and both pilots have been known to take unnecessary evasive action, possibly increasing the risk of a collision with another aircraft (Hawkins, 1987).

3.3.2 Interpretation

Interpretation of information or stimuli of interest to us follows the organization of our perception. Our cognitive processes, the way we think and feel about the world, aid interpretations. We are highly selective in the way we attend to stimuli, which is perhaps unsurprising, given our different needs, values, objectives, education, training, and experiences. Information is filtered through a person’s frame of reference or personal model of the world. Information that challenges cherished positions may be rejected unless it is accommodated in some way within the individual’s belief system (see Chapter 6). It may have to be fed to the individual on a piecemeal basis if a behavior or attitude change is sought. Information that is absorbed into the person’s belief system is afforded some form of protection (Ross et al., 1975).

The notion of consistency, congruity, or balance underlies such theories as those of Festinger (1957) on cognitive dissonance: the basic premise being that people strive to make their attitudes and behavior consistent. The narrative in Summary Text 3.8 illustrates a safety-related example from the cognitive consistency perspective. People tend to strive for consistency in their mental models and can unconsciously modify their existing belief systems by appealing to hindsight (Fischhoff, 1975). With the benefit of hindsight, an unexpected outcome, such as an injury, can be seen to have some purpose and can, to some extent, compensate for poor prediction. This means that the individual does not have to overhaul their ideas completely. If we are concerned with communicating safety messages that are designed to challenge people’s frames of reference, it is important to consider strategies for effecting such change. One approach is to challenge current frames of reference dramatically. An example would be a person who has an injury or hears about a friend who has suffered a traumatic injury. Such an event can pose a substantial challenge
Summary Text 3.8 Cognitive Dissonance: A Safety Example

Cognitive dissonance occurs when our attitudes and behavior are inconsistent or dissonant. The theory is based on an assumption that people need consistency between their attitudes and behavior and that any inconsistency will result in them striving to reduce or eliminate it. For example, if a person smokes (behavior) and at the same time believes that smoking is harmful (attitude) then they are in a situation of dissonance with respect to smoking. Logically there are only two ways in which they can reduce or eliminate the dissonance; first to change the behavior and second to change their attitude toward the behavior. In our example, there is only one way in which they can change their behavior so that it becomes consonant with their attitude and that is to stop smoking. However, there are a number of ways in which they could change their attitude so that it becomes consonant with their smoking behavior. For example, they could reason that smoking helps them to concentrate at work or that it helps them to feel at ease in social situations or that whatever the possible long-term harm, they still actually enjoy smoking. Alternatively, they might think that they are unlikely to get cancer even if others do, or they might say to themselves that they might die in some other way so why stop smoking, or that if they do fall ill they will be looked after, or they might . . . and so on. In other words, there are many alternative ways of changing an attitude about something so that it fits with your behavior, while options for changing behavior may be fewer.

Thus, when we are seeking to make health and safety improvements involving human behavior, it is not enough to change attitudes, as these might simply swing round to remain consonant with risky behavior in some other way. It is essential to address behavior directly and also to ensure that attitudes corresponding with that behavior remain consonant with it. For example, in training people to follow a safe system of work, the behavior that this involves needs to be reinforced with reminders that influence attitudes in the same direction — for example, that intelligent people use this method, that it was developed by people experienced in the technique, and so forth. Cognitive dissonance is a theory with potential practical health and safety applications.

to a prevailing negative perspective about the need for cautionary measures. However, because injuries remain relatively rare events, this option cannot be relied upon. This is similar to the change in views that cultural theory prototypes might experience as a result of contact with an alternative perspective, described in Chapter 2. An alternative is to use a training program to change the foundation that underpins the frame of reference. For example, as part of training sessions in risk management, organizations may use case studies of major incidents in other organizations on the grounds that, given similar circumstances, they could find themselves in a similar position. Using appropriate case studies can help to promote a profound learning experience, leading to changes in management, working practices, training, design, and other risk management components.

3.4 Attention and vigilance

A wide variety of stimuli compete for our attention. Physical stimuli likely to attract our attention include large objects, loud sounds, strong colors, repeated occurrences, a moving
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object in a stationary setting, and an event that contrasts sharply with its surroundings (e.g., an injury or a near hit). As we cannot attend to all stimuli coming our way, we select those that we consider to be most relevant to our needs. A real challenge for safety and risk scientist practitioners is how to influence people’s perceptions, including those responsible for managing others’ safety, so that they are motivated to select safety relevant information at appropriate times. Matthews et al. (2000) provide a more extensive review of cognitive aspects of selective attention, divided attention, vigilance, and sustained attention.

3.4.1 Sustained attention and vigilance

The main sense modality involved in collecting information is vision in many activities, for example, driving. A lack of visual attention has been associated with vehicle crashes (Porter, 1988; Arthur et al., 1994), although other studies have failed to find a systematic relationship between visual performance and driving ability (Evans, 1991). Arthur et al. (1994) found significant correlations between three versions of a computer-based visual attention test (ranging from 0.26 to 0.38) between errors on visual attention scores and self-reported driving crashes. When driving, paying attention to the road (primary task) is essential, multiple secondary tasks in cars, including using cell phones (Lesch & Hancock, 2004; Patten et al., 2004; Törnros & Bolling, 2005) have been shown to have a detrimental effect on driver performance. Effects include significantly reduced headways and increased brake pressure (Lansdown et al., 2004). Motor manufacturers have responded by developing multi-controls that require minimal visual attention; for example, the BMW 5 series is equipped with the iDrive (Dukic et al., 2005).

The capacity to sustain visual attention over prolonged periods (vigilance) is required in a number of work tasks, such as train driving, in which errors can be associated with vigilance failures (Haga, 1984). Vigilance tasks, particularly those requiring monitoring for infrequent events, are susceptible to preoccupation and distraction effects (for further discussion, see Section 4.3.1). Smiley (1990) concluded that sustained attention failure was a major contributing factor in the Hinton train disaster in Canada in 1986. A number of problems are associated with automating tasks, where many of the more challenging tasks are automated, leaving monotonous monitoring tasks, which are ill suited to humans (see Bainbridge, 1987, for further discussion). Automated systems are often introduced to help operators cope with increasing workload, but either prove unreliable with the result that operators cease using them (Muir & Moray, 1996), or they prove extremely reliable, resulting in operators not monitoring them effectively (Parasuraman et al., 1993).

3.4.2 Selective attention

Apart from the effects of physical stimuli attracting our attention, our mental condition is also important, which will be affected by such factors as our personality, motivation, and learning ability. We are inclined to attend to signals or cues that are of interest to us. For example, a safety and risk scientist practitioner may take a keen interest in the safety aspects of a media report of a major disaster. Likewise, a safety and risk scientist practitioner’s motives in respect of his or her professional activities will alert that person to see things in a safety or risk context. Motivations can selectively bias perceptions — for example, a hungry person is drawn to images of foods on display posters because of the association between food and gratification of the hunger need. This is called selective attention. In coping with a threatening situation, selective attention can come to our assistance. This manifests itself when a person ignores stimuli considered to be mildly threatening but attends to stimuli posing greater threats. Apart from their specific motives, the person’s experience of the stimulus can aid perception. This can be seen when an audible sound signifying a hazard...
is isolated as being more important than a number of other sounds that are heard at the same time.

As humans attend selectively to phenomena, in order for a message to be successfully delivered it must be presaged by some mechanism that alerts the receiver. It is like tuning in a radio to a particular frequency to listen to a particular channel. This “tuning in,” which applies to all the senses, is akin to another important aspect of perceptual and attention mechanisms and that is expectation. Using data from our senses, what we perceive is governed very much by what we expect to perceive. This in turn is largely determined by our previous experience. The expectation of perceiving a particular set of circumstances, often known as perceptual set, can be a powerful determinant of whether we are able to take in and act upon new information. For safety and risk scientist practitioners, breaking a perceptual set, for example, in a line manager, may be a problem. Human beings, unlike computers, are not very good at picking up minor deviations from sequences or small changes in routine; this is the type of task that is properly devolved to machines or computers.

A number of studies have noted the contribution that perceptual errors have made to injuries, for example, in relation to train drivers who pass signals at danger (Davis, 1958, 1966; Buck, 1963; van der Flier & Schoonman, 1988; Gilchrist et al., 1989). Van der Flier and Schoonman (1988) examined the circumstances of 224 signals passed at danger (SPADs) on Dutch Railways over a 2-year period. Causes associated with driver error included those shown below with percentages of incidents classified under each cause. Some incidents could be classified under more than one cause as follows:

- Stop signal not noticed: 32%
- Stop signal noticed too late: 26%
- Previous signal not noticed: 7%
- Incorrect anticipation of signal: 11%
- Distraction: 11%
- Faulty braking: 11%

The first five causes are all perceptual errors that are related to the mechanisms of false hypotheses and preoccupation. False hypotheses can take a number of forms, but generally occur when people respond to situations as they perceive them, rather than as they really are (Davis, 1958). The hypothesis governs the way in which a person perceives the situation and how the perceptual material available is organized (Davis, 1958). The persistence of a false hypothesis can be strengthened under a number of conditions, two of which are particularly relevant in the railway industry. First, is the condition of strong expectation and can be based on past experience or on appraisal of the current situation. This has a particularly strong effect and has been shown to persist even when the signal is strong and of some duration. Second, is the effect of specific end deterioration, which occurs when anxiety is low, particularly following a stressful period or event. Studying causes of collisions with highly conspicuous police vehicles parked on the hard shoulder of a motorway, Langham et al. (2002) found similar factors operating. These collisions resulted from vigilance failure and false hypotheses about road conditions (e.g., drivers would assume that a vehicle was moving, not stationary) rather than sensory failure. Sufficient is known about the limitations and influences upon humans’ visual and other senses for work and other environments to be designed to take account of many of these.

Analyzing causative factors that led to the Ladbroke Grove train crash, Lawton and Ward (2005) identified a number of perceptual errors that could lead the driver to pass a signal at danger and to contribute to the crash. These were: expectation — the train driver had never experienced a red signal at the particular signal site, an expectation that may have delayed his interpretation and response; distraction/preoccupation — as the driver was relatively inexperienced, he may have been distracted, for example, by checking the route;
and false perceptions — direct sunlight on the signal may have led the driver to perceive the signal as a double yellow, meaning proceed with caution, rather than red, meaning stop. The authors concluded that possible actions involving perceptual errors included:

- Driver expected to see a yellow signal and consequently misperceived the signal
- Driver failed to check the signal again (perhaps because he became distracted, by the need to make a public announcement, log into the cab secure radio, or check the route)
- Driver performed only a cursory check to reaffirm his biased first sighting of the signal

3.4.3 Effectiveness of warnings

Warnings can take many forms, including verbal, written, or pictorial, as appealing to human cognitions; or they may appeal directly to the senses, as in the case of alarms, bells, or other noises, smells, or sights. Most warning systems use the visual and auditory senses, but other senses can be used. For example, Wogalter and Mayhorn (2005) gave the illustrations of bitter substances added to detergents so that children would spit out rather than swallow dangerous chemicals; odor added to natural gas to aid gas leak detection, and an aircraft control stick that shakes to indicate that too steep a slope has been taken by the pilot.

For any communicated message, including a warning, to be effective, certain conditions must be fulfilled. These are shown in Summary Text 3.9, from which it should be clear that presenting effective warnings requires at least the following features:

- Timing — the warning should be given at exactly the right moment
- Audience — the warning should reach all those for whom it is intended, and ideally should not be wasted upon those for whom it has no use or meaning
- Explicitness — the warning should tell those for whom it is relevant exactly what they should do — general exhortations are unlikely to be effective

An example of a warning that meets these requirements well is given in Summary Text 3.10. The style and format of an effective warning will be dictated very much by the nature of the danger and those who might be affected by it. Thus, in the example given in Summary Text 3.10, a combination of written and pictorial warning messages was effective. Auditory warnings are particularly useful when the person is engaged in a visual task, where a visual warning might be missed or interfere with the primary task. Criteria are available for deciding when to use auditory or visual presentation of warnings, and these are shown in Summary Text 3.11. Less predictable or immediate dangers will require different approaches. Dimensions associated with danger perception identified by Pérusse (1980) are shown in Figure 3.1. The crucial dimensions used are those shown at the top of Figure 3.1, namely scope for human intervention (what could I do about a given danger?) and dangerousness (what is the worst thing that could happen as a result of this danger?). Components of each of these major dimensions are discussed in various publications, for example, HSC (1993a) — see also the discussion in Chapter 2.

People may adapt to repeated stimuli by developing reduced awareness. For example, we may become oblivious to the dangers of driving a daily route, thereby increasing our crash risk. Accounting for this phenomenon, it could be argued that a repeated stimulus contains no new information. This is analogous to people living near to a nuclear power station adapting to this situation in the absence of an incident. Anxieties subside with the accompanying cognitive reassessment of the probability of an incident. However,
Summary Text 3.9 Conditions Required for Effective Communication

<table>
<thead>
<tr>
<th>Sender should be</th>
<th>Message should be</th>
<th>Channel should be</th>
<th>Receiver should be</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>Accurate</td>
<td>Open</td>
<td>Present</td>
</tr>
<tr>
<td>Aware</td>
<td>Adequate</td>
<td>Capacious</td>
<td>Attentive</td>
</tr>
<tr>
<td>Sensitive</td>
<td>Addressed correctly</td>
<td>Economical</td>
<td>Literate</td>
</tr>
<tr>
<td>Selective</td>
<td>Economical</td>
<td>Low noise</td>
<td>Perceptive</td>
</tr>
<tr>
<td>Sympathetic</td>
<td>Direct</td>
<td>Secure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timely</td>
<td>Swift</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reliable</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up-to-date</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Actually sent!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary Text 3.10 A Case Study in Communication

An airline was becoming increasingly embarrassed by injuries resulting from passengers falling down the steps to the tarmac after alighting from its aircraft. It had tried various means of reducing the passenger injury toll, including in-flight warnings and cabin crew members instructing passengers to mind how you go as they left the aircraft, but none had any noticeable effect. The airline’s management then called in a research team to see whether they could provide a solution. The researchers tried a number of alternative solutions before coming up with one that seemed to work. The method was as simple as it was elegant. As passengers left the aircraft and walked onto the platform at the top of the steps they were confronted with a poster on the side panel of the platform. The poster displayed the words HOLD THE RAIL, underneath which was a picture of someone lying on the tarmac at the foot of the steps. Following the introduction of the poster on all its airport steps, the airline found that a significant reduction in passenger falls resulted.

The poster that was used in this case fulfilled the essential criteria for effective communication in safety. It was given at exactly the right moment — when passengers were about to descend the steps; it was available only to those for whom the message was intended and not wasted on anyone else; and it gave an explicit instruction as to what to do. The written message was backed up by a picture of what could happen if you didn’t follow the instruction. As a general principle, if fear or threat is used in safety propaganda then this must be accompanied by explicit instruction on how to avoid the threat.


those living at a slightly greater distance may experience greater anxiety or dissonance (see Summary Text 3.8) as they are still close enough to perceive the risk but not sufficiently close to reduce the dissonance, for example, by gaining benefits such as employment or obtaining support from others in the community. This is also an issue in designing warning
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Summary Text 3.11 Guidelines on Using Auditory or Visual Information

<table>
<thead>
<tr>
<th>Use auditory presentation if:</th>
<th>Use visual presentation if:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message is simple</td>
<td>Message is complex</td>
</tr>
<tr>
<td>Message is short</td>
<td>Message is long</td>
</tr>
<tr>
<td>Message will not be referred to later</td>
<td>Message will be referred to later</td>
</tr>
<tr>
<td>Message deals with events in time</td>
<td>Message deals with location in space</td>
</tr>
<tr>
<td>Message calls for immediate action</td>
<td>Message does not require immediate action</td>
</tr>
<tr>
<td>Visual system is overburdened</td>
<td>Auditory system is overburdened</td>
</tr>
<tr>
<td>Receiving location is too bright</td>
<td>Receiving location is noisy</td>
</tr>
<tr>
<td>or dark adaptation is required</td>
<td></td>
</tr>
<tr>
<td>Job requires continually moving about</td>
<td>Person’s job is in one position</td>
</tr>
</tbody>
</table>


Signs, for example, those warning of the presence of children at schools; whilst the signs are permanently erected at the school entrance, the danger will be relatively low, except when children are entering and leaving school. Therefore, some signs are designed to flash at these times, to indicate the increased hazard. Wogalter and Mayhorn (2005) discussed ways in which new technology can be used to enhance warning systems.

3.5 Causal attribution

The essence of a cognitive approach to behavior is that individuals seek to understand and interpret their environment as essential antecedents (e.g., motivators) to action. Central to this approach is to understand how perceptions translate into behavior. Cognitive derivatives, such as attitudes, motives, and beliefs, mediate stimuli and responses, that is to say thought influences action, and a purely mechanistic or behaviorist approach is inadequate to account for the complexity of human action. An illustration is given in Summary Text 3.12. In the remainder of this section, we describe key features of attribution theory—a cognitive approach to motivation.

Attribution theory originated in the study of subjective experience (phenomenology); stimuli from the environment provide information, which is processed to give meaning to that environment. Attribution theory is concerned with how individuals interpret events that are caused in their environment and with their inferential perceptions of causality. Motives are attributed. The development of attribution theory was influenced by Gestalt psychology and by field theory, behavior being a function of person and environment. Early attribution theorists (Festinger, 1957; Osgood et al., 1957; Heider, 1958) considered disequilibrium to be a basic principle of motivation. An individual strives for balance or consonance with the environment and this was considered to be the primary motivating force. However, in modern attribution theory, reducing dissonance (e.g., in the form of conflicts between attitudes and behavior—see Summary Text 3.8 for an example) or achieving balance, is a means to achieving superordinate (i.e., higher order) goals. Thus, attributions are made: first, to enable an individual to predict events, and second, to help them to exert control over events. Thus, the need for control is the primary motivation in attribution theory and predicting events facilitates this control. The sequence of events in making attributions is shown in Figure 3.2.

According to Kelley’s (1972) covariation model, attributions are made on the basis of the three types of information, which are:

- **Consensus**: to what extent does the behavior generalize across actors? Consensus is high when a large majority of people would behave in the same way in the same situation; consensus is low when, given the same situation, a large majority of people would have behaved differently.
- **Distinctiveness**: to what extent does the behavior generalize across situations? Distinctiveness is high when the same actor only behaves in this way in this particular situation, but not in other situations; distinctiveness is low if the same actor would have behaved in the same way in other situations.
- **Consistency**: to what extent does the behavior always occur, given the same actor in the same situation? Consistency is high when the behavior always occurs, but low when the behavior is a rare occurrence.

For example, a manager may observe a worker violating a company safety rule on a certain occasion. Based on consensus, distinctiveness, and consistency information, the manager...
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Summary Text 3.12 The Power of Cognition

A participant in an experiment is occasionally given electric shocks when he makes errors while learning a task. The participant is able to cancel the onset of the shock by quickly pressing a button after making an error — assuming that he realizes the error — in which case a shock is no longer given. The behaviorist experimenter disables the shock generating mechanism and then observes behavior to see how long the participant continues to press the button after making errors. The experimenter is testing how long the now nonfunctional button pressing behavior continues to the point of extinction — the point at which the participant realizes that even if he fails to press the button in time, no shock will be delivered. The experimenter records many superfluous button pressings.

A cognitive researcher carrying out the same experiment simply says to the participant, “Please continue with the task, but I’m not going to deliver any more shocks so you don’t need to use the escape button any more.” The consequence is that having had the situation explained to him, as opposed to leaving him to find out by trial and error, the experimental participant ceases to press the button immediately (assuming that he believes that the experimenter is telling the truth, although in any case he is certain to test this hypothesis to confirm that it is true) and gets on with the task. Thus, if we view human beings as mere recipients of physical stimuli, we cannot advance beyond a behaviorist perspective, whereas if we take account of their complex mental apparatus and explain things to them, then we are dealing with a more complete perspective of what governs or motivates human behavior.

An analogous situation in the risk management field would be to leave an inexperienced worker to find out for him/herself about the hazards of a job. Eventually, through trial and error this may happen — if the youngster is not killed first. However, if the hazards and necessary precautions are explained to the worker, then this constitutes a more immediate and more effective way of getting important safety information across.

could make a number of different attributions as to the reason why the worker violated the rule (see Summary Text 3.13). The incident may be attributed to one of three basic causes: the worker (the actor — the person engaging in the behavior), the task (the entity — to which the behavior was directed), or the situation (the context — the circumstances in which the behavior occurred).

Weiner (1979) suggested that causes are categorized along three dimensions: locus (internal vs. external), stability (temporary vs. permanent), and controllability (controllable vs. uncontrollable). In Scenario A in Summary Text 3.13, an external cause (the situation) provides an explanation for the worker’s behavior. In this case workers may only break the rule when they perceive that there is pressure to put production before safety — for example, when there are tight deadlines to be met and supervisors turn a blind eye to rule violations. In Scenario B, the rule itself (the entity) provides a causal explanation for the worker’s behavior — the rule may be inappropriate to local conditions. Reason et al. (1998) noted, “it is not uncommon for organizations to develop and formalize procedures with little consideration for the practicalities of working with them in everyday situations” (pp. 297–298). In Scenario C, an internal cause (the actor) is responsible for the observed
Information (external or internal stimuli)

Is modified by

Beliefs

That structure

Cognitions

That determine

Behavior

**Figure 3.2** General attribution sequence.

behavior — that is, the manager might attribute the behavior to personality traits (such as risk taking or sensation seeking) or to a cavalier attitude toward safety. The attribution made will have very different implications in terms of safety interventions to prevent this type of behavior recurring. In Scenario A, a cultural intervention might be required, targeting the current safety climate of the workplace (see Chapter 6) and supervisory behavior. In Scenario B, an intervention targeted at the work task could be required, reviewing and redrafting procedures and rules governing the task, in consultation with the workforce. In Scenario C, an individual-level intervention would possibly be required, targeting the perceived internal cause of the behavior, for example, personality or attitudes, or the behavior itself (see Chapter 5). In the latter case, the manager may attempt to change behavior through punishment (e.g., verbal warning), or improve attitudes toward safety (e.g., safety training and education). However, where the cause of the behavior is seen as stable and internal (i.e., enduring and immutable), such as personality traits, the action may be to fire the worker. Dejoy (1994) suggested that when poor safety performance is attributed to controllable factors, such as breaking safety rules, harsh and punitive actions often follow.

The extent to which individuals can successfully weigh up the three sources of information is limited. There is a strong tendency, called the fundamental attribution error, to overemphasize the influence of internal causes, as opposed to external ones, when judging other people’s behavior. Thus, a manager looking for a causal explanation for a worker’s behavior will tend to focus on cues related to the actor, rather than the situation.

To some extent this can be explained when the context of the observer is considered: for the observer, the behavior of an actor is most salient, being viewed against the background of the environment. The fundamental attribution error is only made when judging other people’s behavior, not our own. When we take the role of the actor, our perspective is quite
Summary Text 3.13 Different Ways of Attributing Causality Depending on Consensus, Distinctiveness, and Consistency Information

Scenario A

1. High consensus — in the same situation all workers would violate this safety rule
2. High distinctiveness — this worker only violates a safety rule in this particular situation, but does not generally violate safety rules
3. Low consistency — this worker does not always violate this rule in the same situation

Causal attribution: CONTEXT — the particular situation on this occasion made following the rule impossible.

Scenario B

1. High consensus — all workers would violate this safety rule in the same situation
2. High distinctiveness — the same worker only violates a safety rule in this particular situation, but does not generally violate safety rules
3. High consistency — the same worker always violates this rule in the same situation

Causal attribution: ENTITY — the safety regulation is unworkable in this particular situation.

Scenario C

1. Low consensus — other workers would not generally violate this safety rule in the same situation
2. Low distinctiveness — the same worker tends to violate safety rules generally in other situations
3. High consistency — the same worker always violates this safety rule in the same situation

Causal attribution: ACTOR — the worker is unsuited to this job — for example, is overconfident, arrogant, or a risk taker, or has a cavalier attitude toward safety.

different, the situation, rather than the behavior, is most prominent, as we observe that our own behavior takes place within a particular context. Thus, we tend to use more situational cues when attributing causal explanations to our own behavior. There is also a disparity in the amount of information available to each party. The actor has information about his or her own intentions and experience, while the observer must infer information about intentions from the context of the behavior and from general social norms. A related tendency is to underuse consensus information when making causal attributions; thus, there is a tendency for observers to judge an actor’s behavior in isolation, with little reference to how most people would behave in the same situation. A standard test when analyzing
the behavior of actors involved in major crashes, for example, in the airline industry, is the substitution test, which involves asking whether an individual with the same qualifications, background, and experience would be likely to have behaved in the same way under the prevailing circumstances (Reason, 1997).

Evidence suggests that attributional effects influence the way in which managers interact with their subordinates (Martinko & Gardner, 1987; Crant & Bateman, 1993). However, culture may also influence how attributional effects operate. For example, the fundamental attributional error is much more pronounced in Western cultures, which place greater emphasis upon individual responsibility, compared with many other cultures (Menon et al., 1999). The following section presents a more detailed discussion of attributional effects and some implications for safety.

The ubiquity of attributional effects, or cognitive biases as they are sometimes termed, might indicate that they serve one or more important psychological or social functions, for example, maintaining an individual’s integrity, protecting a person from psychological harm (such as reducing the impact of potential harm in social situations, and maintaining comfortable feelings), or maintaining a view that (contrary to many experiences) the world is a just and fair place. It seems likely that human evolution has primed several of our cognitive processes to serve a general protective function. In Section 3.5.1 a number of attributional effects are described, and it may be apposite to consider the underlying function or rationale for these biases.

3.5.1 Attributional effects

There is evidence to suggest that the fundamental attribution error tends to operate in safety-related situations, so that managers and supervisors tend to overemphasize the role of internal, worker-related factors in incidents, compared with situational factors (Mitchell & Wood, 1980; Dejoy, 1987; LaCroix & Dejoy, 1989). This bias also seems to extend to incident investigators — Perrow (1986) found that investigators attributed 60 to 80% of incidents to operators, despite a more detailed analysis revealing that this was true in a maximum of 30 to 40% of cases. Workers, on the other hand, tend to attribute their own injuries to factors in the environment, for example, design faults in apparatus or layout of controls (see Chapter 4). Recommendations for injury prevention are more likely to be aimed at altering the person rather than the setting; hence the frequently seen recommendation for action on injury report forms ‘told him not to do it again’. Furthermore, Dobbins and Russell (1986) showed that where workers did not perceive themselves as responsible for an injury, post-injury interventions targeted at individuals (such as training and punishment) were met with resentment and resistance.

A further effect is defensive attribution — the tendency for individuals who perceive themselves as personally and situationally similar to an injury victim to make more external attributions regarding injury causation (Burger, 1981). The operation of this bias acts to maintain or enhance the person’s own self-esteem (Shaver, 1970). Taking the example of an injury victim, the more that people believe that one day they may find themselves in the victim’s position, the more they attribute his or her circumstances to chance. This implies that they will be protected from blame should the same misfortune befall them. Another factor influencing the responsibility attribution is the just world hypothesis (Lerner & Simmons, 1966), which postulates that we need to believe that people get what they deserve and deserve what they get. Thus, if we see a victim of misfortune, such as an injury or illness, we tend either to blame or to derogate the victim because it is psychologically threatening to us as individuals to believe in a world governed by random reinforcements. In this scenario, we like to believe that all is for the best in the best of all possible worlds (Voltaire, Candide).
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The controllability dimension will affect attributions of responsibility, and associated emotional responses (Weiner, 1995). As the consequences of an unfortunate event, like an injury, become more severe people are increasingly motivated to assign blame to someone who might be responsible for the injury. Assigning blame reassures people that they will be able to avoid similar disasters, for if causality is assigned to unpredictable (and therefore uncontrollable) events then we have to concede that such an event might happen to us. Thus, motivated attributional processes are a means of encouraging and maintaining a person’s effective exercise of control in their world in order to maintain the belief in control over their environment. The attributional sequence is shown in Figure 3.3. The example of the OJ Simpson trial is given in Summary Text 3.14.

Self-beliefs of efficacy, for example, believing that you can control a situation, are central to motivation because they influence causal attributions, expectancies (see Section 3.5.1.2), and personal goal setting (Bandura, 1989). The concept of self-efficacy has links with the experience of stress and coping strategies, and is discussed in this context in Chapter 7 (especially Section 7.5.3.2).

3.5.1.1 Self-serving bias
This refers to the tendency for a person to take credit for their successes or improvements in their own behavior but not to accept blame for increasing failure or mistakes (Bradley, 1978). This bias can operate when we seek to protect ourselves from blame when things go wrong, for example, when injuries occur. For example, a supervisor will attribute the success of his or her high-performing workgroup to effective leadership skills, whilst explaining poor group performance as the result of insufficient effort from group members. This bias influences people to attribute causality in a way that will avoid any blame or responsibility being directed at them.

3.5.1.2 Severity bias
People are held to be more responsible for serious consequences than for minor ones, even if the antecedents are the same. This bias stems from the supposition that serious

![Figure 3.3 Attributional effects sequence.](image-url)
Summary Text 3.14 The Case of OJ Simpson

Graham et al. (1997) conducted an attributional analysis of Americans’ reactions to a much-publicized media event: the violent stabbing to death of OJ Simpson’s ex-wife, Nicole Brown, and her male friend, Ron Goldman, in Los Angeles on June 12, 1994, and the subsequent trial, and eventual acquittal, of OJ Simpson for their murders.

OJ Simpson was a high-profile African American, whose fame had been built on his success as a professional American footballer, and his later career as a movie actor and sports broadcaster. Although the prosecution case seemed strong (Simpson had a history of domestic violence against his wife, had made violent threats against her, and had purchased a knife similar in size and shape to what was believed to be the murder weapon; he wore shoes the same size as a set of bloody footprints that had been found leading away from the crime scene, and he had no alibi), the defense claimed that Simpson had been framed by the Los Angeles Police Department and was a victim of a flawed and racially biased judicial system. The jury, which consisted of nine African Americans, two whites, and one Hispanic, eventually acquitted OJ Simpson of the murders. Graham et al.’s study examined the responses of 177 Americans (119 White, 58 African Americans); those people who perceived that OJ Simpson’s actions were controllable (e.g., jealousy, anger/rage) inferred responsibility/blame for his ex-wife’s murder, felt little sympathy and some anger, and endorsed severe punishment. On the other hand, a more lenient sentence was endorsed when people viewed his actions as less controllable (e.g., related to his ex-wife’s behavior, such as having affairs, neglect of her children) held him less responsible, reported greater feelings of sympathy and less anger. The dimension of stability also influenced recommendations of punishment severity, with those who perceived the cause of the crime to be more stable, being more likely to endorse severe punishment.

Interestingly, the study demonstrated significant racial differences, with African Americans much more likely to perceive OJ Simpson’s actions as less controllable, and therefore viewing him as less responsible; they also reported feeling more sympathy and were more likely to endorse rehabilitation. A possible explanation is that African Americans were more likely to perceive themselves as similar to OJ Simpson, in terms of race, and therefore made more external (uncontrollable) attributions (defensive attribution).
Summary Text 3.15 The Case of Gary Hart

Gary Hart fell asleep at the wheel of his car whilst driving on the M62 motorway in the United Kingdom on February 28, 2001. In itself, falling asleep whilst driving, particularly on a motorway, is not an unusual occurrence. A U.K. survey (Maycock, 1996) found that 29% of 4600 respondents admitted to having felt close to falling asleep at the wheel in the previous year, and 18% had been involved in sleep-related crashes during the previous three years. However, the consequences for Gary Hart were much more serious than in the estimated 15 to 20% of motorway crashes that are due to the same antecedent, falling asleep, each year (Horne & Reyner, 1995; Maycock, 1996). Gary Hart’s Landrover plunged off the M62 onto the East Coast main railway line below, causing the Selby rail disaster, in which ten people died (HSE, 2002). He was convicted of causing death by dangerous driving and sentenced to a 5-year prison term. His case was compounded by the fact that his sleepiness was caused by having spent the previous night on the phone to a woman he had met over the Internet (controllable); it may have been viewed as less blameworthy if the cause had been viewed as uncontrollable, such as tending to a crying baby.

3.5.1.3 False consensus

People tend to think that their own beliefs are universally shared — that is, that others think the same way as they do. For example, people who believe that most injuries are caused by carelessness might well consider that most other people believe this as well. Children in particular display this bias and need to learn that other people think differently, although some people apparently go through life making few concessions to others’ views!

3.5.1.4 Situation bias

People underestimate the degree to which a person’s role in a situation can modify their behavior. This means that we tend to overestimate the extent to which behavior seen in one situation (e.g., at work) will be shown in another (e.g., at leisure). For example, a person who is a very safe worker may engage in what might be regarded as risky behavior outside work, such as hang gliding. Explanations for such apparently discrepant behavior can be found by reference to the voluntariness dimension of risk cognition (see Chapter 2), by which people will accept a larger amount of risk that they choose to expose themselves to, compared with risks that are imposed on them, as is usually the case at work.

3.5.1.5 Correlational bias

In this case people underestimate the importance of nonoccurrences. We tend to register far more the occasions when X and Y (two events) are found together than when they are not and as a result overestimate a causal link, if indeed there is one. This may happen in nonstatistical analyses of injuries or diseases when an event, such as working at a visual display terminal, is thought to be associated with a variety of conditions, such as migraine or ‘flu symptoms. Only rigorous research can establish whether a causal connection exists. Another example is the Bermuda Triangle: an area of the Atlantic Ocean in which a squadron of planes was mysteriously lost and which subsequently acquired mythological status as a place in which ships and planes were prone to disappear. However, no evidence was
produced to demonstrate that vessels were more likely to be lost in this area compared with any other part of the world’s oceans of comparable size.

3.5.1.6 **Negative weighting**
People generally weigh negative information more heavily than they do positive information. This can happen in situations involving personal judgments such as job appraisal, selection interviews, or personal relationships, where a single piece of adverse information can outweigh any amount of positive material. In the case of safety, a single event can blight an extended run of injury-free months and upset large amounts of careful planning for safety.

3.5.1.7 **Availability**
Tversky and Kahneman (1974) described cognitive biases and errors that people tend to make when arriving at causal inferences as heuristics; these are basic rules that individuals use to simplify difficult mental tasks. Whilst these heuristics are generally applicable, they can lead to substantial and persistent biases. The availability heuristic aids the estimation of event frequency, using the rule that an event is likely or frequent if instances of it can be readily brought to mind. This tends to lead people to overestimate the probability of events that are easy to imagine or to recall, for example, dramatic events like major incidents or those within personal experience. It has also been shown that the risk of rare adverse events occurring tends to be overestimated, whilst the risk of more common events is likely to be underestimated (Lichtenstein et al., 1978). For example, people in Lichtenstein et al.’s study said that murders were more common than strokes, although strokes kill ten times as many people. Floods were said to cause more loss of life than asthma, although death from asthma is nine times more likely. Cancer was judged to be about twice as frequent as heart disease, although the reverse was true. The reason that people’s judged frequencies of a range of risks differs from their actual frequencies is related to the availability bias, which ensures that we are exposed to unusual or bizarre risks through the media, and hence overestimate these, while defensive attribution serves to protect us from acknowledging that we could be struck down by one of a number of common diseases. While governments and other agencies produce statistical data on the risk of adverse events, individuals make their own subjective appraisals on the basis of published statistical data in the light of their personal experiences and makeup. For example, some people may neglect certain serious risks because they are relatively indifferent to them (Royal Society, 1983). Powell et al. (1971) found that workers were more likely to think of hazards that resulted in injuries that had happened to them or to their workmates. In Chapter 2, the possibility was raised that we are hard-wired to select certain types of information that could be critical to our safety or survival (Davis & McLeod, 2003). One approach to overcoming this bias in considering health and safety is using a systematic approach to hazard evaluation, such as an expert system or safety auditing.

3.5.1.8 **Adjustment**
In this bias, people estimate the probability of future events by starting from some a priori estimate and adjusting this up or down (Bayesian approach). The probability of conjunctive events, requiring A + B + C is overestimated, while the probability of disjunctive events, requiring A or B or C is underestimated, because in each case \( p(A) \) is the adjusting factor. For example, for a fire to occur, an ignition source (A), oxygen (B), and fuel (C) are all required. However, we may overestimate the probability of a fire if an ignition source is present because the probability of this, \( p(A) \), is known to be 1 and this affects our judgment of the overall likelihood of fire occurring. At the same time, the probability of a fire where
there is not an obvious ignition source may be underestimated. Thus, this adjustment bias often means that little realized hazards could be overlooked, particularly when their worst effects operate in conjunction with other events.

3.5.1.9 Representativeness

This leads people to ignore the a priori probability of an event and be inclined to predict the future as being representative of the past. One result is that we tend to underestimate an important statistical phenomenon — regression to the mean. A good example of this is seen in injury data. When the injury rate rises, we tend to look for causes and when it falls we assume that we must be getting things right. Yet neither of these is necessarily correct. The popular saying what goes up must come down can apply as much to injury rates as it does to share values. The issue is, when is a rise or fall in injury rates a real rise/fall and when is it merely random fluctuation about a mean level of injuries? Only proper statistical analysis can reveal this, and to perform it a large enough sample of injuries is required (Petersen, 1978; ReVelle, 1980; Tarrants, 1980; Krause et al., 1990a). The hours spent by safety committees and other groups trying to find reasons for changes in injury rates that have no explanation outside statistical variability could be released for positive action on safety and risk management. The need to find meaning for observed events is certainly a powerful motivator!

3.5.1.10 Small numbers

People tend to treat results from small numbers as being better than they should. An example of this is the gambler’s fallacy — a belief in the short run (it must come up red on the next spin) as opposed to long-run probability consistency. One way to counteract this bias is to collect large enough samples of cases — for example, injuries or near hits, before arriving at a conclusion. For advice on how large a sample should be, see for example, Bensiali and Glendon (1987), or Petersen (1989).

3.5.1.11 Anchoring

The anchoring effect of predictions and perceptions results in them being very resistant to alteration once made. Once beliefs have been formed and other cognitions (e.g., perceptions) linked to them, even removing the original data — for example, that someone has had an incorrect bad credit rating due to mistaken identity, may still not result in them being disconfirmed in the mind of the observer. The expression ‘mud sticks’ is a popular illustration of this phenomenon and we may continue to believe that someone was responsible for an injury, for example, and not trust them again (negative weighting bias) even when they have been proved innocent. This bias may well be compounded by the strong tendency for people to subject evidence in support of a belief to much less scrutiny than evidence against the belief. Professionals such as scientists and police investigators are as much prone to this bias as anyone else.

3.5.1.12 Overconfidence

People are poor at estimating the odds of something occurring and are overconfident in their judgments about facts, for example, typically being wrong 20 to 30% of the time on general knowledge questions, which they were 100% confident in being right about (Kahneman et al., 1982). Thus, when investigating injuries, incidents, or patterns of data, it is vital not to jump to conclusions, about which we may be confident but perhaps incorrect. This effect could also be confounded by the anchoring bias. We need to remind ourselves continually that we could be wrong about something we believe strongly.
3.5.1.13  Hindsight

Reported events are seen as being more likely in hindsight than using a priori information. The expression, 'I knew that would happen' illustrates this bias: the point is you did not know it would happen before it happened! If we knew which workers were to be killed next year at work, we could take them away and give them 12 months' holiday; it would certainly be a lot more cost-effective than killing them! But of course we do not have this information in advance of events and are therefore prey to such beliefs as either lightning doesn't strike twice in the same place and history repeats itself. By exaggerating the past, people underestimate what they have to learn from it: this is one of the unfortunate effects of hindsight bias. Anthony Hidden, QC was aware of this bias in investigating the Clapham Junction Railway Accident, when he wrote, “There is almost no human action or decision that cannot be made to look more flawed and less sensible in the misleading light of hindsight. It is essential that the critic should keep himself constantly aware of that fact” (Department of Transport, 1989, p. 147).

The cognitive approach to human motivation offers important insights into human behavior that is often described in the catchall term of human error (see Chapter 4 for further discussion on this topic). Human behavior and motivation is complex and not always easy to take account of in managing risk. However, some understanding of why we behave as we do, for example, because of fundamental biases in our view of the world, helps to unravel some of the more intractable issues of risk-related behavior. While we have the capacity for logical thought, human beings are not naturally logical thinkers and are subject to a number of shortcomings in their attempts to exert cognitive control over their environment. This results in the following features listed here (after Fischhoff, 1976):

- Our everyday learning is not structured to develop cognitive control
- We use simple (often oversimplified) models of the world
- Our ability to process information is exaggerated
- We have poor insight into information integration methods
- We are poor at applying acquired knowledge

Behavioral feedback has been employed to help de-bias people's views — see Summary Text 3.16. For example, in a study reported by Reber et al. (1989), workers who saw themselves on video were able to point out their own mistakes and unsafe acts, a form of training that was found to reduce subjectivity and defensive biases. This relates to the important principle of feedback discussed in the following section.

Organizational factors have also been found to influence the operation of attributional biases. Hofmann and Stetzer (1998) investigated the role of safety communication on workers' interpretations of the causes of injuries when presented with different scenarios. They found that in workgroups where safety-related issues were openly discussed, workers were more prepared to make attributions that were consistent with the cues (either internal or external) given in the scenario. In scenarios implicating a fellow worker (internal causes), workers were more willing to make internal attributions. In contrast, however, in workgroups where communication was not open, workers were more likely to make external attributions, even where the scenario information indicated evidence to the contrary. Ways to overcome these adversely operating human factors in managing risk include the following:

- Strategically designed safety training (see Chapter 10)
- Carefully engineered safety systems
- Detailed planning of safety and risk management
Summary Text 3.16 Attempts to De-Bias People’s Attributions

It is a well-known phenomenon that most people (typically 70 to 80%) consider themselves to be better drivers than their peers (Svensson, 1981; Groeger & Brown, 1989). However, logically this cannot be so because it is only possible for 50% of us to be better than the average for our group. This is an example of an attributional bias in operation — in this case a self-serving bias which leads many of us to believe that we are better than we are (in this case at driving).

To determine whether there might be some way to de-bias individuals’ perceptions of their own driving abilities, McKenna (1991) undertook a series of experiments. In the first experiment, he asked participants to write a story about a vehicle crash in which they were involved. When the stories were analyzed it was found that, as might be predicted, participants mostly wrote about (real or imagined) crashes in which they had been an innocent bystander or in which they had escaped major injury. On testing participants, no evidence was found that their perceptions of their driving abilities had decreased in any way as a result of writing their stories. In the second experiment, different participants were asked to write a story about a vehicle crash in which they were seriously injured. It was predicted that having to confront a bad outcome like this might make participants aware of their own vulnerability and hence reduce their overconfidence in their driving ability. However, the effect found was only slight, and most participants wrote stories in which, although badly injured, they were the victims of misfortune (e.g., as passengers or pedestrians) rather than the perpetrators. In a third experiment, a new group of participants was asked to write a story about a vehicle crash that resulted in serious injury and for which they were to blame. Being obliged to write such a story did have a dramatic effect upon the biases of these participants — who, when tested, no longer considered themselves to be such great drivers! In other words, involvement in an imagined crash with serious consequences for which they were to blame was sufficient to de-bias this group of participants — at least in the short term.

These experiments demonstrated both the relatively robust nature of the self-serving bias and also the possibility that it can be overcome. Getting people to accept the possibility that they could make an error that had serious consequences was demonstrated by these experiments to be a potentially powerful component of attributing responsibility for safety. However, these studies leave open both the empirical question as to the longevity of such de-biasing, and also the ethical issue as to whether it is desirable to deprive people of a bias that has probably evolved, in part at least, to protect them.

- Expert systems in specific areas of safety and risk control
- Rigorous ways of measuring health and safety performance, such as safety auditing
- Developing a more positive safety culture (see Chapter 11)

In organizational crises of various types, including major disasters involving multiple injuries, attribution theory (Weiner, 1986, 1995) contended that attributions about causal conditions resulted in customers assigning responsibility, as well as determining their emotional responses, which in turn influence their behavior. Weiner (1995)
considered that an organization’s response to a crisis intervenes after causality has been assigned, but prior to responsibility being attributed for the crisis. An alternative approach by Jorgensen (1996) maintained that an organization's response intervened after responsibility had been assigned and that this directly impacted customer emotions, which in turn influenced customer behavior. Organizational responses include silence (no comment), denial, excuses, justification, and confession. Using descriptions of an airline crash, Kamen Lee (2004) found that an internal and controllable crisis (crash due to outdated equipment) led to higher responsibility and negative impressions of the organization than did an external and uncontrollable crisis, in which the crash was caused by bad weather. This led to greater customer sympathy and higher trust in the organization. Weiss and Cropanzano (1996) developed affective events theory (AET) to describe the attributional sequence associated with organizational crises. AET focuses on negative events determining customer attributions, emotions, attitudes, and behavior. McDonald (2005) developed a model based on AET to explain how an organization's response to a crisis impacted upon its responsibility, intentionality, foreseeability, and accountability, to determine customers' emotions and behavior toward the organization.

3.6 Behavioral approach to motivation

An alternative perspective on the relationship between stimuli and behavior, the behaviorist approach, focuses on the stimulus–response fundamental relationship, without considering the influence of intervening (cognitive and affective) variables. The importance of understanding the mechanisms by which stimuli are processed and interpreted is discounted in favor of understanding how stimuli may be manipulated in order to achieve desired responses. This behaviorist approach to motivation is practiced in techniques known collectively as behavior modification. These techniques have been used extensively (and in some cases quite successfully) to improve workplace safety behavior.

3.6.1 Behavior modification

In general, behavior that is continuing is being reinforced. Reinforcement may be positive (behavior followed by reward) or negative (behavior followed by removing an aversive experience). It can be difficult to identify the reinforcer of continuing behavior for a number of reasons, including the following:

- Individual preference — because people interpret rewards and punishments differently; what one might view as an unpleasant experience another might view as rewarding.
- Reinforcement does not have to occur on every occasion to be effective — a behavior may need to be monitored over a long period to identify its reinforcers.
- Behaviors can be negatively, as well as positively, reinforced — negative reinforcers can be difficult to identify and change.

Phobias are maintained through negative reinforcement as the person relieves their anxiety about a situation (aversive experience) by escape behavior or avoiding the situation (avoidance learning). Sulzer-Azaroff (1978) noted that in the workplace, unsafe practices persisted because they are naturally reinforced. Consequences of unsafe acts, such as taking shortcuts, are immediate and positive (e.g., time saved, more convenient), whereas punishers may be weak, delayed, or infrequent — near-hits are rare, and may reinforce
the behavior through maintaining a worker’s perception of their skill and ability to avoid injury. Efforts to improve safety need to overcome these obstacles.

In applications of behavior modification to practical situations, the first step is to specify the behavior to be changed — that is, removing an undesired behavior and introducing a desired behavior. Behaviors should be specific, observable, and measurable. Just measuring behavior can have a positive effect and by clarifying what are desired behaviors, so that workers understand what they have to do in order to receive approval. Anderson et al. (1988) found that identifying the necessary tasks to clean a bar properly in a student-run university bar, led to a 13% improvement in performance. It is important that the focus of the behavior modification program is the behavior, not the outcome (even though the target of the program is to change the outcome). For example, an organization seeking to reduce its injury rate (outcome) should focus on reinforcing safe behaviors, rather than rewarding staff for low levels of injuries. An unintended consequence of rewarding low-injury figures is that an undesirable behavior, underreporting of injuries, is reinforced, so that injuries continue to occur but are covered up by staff. Petersen (1989) pointed out that incentive programs often fail because incentives are given for remaining injury-free, rather than for engaging in any specific behavior, thus rewards are linked to outcomes, which may in turn result from many factors (including chance) and not to specific behaviors. To be successful, incentives need to be given at the point when the desired behavior occurs (to reinforce that behavior). However, this can be quite problematic in many work situations and this approach is quite different from that proposed from the standpoint of behavioral adaptation, described in (Section 2.4.3.2), which identifies intrinsic desire to be safe as the prime motivator.

In organizational applications, the program is often referred to as Organizational Behavior Modification (OBMod) or applied behavior analysis. Target behaviors are subject to functional analysis, where circumstances influencing the behavior (e.g., see Chapter 4, Section 4.7) are examined to identify antecedents (or cues) and consequences. Luthans and Kreitner (1985) described the five-step model for OBMod programs outlined below:

1. Identify the key behavior
2. Measure the baseline frequency
3. Functionally analyze the behavior (identify cues and consequences)
4. Intervene (by changing the cues/consequences to increase the frequency of desired behavior and decrease the frequency of undesired behavior — see Summary Text 3.17)
5. Evaluate — to determine whether the behavior/performance has changed in the desired direction

A meta-analysis, reviewing all reported studies in the period 1975 to 1995 (Stajkovic & Luthans, 1997), indicated that OBMod interventions lead, on average, to a 17% improvement in task performance. They also found that these programs were significantly more effective in manufacturing than in service organizations. A strong effect for nonfinancial reinforcers emerged from this study and the authors suggested that in many cases it is not worth the extra resources to develop more complex interventions or to use financially based rewards. One of the areas in which behavioral techniques have been most successfully applied is safety. These interventions are most effective when the desired behavior can be defined with some degree of precision — for example, wearing personal protective equipment (PPE). For example, Zohar and Fussfeld (1981) applied a behavioral intervention in an Israeli factory where workers were provided with earplugs, to protect them from very high noise levels (106 dB) in weaving sheds, but usage rate was only 35%. A scheme was introduced over a 2-month period in which wearing earplugs was rewarded
Summary Text 3.17 Examples of Consequences and Cues Typical of Behavior Modification Programs

1. Consequences — removing undesired behavior
   a. Removing rewards (extinguishing behavior) — for example, deleting graffiti immediately removes the reward of public attention.
   b. Punishment — unconditioned aversive consequences (physical pain) — for example, Leslie and O’Reilly (1999) described a study where minor electric shocks were applied to a 9-month old baby on each occasion it began to vomit; this reduced a life-threateningly high level of vomiting in the baby, over a 3-day period, to zero.
   c. Punishment — conditioned aversive consequences (e.g., verbal warning for absenteeism) can be effective, although punishment must occur on every occasion to extinguish a behavior, while reinforcers only have to occur occasionally.
   d. Timing of consequences — the more immediate the consequence, the greater the effect (e.g., rewards for smoking are immediate, but negative consequences, such as serious illness, are mostly in the future).

2. Consequences — increasing desired behavior
   a. Positive reinforcement — rewards can be tangible (have economic value) or nontangible (e.g., praise, recognition); praise and recognition may be underused by managers as reinforcers.
   b. Negative reinforcement (can have negative emotional reactions — so not recommended in a workplace context).

3. Cues — stopping undesirable behavior
   a. Removing cues or overriding their influence (substitute behavior) — for example, instead of lighting up a cigarette after a meal, do the washing up (this is also an incompatible behavior — cannot wash up and smoke simultaneously).
   b. Introduce cues (e.g., speed camera signs prompt drivers to reduce their speed).

4. Cues — starting desirable behavior
   a. Removing cues (e.g., some airlines have withdrawn drinks trolleys to avoid prompting passengers to have a free drink).
   b. Introduce cues (e.g., sweets, chocolate, stamps, cigarettes placed near checkouts to prompt impulse buys from shoppers).

with tokens that could be exchanged for goods. Observations were random, with increasing time bands. At the end of the intervention, usage rate was up to 90%. The incentive program was withdrawn and a follow-up study conducted after a further three months revealed that the high earplug usage rate had been maintained. Hearing protection use had become self-reinforcing: as the initial discomfort wore off, workers found that removing the earplugs heightened their awareness of the extremely high noise level in the factory, resulting in negative reinforcement as the aversive experience of the noise was removed when workers replaced the earplugs.
Chapter three: From sensation and perception

DeJoy (2005), Fleming and Lardner (2002), Guastello (1993), Krause et al. (1990b), Lund and Aaro (2004), McAfee and Winn (1989), Sulzer-Azaroff (1982, 1987), and Sulzer-Azaroff and Austin (2000) have reviewed occupational safety behavior modification programs. The conclusion reached by these reviews is that behavioral safety interventions that target specific behaviors, such as rule compliance, are effective if rewards are suitable and given in an appropriate manner. Robertson (1997) noted that those behavior change programs that target a single behavior, rather than a range of hazards, tend to be more successful. It is also important that an adequate reward/incentive is chosen for the program. For example, two interventions conducted by Cope et al. (1986a, 1986b) targeted seat-belt wearing amongst workers at a pharmaceutical plant. In the first intervention, which rewarded workers with the chance of winning a weekly draw with a prize of U.S. $30–100, a 9% increase in usage was demonstrated. However, in the second intervention, which rewarded workers with the chance of winning one of two jackets, seat belt usage dropped by 10%. The authors concluded that the failure of the second intervention was related to the inadequacy of the incentive for seat-belt usage.

OBMod safety programs often focus on unsafe acts, which can lead to injuries, which are reduced by replacing specific unsafe acts with safe behavior. However, the reduction in injuries can be quite dramatic and disproportionate to the change in behavior. For example, Reber et al. (1984) increased specific safe acts by 35%, and recorded that subsequently injuries decreased by 54%; Larson et al. (1980) reduced speeding of police vehicles by 10%, whilst physical injuries fell by 70 to 90%. Saari (1994) suggested that this was due to behavior modification initiating wider cultural change; due to the enthusiasm and new atmosphere of trust generated by the intervention, workers are encouraged to reduce other hazards as well. This may lead to a change in attitudes toward safety and a shift in the safety climate (see Chapter 6 for further discussion). Although short-term effects can be dramatic, these positive effects can relapse, and once reinforcement is removed, the target behavior may return to baseline levels (Komaki et al., 1978). The possibility remains that while the rewarded behavior improved, other safe behaviors deteriorated and that improvements were not sustained in the longer term (particularly where no shift in safety climate occurred). One confounding factor is that most reinforcers are not unitary, for example, praise is both an incentive and provides information (knowledge of results). To secure long-term positive changes in safety practices it is necessary to change not only behaviors, but also attitudes underlying those behaviors (Fishbein & Ajzen, 1975). It has been observed that behavior modification programs can lead to behavior change, with little, if any, change in attitudes (McKnight & McPherson, 1986). However, inconsistency between attitudes and behavior may lead to subsequent changes in attitudes to reduce cognitive dissonance, following a shift in behavior (Bem, 1967). The alternative of behavior drifting back toward the baseline, consistent with unchanged attitudes, could be reduced by ensuring that, before withdrawing incentives, new behaviors become embedded as habitual practices; habits being particularly resistant to change. This topic is explored in more depth in Chapter 6 (in particular Section 6.7).

Goal setting and feedback are often used as reinforcers in safety programs (Cooper et al., 1994). Goal setting is effective in improving performance, by directing attention, facilitating a search for appropriate methods, and mobilizing and maintaining effort (Locke & Latham, 1990). It is important that the individual accepts the goal, which can be achieved either through participation in the goal setting process, or through explaining the reasoning behind an imposed goal. Feedback on progress toward a goal also acts as a powerful reinforcer. This is often in the form of the safety index (Komaki et al., 1978): the proportion of safe behaviors as a percentage of all observed behaviors. The role of feedback and goal setting is discussed further in Section 3.6.3.
3.6.2 Principles of learning: implications for safety

Learning involves both mental (cognitive) activity and behavior (verbal and nonverbal). One of the best-known models for describing the learning process is that of Kolb (1984), whose basic argument is that people learn by testing their personal theories against their experiences and modifying their understandings as a result. Kolb developed the notion of a learning cycle in which our experiences are the basis for learning. These are followed by reflecting on the experiences and by making generalizations from these reflections, which are then tried out in new situations. Kolb’s model of learning is an example of a system that provides feedback to the individual, which can result in modified behavior and thought patterns. To learn effectively, individuals need to be able to measure their own progress over time and compare their progress with that of their peers. The model also illustrates interplay between attitudes (cognitions) and behavior (actions), considered in Chapter 6. Using Kolb’s ideas as a basis, Honey and Mumford (1996) developed the notion that individuals have their own preferred styles of learning and that preferences could be related to different stages of the learning cycle, resulting in four learning styles — activist, reflector, theorist, and pragmatist. Some people prefer learning through active experience, whilst others prefer to spend a lot of time reflecting upon their experiences, and so forth. The best learners have preferences for all components of the learning cycle. The Learning Skills Research Centre (2002) has reported on learning styles and their measurement, including a brief bibliography.

An important feature of learning, particularly in respect of tasks or jobs that are undertaken infrequently, or which may never be used at all (e.g., emergency drills) is that of overlearning. In training terms, this means that someone practices a skill or sequence of actions until it becomes automatic. The skill is then more resistant to forgetting and can be reinforced by occasional refresher training, which uses the residual knowledge as a basis for bringing the skill up to the original level in a relatively short period of time. Overlearning is a principle applied by professional performers such as musicians or actors and may be encapsulated in the phrase: an amateur practices until he or she gets it right; a professional practices until he or she can’t get it wrong (see Chapter 10 for more information on training).

3.6.3 Goal setting and performance feedback

To learn effectively a person must be motivated. This motivation may be extrinsic (as in rewards or incentives) or intrinsic (from performing the task itself, such as enjoyment, interest, or a sense of achievement). Behavioral safety interventions provide motivation toward safe behavior by (1) increasing individual confidence in performing work-related tasks and (2) focusing on individual safety improvement goals (Cox et al., 2004). To be successful, goals should be challenging, but achievable, and feedback on progress should be accurate and timely (Locke & Latham, 1990). Many studies have reported successful behavior change programs using goal setting and feedback as reinforcers. For example, Smith et al. (1978) and Zohar et al. (1980) used information feedback to overcome barriers associated with PPE use. Sulzer-Azaroff and De Santamaria (1980) used supervisor feedback and found that hazard frequencies dropped by 60%. Whilst many studies have illustrated the success of behavioral safety programs within manufacturing, several recent studies have demonstrated its utility in high hazard industries, such as offshore oil production (Zhu et al., 2000) and nuclear power plants (Cox et al., 2004). Summary Text 3.18 describes a successful intervention.

Although the intervention conducted by Cooper et al. (1994) resulted in a significant reduction in injuries at the company, the authors noted that, although there was a small negative correlation ($r = -0.20$) between safety performance and checklist-related injuries,
Summary Text 3.18 An Example of a Successful Behavior Modification Program in the Manufacturing Industry

Cooper et al. (1994) conducted a successful intervention at one site of an international cellophane manufacturing company, using goal setting and posted feedback.

- A list of critical behaviors was established for each department based on injury records.
- Observers were recruited from the factory and trained.
- A 4-week observation period was used to establish a baseline figure for each department.
- Goal-setting meetings between all personnel, including senior managers, were used to establish goals for each department; thereby involving all participants in the process of selecting goals, increasing commitment and ownership of the improvement process.
- A 16-week intervention period followed during which weekly feedback charts were posted in each department; in addition, information on the three worst scoring behaviors was also posted.

Results from the study revealed that 9 of the 14 departments demonstrated a significant increase in safe behaviors (with an additional two achieving a 100% baseline and maintaining this rate across the intervention), with the overall site average increasing from a baseline of 52.5 to 75.6% (by week 12, although performance then fell off to 70% by the end of week 16). The study also demonstrated that the success of the intervention was reflected in the plant’s injury rate, with overall injuries reduced by 21%, and injuries specifically related to the critical behaviors targeted in the intervention, reduced by 74%. The success of this intervention may be related to a wider cultural change, as Cooper and Phillips (1994) described how the plant’s overall safety culture had improved.

this was not significant; in fact, overall only 4.9% of the factors accounting for variability were common to both variables (i.e., safety performance and related injuries). This result indicated that mediating variables operated in the relationship between safety performance and injuries (i.e., this was an indirect, rather than a direct, relationship — including organizational and nonsafety factors). One interpretation is that safety climate acts as a mediating variable, with a positive change in safety attitudes resulting in a range of behavioral changes, not just those targeted within the intervention (for more detailed discussion of the wide-ranging effects of safety interventions, see Clarke and Cooper (2004).

DePasquale and Geller (1999) highlighted the role of managers and supervisors as key to the success of behavioral safety interventions. The authors investigated perceptions of 701 participants in 15 companies that had implemented behavior change programs to identify organizational factors that are critical to success. They identified the factors described below as being particularly important.

- Mandatory participation in the program, if properly instituted, rather than voluntary: workers gain personal control through choosing when and how they conduct observation and feedback sessions; through participating in the process, the program
facilitates perceptions of control (rather than creating negative feelings and resistant behaviors); but depends on managers allowing worker discretion in how the process is implemented.

- Visible support from managers and supervisors: the commitment of supervisors and managers to the process must be evident to workers participating in the program; providing financial resources is a necessary but not sufficient condition; managerial support must be evident in providing the necessary time for observations and analysis of the results; managers must implement changes that are recommended by the program, such as to environmental conditions or safety procedures.

- Role of the steering committee: whilst important for the initial stages of setting up the program, continuing involvement of a committee, particularly when workers have negative perceptions of committee members’ motives, was found to be non-beneficial; careful selection of members and running down of the role after start-up are important.

- Nature of the training: this must be relevant to the work setting and the workers’ circumstances; it is important that trainers emphasize that the program is not a vehicle for blaming individuals or for delivering criticism; training should focus on a simple behavior checklist and build up complexity to facilitate learning.

A key finding from DePasquale and Geller’s (1999) study related to interpersonal trust. Worker involvement in a behavior change program was significantly predicted by perceived trust in management abilities (but not by management intentions). Thus, programs were more successful when workers trusted managers in supporting the process (with beliefs in managers being well intentioned having no effect). It was also found that participation in mandatory programs facilitated greater trust in both managers and coworkers (relating to both intentions and abilities). Thus, whilst adding to the success of the program, greater interpersonal trust is also an outcome, which may help to explain changes in safety culture, as trust is a key variable in this concept. In addition to factors identified by DePasquale and Geller (1999), the “Step Change” Group (2000) suggested that programs often fail due to a mismatch between program requirements and the organization’s cultural maturity (i.e., the level of management commitment to safety, trust between managers and workers, and effectiveness of communication). In their telephone interviews with nine U.K. providers of behavioral safety programs Fleming and Lardner (2002) demonstrated that providers carried out preassessments of the organization’s readiness and its safety climate, in order to anticipate potential problems in implementing programs. Key indicators of a company’s readiness to undertake a behavioral safety program include: managers and workers perceive a need to reduce the current injury rate; managers express willingness to empower workers to make observations and recommendations; workers express willingness to trust managers; adequate systems are in place to deal with more frequent communications between managers and the workforce (The Keil Centre, 2000).

It is not uncommon that the initial success of feedback as a reinforcer is reduced following its withdrawal. For example in Chhokar’s (1987) study, learning from training, using slides depicting safe and unsafe behavior, was reinforced using periodic feedback on performance and praise from supervisors. However, the initial increase in safety performance returned to previous levels when feedback was discontinued. In a further example, Haynes et al. (1982) used a combination of daily feedback on injury-free driving, team competition, and frequent low-cost incentives (cash, free passes for relatives, and free fuel) to reduce injuries among urban transit operators in a U.S. city. In this study, the authors indicated that, although the variables were confounded, it might be possible to phase out the incentives, leaving feedback and competition as an effective long-term strategy. It is important
for the long-term effectiveness of an intervention that feedback is sustained over a reasonable period, so that new habits are thoroughly learnt, and that feedback is withdrawn gradually (Saari, 1994). Several studies have observed overreliance on outside agents for effective implementation (Komaki et al., 1980; Chhokar & Wallin, 1984; Reber et al., 1989) and consequently, involving supervisors to continue with feedback (rather than external consultants) has been recommended to help extend results (Zhu et al., 2000). Makin and Sutherland (1994) emphasized that active involvement and commitment of senior managers is also important for long-term effectiveness.

Krause et al. (1999) conducted a longitudinal evaluation of the effectiveness of one U.S.-based consultancy firm’s application of behavioral safety interventions (using a worker-driven process of all levels of workers being trained to observe and give immediate positive feedback) across 73 companies. The meta-analysis demonstrated that, on average, the programs achieved a significant reduction in injuries, with average reductions (calculated sequentially over the baseline) of 26% in the first year, increasing to 69% in the fifth year, from baseline observations. This reduction in injuries demonstrated a steeper downward trend than expected compared with the U.S. national average for manufacturing companies; therefore, the reduction is over and above that expected due to a general safety improvement over the same period. In some cases, companies demonstrated that results were not only sustained but that they improved over time. The main features of this as an effective methodology were: active involvement of all levels of workers in the program; a high degree of buy-in or ownership from workers; and, the self-sustaining nature of the reinforcement. Cox et al.’s (2004) investigation of workers’ perceptions of behavioral safety programs implemented in U.K. nuclear reactor plants identified some underlying worker beliefs that facilitated their positive attitudes and commitment, toward the program. They included the following:

- Supported culture of safety first: through their support of the program, managers were seen to be committed to safety.
- Effective motivational tool: safety motivation increased as a result of praise received for performing work tasks safely.
- Increased opportunities for individual learning: by reinforcing the benefits of learning from mistaken actions and by enabling workers to perceive direct links between performing specific behaviors and their safety consequences.
- Increased opportunities for organizational learning: via communication and knowledge-sharing between workers, and by increasing awareness of safety and site values.

Factors that were perceived as potential barriers to the continued success of the program included (1) managing unrealistic expectations that behavioral safety programs could solve all safety-related problems; (2) providing ongoing visible leadership and support from senior managers; (3) building a foundation of mutual trust between key stakeholders; (4) preventing loss of individual enthusiasm; and (5) effectively managing the safety consequences of the observations. Failures in these five areas could threaten the long-term sustainability of behavioral safety programs, despite the considerable benefits highlighted by the study, in terms of supporting cultural values, motivating workers, and increasing opportunities for both individual and organizational learning. Fleming and Lardner (2002) found that introducing something different or new to a program on an annual basis helped to keep the program fresh and maintain momentum.

From the material reviewed in this section, is clear that safety motivation is likely to be highly situation-specific. This means that situation or behavior-specific campaigns (e.g., don’t drink and drive) are much more likely than general exhortations (e.g., be safe)
to be successful. However, behavior change is likely to be short lived, unless it is supported (e.g., by continuing extrinsic motivators, such as legislation or company standards), or becomes self-sustaining through changes to intrinsic beliefs and attitudes. People are motivated to take, as well as to avoid, risk as long as they perceive that they have some control over it. In assessing people’s likely behavior, respective costs and benefits of both relatively safe and unsafe behaviors need to be taken into account.

One problem in motivating for safety is the typical low probability of adverse outcomes (such as being caught or being injured) set against the usually very high probability of benefit (such as completing a job quickly or getting to your destination sooner). In general, it is better to use less powerful motivators, such as praise or feedback of results, to achieve positive outcomes (learning as well as motivation) rather than fear or compulsion, for example, using a rules-based approach. The real issue for behavior modification is the extent to which it can be sustained in the long-term. Whilst there is clear evidence that, when designed and implemented properly, behavior modification techniques can be effective in changing behavior, there is little published evidence linking behavior change to long-term reductions in injury rates. Nevertheless, the literature shows that the most effective programs continue to perform where there is ongoing management support, mutual trust between managers and workers, and action taken to tackle problems identified by the process (e.g., task or work redesign and environmental changes), resulting in a supportive safety culture. It also appears that organizations implementing such programs must exhibit a certain degree of cultural maturity, as behavioral safety programs cannot transform the culture in a company that is strongly negative (e.g., characterized by distrust and suspicion between managers and workers, industrial relations problems, and lack of resources and management commitment). Programs implemented within such an atmosphere have little chance of success (Fleming & Lardner, 2002).

Behavior changes will be sustained if they are supported by consistent attitudes and intrinsic motivation. If the behavior is supported only by extrinsic rewards, particularly when instituted within a hostile environment, then once these are removed the behavior will tend to decline (see also discussion in Chapter 6, Section 6.7). Although there is a relationship between worker behavior and safety culture, little research to date can clarify the nature of this relationship. It also has been suggested that behavioral safety initiatives could be integrated within an organization’s safety management system (Fleming & Lardner, 2002; see also Chapter 10 and Chapter 11). There has been little attempt to use behavioral techniques to modify behavior of personnel at supervisory and managerial levels; this remains an area for further investigation.

The approach to changing behavior through behavioral safety may be peculiar to Western-style managerial practices within individualistic cultures that allow for worker involvement in decision making. Its effectiveness in other cultures has yet to be established. Where power distance between management and workers is high and where the external culture is more collectivist, then it may be very difficult to implement behavioral safety programs in the way that they have been introduced in workplaces in the United States, United Kingdom, and similar cultures. Within Western cultures, such programs are only likely to be relevant in workplaces where the injury rate is already high enough to be measured against a rate reduction that can be considered statistically significant over a relatively short period (perhaps 6 months). To this extent, their use is likely to be restricted to workplaces or sites that are seeking an immediate solution to an injury problem. For these reasons, while such programs will have their place as part of an overall risk management program in certain workplaces, the target for management that is genuinely seeking safety improvements should be to move beyond a position that requires such programs, to one in which they are no longer necessary as a foundation for workplace safety.
3.7 Motivating for safety

Encouraging and reinforcing safe behavior is an important consideration for safety and risk scientist practitioners. Whilst some knowledge of the general theories of motivation discussed above is useful, the following sections review material specifically targeting safety motivation.

Neal et al. (2000) found that perceptions of safety motivation, that is, motivation to perform safely, and safety knowledge influenced individual reports of safety performance (compliance and participation). The strongest effects related safety motivation, and to a lesser extent safety knowledge, to safety compliance, with weaker links between safety motivation and knowledge to safety participation. This study highlighted the particular importance of safety motivation in ensuring that workers adhere to safety rules and work safely. A number of psychological factors, both social and motivational, influence the extent to which individuals will comply with, or violate, safety rules and regulations. To appreciate an individual’s level of safety motivation, it is important to understand relative costs and rewards of different types of behavior, both safe and unsafe — as in the approach from behavior adaptation (see Section 2.4.3).

Reason et al. (1990) suggested that violations, “can only be described with regard to a social context in which behavior is governed by operating procedures, codes of practice, rules, norms and the like” (p. 1316). Violations are not usually acts of deliberate risk taking, but shortcuts designed to make work more efficient, quicker, or easier (Reason et al., 1994). As operators are not able to assess the impact of violations on the system as a whole, because there are no obvious or immediate negative consequences, their actions are often reinforced. Reason et al. (1994) identified three types of violation: routine (shortcuts that become a habitual part of the behavioral repertoire), optimizing (serving nonfunctional goals, such as joy of speed or aggression, that become part of an individual’s performance style), and situational (noncompliance needed to get the job done). Thus, systems should ideally be designed so that it is at least no more trouble (e.g., awkward, time-consuming) to take precautions than not to do so. It may also be necessary to modify relevant attitudes and behavior, for example, driving at speed in fog or overtaking decisions, because such changes involve changing perceived relative values of the respective rewards (e.g., arriving sooner at your destination, demonstrating skill to self or peers) and risks involved (Chapter 6 considers this issue in more depth). The way to address such risky behaviors is not to attach labels such as motorway madness or allege that drivers are careless or stupid because drivers do not think that these labels apply to them personally, although some may see them as applying to others. Instead, it is necessary to understand motives underlying fast or dangerous driving and the benefits of so doing and to work on these factors (Rolls et al., 1991).

The driving environment also provides sound reasons for studying violations. Observational data from over 20 years ago established that close following and other violations are statistically related to drivers’ crash involvement (Evans & Wasielewski, 1982, 1983). From questionnaire studies, Parker et al. (1995) reported that driving violations are statistically associated with crash involvement. Golias and Karlaftis (2002) found that speeding was associated with dangerous driving violations, and Kontogiannis et al. (2002) found that highway-code violations were related to speeding convictions. From telephone survey data, Jonah (1990) found that younger drivers reported higher crash and violation rates — including speeding and tailgating. Studies in several countries have found that males and younger drivers report significantly more violations than do females and older drivers (Parker et al., 1992a; Lawton et al., 1997; Yagil, 1998; Kontogiannis et al., 2002; Mesken et al., 2002). In an Australian study, Glendon and Sutton (2005) found that nearly 56% of all drivers were violating at the time that their driving behavior was observed — in some cases these were multiple violations. Males and younger drivers were overrepresented in
some, but not all, categories of violations. These authors considered that their findings were consistent with the notion that violations such as speeding and tailgating are imitative in respect of other drivers’ behavior (Connolly & Åberg, 1993; Groeger & Chapman, 1997). Greater understanding of driving violations could serve to improve counter measures in traffic environments.

Risk taking, for which various motivational bases may be discerned, can in some circumstances be interpreted as a demonstration of skill. In some cases, young people’s injuries may be due to attempts to emulate behavior of more experienced (i.e., skilled) drivers or work colleagues, but without the necessary skill to undertake the behavior successfully on every occasion. It has been pointed out that allowing relatively inexperienced drivers onto roads, where the great majority of drivers have had many years to practice their driving skills, places unreasonable expectations upon the performance of younger drivers in mixed traffic conditions. To counter the beliefs that underlie a self-image in which an individual equates skilled performance with risk taking, it is necessary to associate competence with taking precautions, whether this is in the use of motorcycle helmets, safety helmets, car seat belts, or driving style. These help to overcome the negative image that may attend a safety conscious worker in full safety gear (Pirani & Reynolds, 1976). An interesting example of instilling safety into new workers is given by Kendall (1985), who described a scheme whereby new site workers wore different colored helmets for their first 30 days so that experienced workers could ensure that new workers did their jobs safely.

One of the most basic motivators is to induce fear (see Chapter 2, for a discussion of evolutionary origins of fear). This addresses one of our real basic instincts: to avoid things that can harm us. Fear may be induced in a variety of ways, for example, via films, posters, or the written or spoken word. Arousal of fear motivates us to find ways of reducing the arousal (which may take the form of dissonance, discomfort, or stress). One way in which we may act to reduce negative arousal is to change our behavior, that is, to act more safely. However, there are other possibilities, for example, that we will change our beliefs rather than change our behavior (as would be predicted by cognitive dissonance theory). For example, if the information is very threatening we may reject it altogether because it is uncomfortable to think about (e.g., the chance that we might be killed or seriously injured or our health severely impaired). We might alternatively consider the information to be inapplicable to our own situation, that is, that the message is not for us, but rather for other people to take note of. Another possibility is that we might seek to justify or rationalize our behavior in some way — for example, that the rewards we are getting are worth the risks we are taking. Finally, we may opt to live with the dissonance of knowing that what we are doing is harmful to our health or threatens our safety, which can be stressful.

Evidence from studies of the use of fear suggests that it is only effective as a motivator when individuals feel that they can control the behavior for which change is sought. Thus, using fear is a good way of strengthening already held attitudes or beliefs, for example, on health, as it confirms in people’s minds that they are already behaving sensibly. For example, Becker and Janz (1987) noted that if motivation to improve health is already high then information provision on how to achieve this has positive effects. Otherwise, information provision can have negative effects, inducing fear and rejection of the information. A middle stage is where information provision can induce some motivation and attitude change. In health education, no single intervention strategy can produce long-term changes in important behaviors (Green, 1978). Thus, by itself fear is not at all effective in changing behavior. Indeed, it may have the reverse effect, for example, further strengthening an addict’s habit — for example, smoking or other drug use. After all, if anxiety is partly what initially drove a person to the habit, then anything that serves to increase anxiety is likely to drive them back to it. A better approach is to give simple, straightforward information on what the person should do — for example, go for a health check. There are individual
Figure 3.4 Fear, motivation, and safety.

3.8 Conclusions

There are number of complex processes by which humans sense, interpret, and organize their impressions of the environment. In turn, these perceptual processes influence our behavioral responses to the environment. Humans develop strategies to simplify perceptual processes. For example, we attend selectively to physical or social phenomena in order to reduce the amount of information to be processed. In perceiving things, the visual sense in particular may be subject to various illusions. An understanding of perceptual errors and cognitive biases can help to design work environments that minimize their effects (see Chapter 4). In attributing such a large proportion of injury causes to human error or similar personal factors (such as carelessness) we fall prey to the fundamental attributional error, that of ascribing others’ injuries to personal factors, while our own mistakes are attributed to situational factors such as design or lack of training or to anything but ourselves. One
unfortunate consequence of this attributional bias is that we underestimate what we have to learn from situational factors (e.g., pertaining to the work environment). A classic case is that of the Kegworth air crash in which the principal causal attribution made was that of pilot error (Department of Transport, 1990), which is described in Summary Text 4.4. Important lessons include that we should be aware of this bias, and seek ways to overcome it so as to gain a more enlightened view of the role of the individual in injury causation. Safety and risk scientist practitioners need to be aware of the possibilities for reducing these biases and use that knowledge whenever possible, for example, in injury/incident investigations or in training/briefing sessions.

Motivation is a complex but critical concept in psychology and is also central to risk management through understanding safe and unsafe behavior. It has close links with most other behavioral aspects of risk and safety, especially learning, perception, and attitudes. However, individuals can differ widely in their motivation to do things, although common threads link us all. Motivation forms a crucial link between underlying variables such as personal values, attitudes, personality, and behavior. Our basic instincts, including avoidance of danger or situations that could cause us harm, are our fundamental survival pack. However, we can learn to override these instincts in order to reward higher goals, for example, to experience excitement or to rescue others. As we have developed ways of overcoming our fears, it is important to ensure that adequate checks exist when people are operating in dangerous environments, such as at heights or in fires.

Of the various approaches to motivation, the behavioral approach has attracted much attention due its success in modifying safety-related behavior in certain environments. However, it is increasingly likely that effective management will depend upon identifying each individual’s unique motivations. This means that management should seek to determine each individual’s motivations, in respect of safety, risk taking, and work. Rewards or reinforcement may be intrinsic (e.g., a job or task is seen as worth doing for its own sake) or extrinsic (e.g., doing a job or task leads to some external reward, such as money or status). In selecting extrinsic safety motivators (e.g., as in incentive schemes), consideration needs to be given as to whether such a behavior modification approach can be applied consistently in the long term. In promoting safe behavior, use of intrinsic rewards is more durable and effective than using extrinsic rewards. People need to understand the reasons for engaging in safe behavior and be able to participate in decisions that affect them. An optimum strategy would be to combine the best features of both cognitive and behavioral approaches. Motivation is central to safety and risk taking and is closely related to a number of topics that are considered in this and other chapters, including attitudes and behavior (Chapter 6) and training (Chapter 10).
chapter four

Human error and human factors

The man who makes no mistakes does not usually make anything
(William Conor Magee)

This chapter focuses upon physical aspects of workplaces and people’s behavior in them. The topic of human error is dealt with first before a broader discussion of human factors or ergonomics. This is followed by a consideration of human–machine interface design issues and a review of some techniques used to mitigate human error.

4.1 Introduction

We first consider a fundamental aspect of human behavior — that of making mistakes or errors. This discussion is then taken into the area of some techniques that have been developed to address human error under the general heading of human factors or ergonomics. Addressing such topics within the context of human resource aspects of safety and risk management should hardly require justification. It is widely acknowledged that some understanding of human error and human reliability, as well as a sound grasp of ergonomic principles and practice, should be part of the repertoire of the safety and risk scientist practitioner. The chapter aims to explain different types of human error and to show how selected human factors (ergonomic) interventions can be used to diagnose and provide guidance for reducing either the likelihood or the consequences of human error.

Human errors are complex phenomena, the description of which can be traced back at least as far back as Sigmund Freud, from whom the expression Freudian slip has entered the language. Freud’s view was that erroneous actions resulted from some underlying need or purpose (usually sexual). However, human error, and conversely human reliability, has only been investigated as an identifiable field of study since the 1970s and the contemporary orientation is essentially cognitive. Reason (1990) and Reason and Mycielska (1982) argued for a cognitive interpretation for most (if not quite all) human errors. Reason (1990) defined human error as, “a generic term to encompass all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency” (p. 9).

Cognitive factors that relate closely to human error include attention and control mechanisms (discussed in Chapter 3). Empirical data on human error have been collected through
questionnaires and self-report diaries (see Reason & Mycielska, 1982; Reason & Lucas, 1984) as well as from case studies. Human error has both theoretical and practical implications, both of which are considered in this chapter. The other main component of this chapter is human factors (or ergonomics as it is also known) — a discipline with widespread safety applications. Some relevant applications are illustrated in this chapter, especially those concerned with human reliability.

4.2 Human error

This section addresses the following issues:

- Outline what human error is and why it occurs
- Explain the main types of human error
- Illustrate how different types of human error may be addressed

4.2.1 Errors as a learning tool

Let us begin with the well-known saying to err is human. Why then do humans make errors? This question may be answered from an evolutionary perspective in that making errors has been functional, that is, it has been central to our survival as a species. In contemporary society, it is similarly necessary for all of us to make errors in order to learn, especially as children, but also as adults. Therefore, it is important to recognize that making errors and acting on the feedback we get from so doing is essential for human learning to occur. Thus, from an early age, error performance is how we learn not only about hazards in our environment, that is, from direct experience, but also about aspects of our social world — about what is correct or expected behavior in a wide range of situations. In this way we learn what is appropriate in different contexts, for example, how to treat other road users and how to behave at work. Much of our early learning is developed in part by us making errors and being able to learn from them. Thus, the reason that human errors are important in a functional sense is that they provide feedback that is essential for learning to occur. This principle can usefully be extended to learning situations. For example, Rubinsky and Smith (1973), during training in the correct use of grinding wheels, used a jet of water aimed at the trainee’s forehead to warn them that they had made an error. In a word processing training study, Frese and Altman (1988) found that trainees who were allowed to make errors performed better than those who were denied this opportunity.

Why then is human error such a problem in many modern industrial systems, for example, civil aviation (Wiegmann & Shappell, 2001)? From a human evolutionary perspective, learning took place over a lengthy time scale. Many generations of our ancestors had to learn initially through trial and error as to which roots, berries, and other naturally occurring plants and animals were edible and which were to be avoided. Once learnt, this important survival information was passed on to subsequent generations by word of mouth and became part of societal knowledge, that is, known by all. Thus, trial and error learning has been functional for human evolution. Also functional was the inherent variability in human behavior and therefore in error making. This feature of our behavior enabled generations to learn from a large variety of errors over a long period. However, because of the massively harmful consequences that can sometimes result from certain types of human error in contemporary settings, it is no longer the case that trial and error learning or the inherent variability of human propensity for error making is necessarily the most appropriate way of learning. Reason (1990) noted, “whereas in the more forgiving
circumstances of everyday life, learning from one’s mistakes is usually a beneficial process, in the control room of chemical or nuclear power plants, such educative experiences can have unacceptable consequences” (p. 183). Thus, in respect of complex work activities (as well as some other tasks, like driving) humans may have to collapse their learning into ever decreasing time periods. During this time, possibilities for making errors may be small and correspondingly the opportunity to learn from making errors is lessened and an important feedback element of the learning process may thereby be considerably attenuated.

Attempts to improve opportunities for experiential learning, including making errors and learning from them, may involve using simulators, for example, as used in the civil or military aircraft industry or in process control room operation. Managers who feel secure in their positions may be willing to let subordinates learn from their own mistakes, acknowledging the potency of this form of learning. Unfortunately, it is not possible to simulate all aspects of work behavior or all situations in which human error might lead to disasters or other undesired consequences. Thus, it is impossible in complex and tightly coupled systems (those that are linked with many other aspects of the system) to simulate all possible combinations of events (even if these are known) that might lead to disaster, for example, in the nuclear power generation industry (see Perrow [1984], for a more detailed exposition of this point). The speed of our industrial advance has not allowed human ability to learn from making errors to keep pace so that an aspect of human behavior, which was once functional for survival, under different circumstances can become part of a potentially dangerous system.

It should also be noted that as part of learning from their errors humans are also quite good at detecting and correcting certain types of errors. Thus, it is likely that it will always be necessary to have humans within complex systems in order to solve problems when they arise. However, notwithstanding the necessity for humans to be located within complex systems considerable energies of safety and risk scientist practitioners, designers, and manufacturers are devoted to attempts to eliminate, or at least to minimize opportunities for human error to occur, and to mitigate adverse effects of human errors that do occur. For example, in the operation of complex systems, it is important that human operators have an adequate and accurate representation of what is happening in the system as a whole or at least that part of it for which they are responsible. In a number of nuclear power plant incidents, for example, Three Mile Island (TMI) (Kemeny, 1979), an important aspect of the incident was that the operators did not have an accurate view of what was happening in the plant. Summary Text 4.1 provides three airline industry examples of detecting system problems.

Knowledge of operating a complex system is encapsulated in some mental representation or model of the system (Wilson & Rutherford, 1989; Matthews et al., 2000), also termed situational awareness (Endsley, 1995a, 1995b; Endsley & Garland, 2000). Mogford (1997) described maintaining an accurate mental picture of current air traffic movements as critical for effective air traffic control. A mental model can be considered as a knowledge base that develops depth and stability relatively slowly over time, gradually enabling the controller to understand and predict dynamic system behavior (Mogford, 1997; Matthews et al., 2000). Successful performance depends upon an adequate mental model of the dynamics of a process as well as an accurate mental representation of the system’s current state (Wickens, 1992; Matthews et al., 2000). However, seeking to acquire adequate mental representations of some complex systems can stretch human capacity up to and beyond its limits — for example, an aircraft cockpit may present up to 400 different displays for flight crew to interpret (Adams et al., 1995), while nuclear power plant control rooms may contain more than 3000 different displays and controls (Wickens, 1992). However, an adequate mental model of the system is essential for situation awareness and correct task performance (Sarter &
Woods, 1991). Endsley (1995a, 1995b) distinguished the three levels of situation awareness as follows:

- **Level 1** — Operator’s attention to and perception of current events
- **Level 2** — Operator’s integration of information on the current process state into an overall understanding of the current situation and its relation to system goals
- **Level 3** — Operator’s extrapolation from levels 1 and 2 to project the current process state into the near future and to compare it with the desired state

## Summary Text 4.1 Examples of Detecting System Problems in the Airline Industry

The Airbus A380 double-decker superjumbo jet plane, first publicly displayed early in 2005, incorporates a sophisticated pattern of electromagnets within its design. These apply a slowly increasing electromagnetic field to the structural metal beams, while a coil picks up distinct audio frequencies created by the material’s magnetic domains as they align with the field. Prior to a plane going into service, the initial pattern is recorded and stored for use as a reference for future superstructure checks. This allows ground staff to continually monitor the A380’s airframe for defects by listening to the behavior of the plane’s structure in a varying magnetic field — thereby providing an accurate picture of the state of the plane’s structure. This system can indicate when the plane’s structural integrity is threatened and when maintenance is required. Concerns have been raised about the difficulties of detecting damage to the composite superstructure of aircraft such as the Boeing 787 Dreamliner as well as the A380 (Marks, P., *New Scientist*, May 28, 2005, pp. 21–22).

In 2001 a very different scenario concerned the demise of Ansett — a major domestic Australian airline. This was preceded by the grounding of Ansett’s fleet of ten Boeing 767s on the instructions of the Australian government’s Civil Airline Safety Authority (CASA) due to the discovery of cracks in the wings during CASA safety checks. The immediate outcome was flight cancellations, travel chaos, and reputation damage. The grounding was estimated to have cost the airline AUD4.24 million, and the ensuing advertising campaign seeking to recoup lost market share (of around 20%) to other carriers a further AUD20 million. The company collapsed soon afterward (Creedy, 2002).

In February 2005, an Airbus A340-642 Virgin Atlantic flight from Hong Kong to Heathrow was diverted to Amsterdam after a computer controlling fuel supply to the engines malfunctioned. The Civil Aviation Authority report on the incident concluded that dependency on automatic systems could lead crews to accepting what the aircraft is doing without adequate monitoring. The report also maintained that overdependence on automatic systems is being blamed for controlled flight into terrain (CFIT) overtaking mechanical failure as the leading cause of airline passenger deaths. Pilots are now actually needed only for small parts of flights and for emergencies — an illustration both of the ironies of automation (Bainbridge, 1987) and inappropriate allocation of function (see Section 4.5.2).

Loss of situation awareness has been considered as a factor in aviation crashes (Jones & Endsley, 1995; Endsley, 1996; Hardy & Parasuraman, 1997) as well as in anaesthesiology (Gaba & Howard, 1995), road vehicle crashes (Gugerty, 1997), and process control (Hogg et al., 1995).

### 4.3 Categorizing human error

A first essential step toward ameliorating potential adverse effects of human error within any organization is to understand it. Thus, we need to know what types of errors occur and where they happen before we can begin to address them. In risk management terms, it is necessary to undertake the following steps:

- Identify errors
- Assess any risks that they might pose
- If necessary, take steps to control the behavior that gives rise to errors
- Monitor any control measures taken

Human error is a term that can include a wide variety of human behavior and therefore as a sole descriptor of an act or series of events is not particularly useful. What is needed is a way of analyzing the scope and nature of human error. Of several attempts that have been made to classify human error, Miller and Swain (1987) adopted an outcome-oriented approach in which there are six types of errors, which are:

1. Commission — adding or including something that should not be there
2. Omission — missing something out, for example, from a sequence of steps
3. Selection — incorrect choice from a range of options
4. Sequence — incorrect serial positioning of actions or events
5. Time — too late or too early with an action
6. Qualitative — not performing an action properly

Bryan’s (1989) human error taxonomy is shown in Summary Text 4.2.

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**Summary Text 4.2 Taxonomy of Human Error**

- Substitution — wrong selection due to habit intrusions
- Selection — among choices, not governed by habit
- Reading — for example, altimeters, often a design problem
- Forgetting — cognitive failure, use a checklist
- Reversal — wrong direction, especially under stress — design issue, for example, warning labels
- Unintentional activation — need controls to be locked off so that this is impossible
- Mental overload — fatigue, training, and design could all be important here
- Physical limitation — for example, due to physique, perception, design, placement, layout

Most human error classifications are likely to have some validity, particularly if they are based upon systematic study of errors in particular environments. Transport environments have been frequently studied in this respect. For example, Mashour (1974) found that the most frequent causes of train crashes were failures to confirm a signal, including detection error, perceptual error (especially those due to characteristics of signals), and recognition error (problem of meaning or interpretation) (see Chapter 3, Section 3.3). In a study of road crashes, Rumar (1985) found the most frequent human errors to be concerned with recognition (information acquisition) and decisions (information processing). Of 100 marine incidents studied by Wagenaar and Groeneweg (1987), only four did not involve human error; most were characterized by more than one error made by one or two individuals. The most frequent error types were false hypotheses (incorrect assumptions about the state of things) and dangerous habits. Another example is the system developed by Shorrock and Kirwan (2002) for air traffic control. However, while these various studies found different types and causes of human error, as Lourens (1989) noted, attributing causality to human error is problematic because there is no universally agreed classification system. He also pointed out that definitions of human error differ depending upon who is doing the judging. Thus, it is likely to be more useful in general to seek a classification that has a strong theoretical basis, so that generic categories can be derived to advance understanding of relevant phenomena and to serve as a foundation for appropriate interventions across a range of circumstances.

A generic classification system developed by Reason (1990) was the generic error modeling system (GEMS), which identifies three distinct error types (see also Embrey, n.d.). These error types occur at different levels of performance: skill-based (SB), rule-based (RB), or knowledge-based (KB) (Rasmussen, 1986). GEMS identified the following error types:

1. Skill-based slips and lapses — Unconscious, automatic actions resulting in slips (observable, at action stage) and lapses (inferred, at storage stage, e.g., memory failures), many of these being monitoring failures due to either inattention or overattention.
2. Rule-based mistakes — Following a series of steps and making a mistake, either applying good rules incorrectly or applying bad rules to a situation.
3. Knowledge-based mistakes — Learning from first principles, mistakes made during problem solving, for example, those subject to attributional biases (see Chapter 3).

Reason (1990) distinguished between these three types of error within the GEMS decision-making sequence in which routine actions are performed at the SB level, where slips and lapses may occur if attentional checks fail. The next level (RB) is accessed when the individual becomes conscious of a problem; at this level the problem is compared with existing problem-solving rules. If it still cannot be solved, the KB level is accessed, which involves iterative attempts to solve the problem from first principles, until a solution is reached. Figure 4.1 summarizes the different error types. A primary distinction between slips/lapses and mistakes is that the former are \textit{execution stage} failures, which are usually readily detected, whereas the latter result from intended actions that fail to achieve their desired consequences, that is, \textit{planning stage} failures, which are usually much harder to detect.

4.3.1 \textit{Slips and lapses}

At the SB level of performance (e.g., an experienced motorist driving a car, a skilled operator carrying out tasks on a machine or tool at work, or using computer software that you are
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Summary of main error types

Slips — skill-based, actions not as intended, perpetrator unaware, task-execution failures
Lapses — skill-based, unconscious mental errors, perpetrator may become aware of later, storage-stage (memory) failures
Mistakes — rule- or knowledge-based, perpetrator unlikely to be aware of unless deliberate (violations), planning-stage failures
Violations — deliberate deviations from standard practice, carried out to maintain safe operation

Figure 4.1 Human error types. (Reproduced from Reason, J. T. (1990). Human Error. Cambridge: Cambridge University Press. With permission.)

very familiar with), according to Reason, errors result from either inattention to the task in hand to overattention to the task (monitoring SB behaviors too closely). An illustration of an inattention error would be an omission associated with an interruption or distraction. For example, someone interrupts you by speaking to you in the middle of carrying out a familiar task (such as making a cup of tea) and, when you return to the task, you forget where you were and miss out a step (e.g., failing to put tea into the teapot). Usually, this type of error is quickly spotted and corrected by the operator and, even when not immediately seen and corrected, rarely results in serious consequences. However, occasionally, a missed step is not noticed and thus not recovered, and undesired consequences may result. For example, a busy plant operator about to make an important telephone call to correct a malfunction was interrupted by a colleague with an urgent problem and, on returning to the work station, forgot to make the call until it was too late. Another example concerned a flight crew making preflight checks being interrupted by air traffic control staff to make a runway change and omitted a critical step when they returned to the checklist, resulting in a subsequent crash because the flaps were in the wrong position for takeoff. Such errors have been called program counter failures (Reason & Mycielska, 1982) because an action that is not part of the sequence (dealing with the urgent problem)
Summary Text 4.3 Types of Skill-Based Errors

Repetitions — An action carried out more than the required number of times, for example, a toggle switch that is pressed one more time than is required may be annoying if you find that you have typed the last two lines of text on your word processor in capitals, but could be critical if it is a design fault in a two-handed control on a power press.

Wrong objects — Actions carried out in relation to the wrong object. It may be very inconvenient if you have brought your reading spectacles by mistake to the conference session where you are sitting at the back and cannot see a presenter’s poorly prepared slides, but bringing the wrong spectacles to a job that requires precision engineering for safety to be ensured could result in more than mere inconvenience for those ultimately affected. Another case involved an elderly woman’s daughter mistaking a super glue dispenser for her mother’s eye drops, with excruciatingly painful results for the poor old lady.

Intrusions — Unintended actions are incorporated into a sequence of behavior (sometimes called errors of commission). These usually take the form of strong habit intrusions in which one sequence is captured by another, perhaps more familiar sequence. Thus, adding sugar to your tea when you only take sugar in coffee may result in a displeasing taste, although adding water to concentrated acid in the belief that you are dealing with a different chemical could leave more than a nasty taste in the mouth!

Omissions — Intended actions are left out of a sequence of behavior. Forgetting to pack your personal organizer for a business trip could result in embarrassment; forgetting to check the setting before replacing the grinding wheel could result in a bad accident.


is counted in instead of the intended action (calling in). An example of such an incident that had disastrous consequences concerned the actions of a maintenance engineer who was rewiring a signal at Clapham Junction when he was momentarily distracted in this task. This led to him missing a vital step of cutting back and covering the old wires so that they could not reconnect (see Embrey, 1992, and Summary Text 4.13, on the Clapham Junction train crash). Summary Text 4.3 outlines Reason’s categorization of skill-based errors.

Inattention errors also occur due to strong habit intrusions, where an intended departure from a familiar routine fails to occur — for example, you hear a traffic report on the way to work and decide to take an alternative route to avoid congestion, yet you continue to drive along your normal route forgetting your previous decision. Overattention errors result from mistimed checks, where an attentional check is performed at a point in the sequence where no check was required. This can lead to either omitting a necessary step or repeating an already completed step. For example, a toggle switch or a valve lever, which has been operated once for a sequence of events to occur, is operated a second time to end up in the wrong position. In most cases, following the sequence of tasks through will reveal such an error but occasionally it will not and serious consequences could ensue.
4.3.2 Mistakes

As noted earlier, mistakes occur during conscious problem-solving activity, when actions fail to proceed as intended; these occur at both RB and KB levels. The following sections describe both types of mistake, with safety-related examples of each type.

4.3.2.1 Rule-based mistakes

At the RB level of performance, actions are governed by a hierarchy of rules, developed over time by an individual experiencing different types of problem, and learning a variety of ways of solving them. Rules take the form of if (situation)–then (action). Rule hierarchies are formed with the most general rules at the top of the hierarchy and rules describing more specific cases at lower levels. As exceptions are encountered for more general rules, an additional layer is added with more specific rules to allow for the exceptions (Holland et al., 1986). This learning process is exemplified in the way that children learn English; for example, at first, children learn the general rule of pluralizing a word, by adding “s,” then their rule hierarchy becomes more sophisticated over time as they meet plurals that violate this rule, such as “one sheep, many sheep” or “one woman, many women.” Children’s mistakes in pluralizing English words often take the form of overusing the more general rule, that is, they will speak of “sheeps” instead of sheep and “womans” instead of “women.” This is an example of misapplying a higher-level rule, which Reason describes as strong-but-wrong. As a rule at the top of the hierarchy is activated more frequently and has proven itself reliable in previous situations, it is more likely to be used than are less frequently encountered rules at lower levels of the hierarchy. In general, RB mistakes result when good rules are applied wrongly or bad rules are applied.

Examples of these types of RB mistakes might be recognized in the behavior of the senior police officer in charge of managing football fans during the occurrence of the Hillsborough football stadium disaster in 1987 (Taylor, 1989). The police first decided to allow fans to find their own level in the area behind the goal that was divided by fences into pens, which resulted in too many fans being packed into a confined area (in the belief that this would reduce the capacity for fans to cause trouble). On subsequently seeing fans clambering over the perimeter fences and spilling onto the pitch, the police initially interpreted this as a pitch invasion (sending reinforcements and dog-handlers to the scene), rather than fans escaping the crush (and initially failing to recognize the true horror of the unfolding crushing incident in which 96 people eventually died). The first case is an example of applying a bad rule: although the police believed that packing fans into the terraces back to front, shoulder to shoulder was effective in reducing the likelihood of trouble, allowing fans to find their own level actually resulted in an unsafe level of overcrowding in the most popular areas. In the second case, a good rule (one that is successful when applied in appropriate circumstances) was misapplied. While the signs (climbing perimeter fence, fans on the pitch) were consistent with a pitch invasion, countersigns evident from CCTV cameras (fans in distress) claimed little attention as they were inconsistent with the police’s worldview of football fans as troublemakers.

In the above example, incidents of football fans causing trouble were much more frequently encountered by the police, and therefore led to a stronger rule, than did the less frequent (but not unknown) incidents of fans being crushed in overcrowded terraces. For example, many years ago, one of the authors was a spectator in a stand that caught fire during a football match as a result of which all the spectators in that stand had to be evacuated onto the pitch, with considerable help from the police in attendance. Despite the stand, which had held thousands of people, being completely destroyed there was not a single casualty.
Reason (1990) explained that in a world that includes cases of both regularity and uncertainty, people tend to gamble in favor of high frequency alternatives (e.g., events that we know have happened before) and that this is generally an adaptive (successful) strategy. However, like any gamble, there is always a potential loss. Individuals' rule hierarchies are likely to develop over time and particularly within occupational settings develop into common knowledge, or rules of thumb, at group level (for further discussion of group norms see Chapter 8). While it may be possible to review all such rules operated within a system, many of these bad rules may become embedded as normative, and largely tacit, ways of operating and thus are difficult to detect and correct.

The other type of RB error is incorrect application of good rules. Again, this may occur in various circumstances, one instance of which is information overload. This might result in operator stress and, as for SB behavior, an important step in a sequence may be omitted or two of the steps reversed. During emergencies, there is usually additional pressure on operators, for example in the form of large number of alarms going off, as at TMI (Kemeny, 1979), with operators being unable to deal with them all satisfactorily.

4.3.2.2 Knowledge-based mistakes
The KB level of performance is the one at which we first learn new tasks. For example, on his or her first day in a workplace a worker has to learn about the new environment; the learner driver who sits in the driving seat for the first time; or our efforts to solve a novel problem — all illustrate KB learning. Here, opportunities for error are considerable because we often try out ideas and actions for the first time. As individuals behaving at the KB level we make assumptions about a new task or problem to the extent that we may infer that it is like some other task or problem with which we are familiar. We might focus our attention on certain features of it and ignore others that might be very important. For example, we might assume that a new car, a different control panel, or a novel flight deck, is sufficiently similar to the one we last used that our behavior in respect of it can safely remain unchanged. For example, in the Kegworth air crash, the pilots were flying a Boeing 737 aircraft, which developed engine trouble. They incorrectly identified Number Two engine as the faulty engine and shut it down. The immediate feedback from this action seemed to indicate that the pilots had solved the problem. However, they had actually shut down the wrong engine, leaving the plane flying on one damaged engine. A summary of key factors associated with the crash is given in Summary Text 4.4. It transpired from the crash investigation (Department of Transport, 1990) that the commander, probably based on his past experience on the McDonnell Douglas DC9, assumed that the vibration gauges on the Boeing 737 were unreliable. Thus, he flew the Boeing 737, with its much-improved AVM system, as though it was the older, less reliable DC9. In addition, it seems that his training on the 737 had failed to emphasize the improved performance of the AVM indications. Thus, the gauge, which should have been taken to indicate high vibration in Number One engine, was ignored, ultimately leading to the shutting down of the wrong engine and the subsequent devastating crash.

The potential for human error at the KB level is considerable, given the great diversity of KB learning, and it is the most difficult to correct. A number of KB mistakes are characterized as problems with causality, influenced by the representativeness and availability biases (described in Chapter 3, Section 3.5). Mistakes are common at the KB level due to the novel nature of a problem — individuals may need to improvise solutions where there are no established rules or procedures to follow. In such situations, the success of improvisations depends on the accuracy of the individual’s mental model, the summary of their knowledge regarding the system, and how this is organized. Where there is missing or inadequate information, individuals may need to “borrow” ideas from other situations that
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Summary Text 4.4 Summary of the Airline Crash at Kegworth

On January 8, 1989, at 20.25, a British Midland Boeing 737-400 series crashed into a bank alongside the M1 motorway at Kegworth, just short of the East Midlands Airport runway. Forty-seven passengers died from their injuries and most of the remainder who were on board suffered serious injury. The active failure was that the flight crew shut down the No. 2 engine after a fan blade had fractured in the No. 1 engine. This engine subsequently suffered a major thrust loss due to secondary fan damage after power had been increased during the final approach to land. Factors that affected the incorrect response of the flight crew included those outlined as follows:

- Symptoms of engine failure — heavy vibration, noise, and smell of smoke were outside their training and expertise.
- Previous experience of vibration gauges on other planes, which, unlike the 737-400 gauges, tended to be unreliable.
- Secondary position of the vibration gauges and absence of any warning light or labeled danger zone.
- Lack of familiarity with the automatic fuel system, which meant that when the healthy No. 2 engine was throttled back the automatic fuel system was shut off thereby resulting in a normal flow to the damaged No. 1 engine persuading them that they had (by trial and error) correctly identified the defective engine.
- No cabin crew or passengers who could see the flames emanating from the No. 1 engine informed the flight crew which engine was involved. The flight crew had no means of seeing which engine was faulty and their instruments gave no strong clue that the No. 1 engine was faulty, even when No. 2 engine had been shut down.

When the flight crew were about to review the action they had taken, they were interrupted by messages from flight control and did not return to the review process. Although the flight crew was primarily blamed for the crash, there were other contributory factors, which are:

- Design, manufacture, and inadequate testing of the newly designed engine
- Inadequate training on the new aircraft
- Inadequate procedures for determining which engine to shut down
- Position and display features of critical instruments


provide analogous solutions or to derive novel solutions from first principles. The latter process is particularly prone to error as it creates a substantial mental workload. In addition, errors can be compounded because most forms of work activity involve behavior at all three levels (skills, rules, and knowledge). Nearly all disasters involve errors of various types, typically three or four in combination, whose coming together could not have been...
Summary Text 4.5 Sinking of the Ferry Ship Herald of Free Enterprise

On March 6, 1987, the roll on/roll off passenger/freight ferry, Herald of Free Enterprise sailed from Zeebrugge inner harbor at 18.05. The ship capsized rapidly about 23 minutes later, just after it had left the confines of the harbor: 188 passengers and crew were killed and many others were injured.

It was revealed that both inner and outer bow doors had been left fully open and that water entering the ship through the doors had resulted in the capsize. The most immediate cause was that the assistant bosun, whose job it was to close the doors was asleep in his cabin, having just been relieved from maintenance and cleaning duties. His immediate superior, the bosun, had seen that the bow doors were still open, but did not close them as he did not consider this to be his duty. The chief officer, responsible for ensuring that the bow doors were closed was also required to be on the bridge, 15 min before sailing time. He thought he had seen the assistant bosun going to close the doors. There was pressure from management on the first officer to sail early (15 min) to avoid delays. Company procedures appeared to require “negative reporting” only — that is, unless informed to the contrary, the master assumes that all is well. The chief officer had not made such a report on this occasion. Despite repeated requests from the masters to the management, no bow door indicators were available on the bridge and the master was unaware that he had sailed with the bow doors open. Design features meant that, once water entered, the ship was inherently unstable. A combination of factors or “human errors” — individual, management, and design thereby combined to produce the disaster.


reasonably foreseen (Perrow, 1984). Examples include the sinking of the ferry ship the Herald of Free Enterprise (Department of Transport, 1987) and the Kings Cross Underground station fire (Department of Transport, 1988). Brief summaries of the human factors components of these disasters are given respectively in Summary Text 4.5 and Summary Text 4.6.

4.3.2.3 Violations

In addition to slips, lapses, and mistakes, violations typically occur at the RB level, but could also occur at the KB level. Reason (1990) described these as, “deliberate, but not necessarily reprehensible, deviations from those practices deemed necessary (by designers, managers and regulatory agencies) to maintain the safe operation of a potentially hazardous system” (p. 195). As well as being subject to adherence to rules, policies, and procedures, (HSE, 1995) for example, through selection and training processes, violations are also subject to individual differences. In a study of unsafe acts committed by motorists, Reason et al. (1990) found evidence for three distinct categories of aberrant behavior — violations, dangerous errors, and relatively harmless lapses. Violations are deviations from safe operating procedures, and while such actions are deliberate, they do not usually have a malevolent intent (which would constitute sabotage). Lapses were the most frequently reported driver errors (reported most by women), whilst violations and dangerous errors were less frequent (with more violations being reported by men, particularly young men). It was suggested that because violations were found to decrease with age, but that errors remained stable, the
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Summary Text 4.6 King Cross Underground Station Fire

On November 18, 1987, at 19.25, a discarded match or cigarette end (most probable cause) set fire to grease and rubbish on the Piccadilly line ascending escalator running track at Kings Cross station. Running tracks were not regularly cleaned because of ambiguous responsibilities. Smoke detectors were not installed on cost grounds and water fog equipment was infrequently used due to rust problems. A passenger alerted a booking clerk to the fire at 19.30, although only four of the 21 station staff on duty at the time had received any training in evacuation or fire drills. At 19.34, railway police evacuated passengers via an alternative escalator, although no evacuation plan existed for the station and no joint exercises had been conducted between London Underground staff and the emergency services. A relief inspector, not regularly based at Kings Cross and without any fire training, entered the upper machine room at 19.38 but could not get close enough to the fire to use a fire extinguisher and did not activate the water fog equipment. At 19.39, police in the ticket hall began evacuating the area and requested that Piccadilly and Victoria line trains do not stop at Kings Cross, although trains continue to stop there. At 19.41, police closed metal gates to the ticket hall and the first fire engines arrived soon after. At 19.45, flashover occurred and the whole ticket hall was engulfed in intense heat and flame: 31 people were killed and many others were seriously injured.

The tragedy was aggravated by the lack of an evacuation plan, escape routes being blocked by locked doors and metal barriers, outdated communication equipment, no access to station public address system by headquarters controller, nonfunctioning of cameras and TV monitors, lack of public address system on trains, and absence of public telephones at the station. A combination of factors resulted in a disaster made worse by a variety of behaviors and circumstances.


two categories have different underlying causes. In addition, it was found that drivers with a high violation score, rather than a high error score, reported greatest crash involvement.

Reason et al. (1990) suggested that psychological processes underlying the commission of errors and violations are fundamentally different. Errors are said to result from faulty information-processing at an individual level, whereas violations, “can only be described with regard to a social context in which behavior is governed by operating procedures, codes of practice, rules, norms and the like” (p. 1316). Safety rule infringements are not usually acts of deliberate risk taking, but shortcuts designed to make work more efficient, quicker, or easier (Reason et al., 1994). As operators are not usually able to assess the impact of violations on the system as a whole, and because there may be no obvious or immediate negative consequences, their actions are often reinforced (principles of reinforcement are discussed in Chapter 3). Reason et al. (1994) identified the three types of violation, which are as follows:

1. Routine — short cuts that become a habitual part of the individual’s behavioral repertoire
2. Optimizing — serving nonfunctional goals, such as joy of speed or aggression, which become part of an individual’s performance style
3. Situational — noncompliance, needed to get the job done

The first two types of violation relate to achievement of nonfunctional goals, such as finishing work early or enjoying the sensation of speeding. However, situational violations occur due to organizational constraints, such as unavailable equipment or inadequate staffing.

Reason et al. (1998) developed a rule-related behavior taxonomy, which identified ten different categories (see Summary Text 4.7). A number of factors influence the nature of rule-related behavior, including whether there are relevant safety rules, whether performance is correct, and whether the behavior is psychologically rewarding. Rules and procedures designed to ensure safe behavior are not always appropriate. For example, workers on a North Sea oil rig had been instructed never to jump from the side of the platform in the event of an emergency but to await rescue by helicopter. However, during the emergency on the rig Piper Alpha some of those who ignored these instructions survived, while those who followed the rule perished in the fire, as the clouds of smoke prevented rescue helicopters from landing (Department of Energy, 1990). When rules are inappropriate, the safest course of action would be to violate the rule; mispliances (combining a mistake with compliance) occur when inappropriate rules are mistakenly complied with.

Rule-related behavior in workplaces may result in either correct or incorrect performance. Correct performance is associated with accurate hazard perception, task training, learning from experience, and organizational factors (e.g., leadership, supervisory example). Reason et al. (1998) argued that correct actions are based on the individual conducting an accurate hazard evaluation of prevailing local conditions and acting according to the level of risk. Including risk perception blurs the distinction between errors and violations (Reason et al., 1990) by recognizing that some actions may involve a deviation from procedures (violation), but are based on inaccurate judgments about consequences (mistake) resulting in misventures (combining a mistake with a circumvention). Correct violations — that is, breaking a rule because an immediate hazard assessment indicates that the rule is inappropriate, demand that individuals are given latitude to make decisions. To do this they must be appropriately trained and empowered to assess and evaluate hazards accurately. A further dimension affecting the commission of violations is psychological rewards. Individuals are more likely to violate safety rules where psychological rewards that fulfill personal goals are attached. Correct compliance is undermined where the behavior required is correct but psychologically unrewarding. Such behaviors are likely to become extinct, as the temptation to violate the rule is too much (e.g., wearing uncomfortable PPE, such as gloves or masks). Other forms of violation include those that are incorrect, but hold psychological rewards for the individual, such as bypassing safety regulations as a demonstration of skill and expertise (“only novices need to go by the book”). Reason et al. (1998) noted that such violations may seem innocuous, but can have negative effects, “incorrect but psychologically rewarding violations are the breed stock from which occasional misventures emerge. Though often inconsequential in themselves, they create the conditions that promote dangerous misventures, particularly overconfidence in personal skills and an underestimation of the hazards” (p. 296).

Although they have been considered as independent unsafe acts, incidents often result from a combination of errors and violations. Brown (1990) suggested that motorists have a bias toward inadequate safety margins, where driving with an insufficient margin for safety means that certain types of error become more likely. Motorists who violate accepted road rules by speeding or following too closely reduce their safety margin, thereby creating a
Summary Text 4.7 Ten Categories of Rule-Related Behavior

The behaviors described below achieve both organizational goals (correct behavior) and individual goals (psychologically rewarding).

- **Correct improvisation** — Successful outcome of improvised KB processing (correct and psychologically rewarding behavior, in the absence of appropriate procedures, e.g., a nuclear power plant operator successfully releases a valve through using an adapted procedure learnt on another type of reactor).
- **Correct violation** — Psychologically rewarding behavior (e.g., achieving a personal goal) from not following an inappropriate procedure (e.g., a surgeon does not wear a mask where there is a minimal risk of cross-infection, despite the procedure stating that masks should be worn at all times).
- **Correct compliance** — Psychologically rewarding behavior from following an appropriate procedure (performance conforms to appropriate safety rules, e.g., a train driver stops at a red signal).

These categories of behavior described below achieve neither organizational goals (incorrect behavior) nor individual goals (psychologically unrewarding).

- **Mistake** — Unsuccessful outcome of improvised KB processing (incorrect plan of action devised, which is ultimately unsuccessful, in the absence of appropriate procedures, e.g., a flight crew falsely diagnose a faulty engine, based on experience on different aircraft types, and shuts down the wrong engine — see Summary Text 4.4).
- **Mispliance** — Psychologically nonrewarding behavior from following an inappropriate procedure (combines “mistake” and “compliance”), for example, a doctor prescribing according to protocol, rather than using some degree of flexibility, depending on patient needs.
- **Misvention** — Psychologically nonrewarding behavior from not following an appropriate procedure (combines “mistake” and “circumvention”), for example, welding next to an open furnace, which increases explosion risk.

The categories of behavior described below illustrate situations where organizational goals and individual goals are inconsistent or conflict with each other.

- **Correct but unrewarding compliance** — Psychologically nonrewarding behavior from following an appropriate procedure, for example, wearing uncomfortable gloves or masks.
- **Correct but unrewarding violation** — Psychologically nonrewarding behavior (e.g., failing to achieve a personal goal) from not following an inappropriate procedure — for example, an operator feels uncomfortable when violating a company rule, but recognizes that this is the safest route.
• Incorrect but rewarding compliance — Psychologically rewarding behavior from following an inappropriate procedure, for example, an operator recognizes that a procedure is not appropriate, but follows it anyway as it’s “more than my job’s worth” not to comply.

• Incorrect but rewarding violation — Results from psychologically rewarding behavior from not following an appropriate procedure, for example, removing safety guards from machinery so that work pace can be increased.

The five main factors shaping these rule-related behaviors are:

1. Availability of a procedure
2. Appropriateness of the procedure
3. Whether the procedure was followed
4. Correctness of the chosen course of action
5. Outcome in terms of personal goals


self-imposed time constraint. Thus, drivers have less time to assess the situation (leading to attentional errors), less time to process incoming information (leading to perceptual errors), and limited opportunity to appreciate the potential danger of a situation (leading to judgmental errors). Thus, drivers who violate rules create a situation for themselves where their likelihood of making an error can be greatly increased. Fergenson (1971) found a significant interaction such that high violators with lower cognitive efficiency had a high crash rate, whereas those with a zero crash rate were significantly better at processing information. This suggested that whilst violations reduce safety margins for all drivers, those who are least able to deal with the increased cognitive load are most susceptible to errors. Reason et al. (1990) found that error proneness was a significant predictor of dangerous errors and less dangerous lapses. Neurological research (Durston et al., 2001; Baird & Fugelsang, 2004) has suggested that because the prefrontal cortex — responsible for planning, judgment, and self-control, is the last part of the brain to mature — at around 18 years of age, this could help to explain the apparent occasional irrationality of young people, whether as drivers or in other situations. Although mood was also a significant predictor of errors (and violations), error proneness, which is characterized by higher rates of absentmindedness and inattention, can be treated as a relatively enduring individual characteristic as it is stable over time (Broadbent et al., 1982; Matthews et al., 2000; see also Section 5.6). A lethal combination of errors and violations contributed to the Chernobyl disaster (see Munipov, 1991 and Summary Text 4.8).

4.4 Error occurrence and detection

As already indicated, errors at different levels are not equally likely to occur, nor are they equally likely to be detected or recovered from. A common way of designating human error probability (Miller & Swain, 1987) is number of errors/number of opportunities for error (exposure).

In numerical terms, the range of probabilities for making errors at the three levels has been calculated (Rasmussen, 1980). At the SB level the probability of making an error (e.g., depending on type of task and current stress level) varies between less than 1 in 10,000
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Summary Text 4.8 The Chernobyl Disaster — An Illustration

The world’s worst nuclear power disaster occurred at Chernobyl (in the Ukraine) on April 25–26, 1986. Tests were being carried out on No. 4 reactor, which involved shutting down the reactor and switching off the emergency core cooling system. A series of operational errors and procedural violations led to an out-of-control chain reaction, resulting in explosions that destroyed the reactor core.

The operators, probably all Ukrainians, were members of a high-prestige occupational group, and had recently won an award. They probably approached the task with a ‘can do’ attitude with some confidence in their ability to ‘fly’ the reactor. Like other nuclear power plant operators, they would operate the plant using process feel, rather than a knowledge of reactor physics. Their immediate aim was to complete the test as quickly as possible, get rid of the experimenters, and to shut down the plant in time for the start of the Tuesday maintenance program. But they had forgotten to be afraid of the dangerous beast they were driving. The Russian report expressed it thus:

They had lost any feeling for the hazards involved. The experimenters, akin to a development group, were electrical engineers from Moscow. Their aim was quite clear: to crack a stubborn technical problem once and for all. Although they would have set the goals for the operators before and during the experiment, they would not, themselves, have known much about the actual operation of a nuclear power station.

The Russian report makes it evident that the engineer in charge of this group knew little or nothing about nuclear reactors. Together the two groups made a dangerous mixture. The experimenters were a group of single-minded but non-nuclear engineers directing a group of dedicated but overconfident operators. Each group probably assumed that the others knew what it was doing. And both parties had little or no understanding of the dangers they were courting or of the system they were abusing.

The operators’ actions were consistent with an illusion of invulnerability. It is likely that they rationalized away any worries (or warnings) that they might have had about the hazards of their endeavor. Their single-minded pursuit of repeated testing implied an unswerving belief in the rightness of their actions. They clearly underestimated the opposition: in this case, the system’s intolerance to being operated within the forbidden reduced-power zone. Any adverse outcomes were either seen as unlikely or possibly not even considered at all. Finally, if any one operator experienced doubts, they were probably self-censored before they were voiced. The above speculations suggest that the group aspects of the situation were prominent (see Chapter 8 for further consideration of group effects that might have been operating in this situation).

Figure 4.2 Probability ratios for different error types.

Table 4.1 Error Occurrence, Detection, and Recovery Rates

<table>
<thead>
<tr>
<th>Error type</th>
<th>Probability of occurrence range</th>
<th>Proportion of all occurrences (%)</th>
<th>Detection rate (by perpetrator) (%)</th>
<th>Recovery rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills</td>
<td>&lt;1 in 10,000 to &gt;1 in 100</td>
<td>61</td>
<td>86</td>
<td>69</td>
</tr>
<tr>
<td>Rules</td>
<td>&lt;1 in 1000 to &gt;1 in 10</td>
<td>27</td>
<td>73</td>
<td>35</td>
</tr>
<tr>
<td>Knowledge</td>
<td>&lt;1 in 100 to 1 (certain)</td>
<td>12</td>
<td>71</td>
<td>23</td>
</tr>
</tbody>
</table>


and greater than 1 in 100. The comparable range for RB errors is between less than 1 in 1,000 and greater than 1 in 10, depending on the rules and the circumstances in which they have to be executed. At the KB level, the lower limit of the range is below 1 in 100 while at the other end the probability is 1. This means that for a novice performing certain tasks it is certain that they will fail (imagine someone who has never flown an aircraft before trying to land one unaided). These error probability ranges are summarized in Figure 4.2, while average error occurrence, detection, and recovery rates given by Reason (1990) from reviews of a number of studies, are shown in Table 4.1.

As far as error detection is concerned, because of the evolutionary learning function of human error, we are reasonably adept at correcting errors. A number of possibilities exist. First, there is self-monitoring, or feedback control, itself an error-prone process. Slips and lapses are more likely to be detected than mistakes are, although any type of error could remain undetected, unless detection is immediate. However, certain types of error are known to be particularly resistant to detection, for example, omitting steps in a calculation sequence. A second possibility is error detection by others. This is likely to be particularly helpful in respect of diagnostic errors and when the operator is under stress — for example, when driving under time pressure to an unfamiliar location, it is very helpful to have a companion with a map. A third possibility is that the system responds to an error in some way, for example, by flagging up a warning or locking up the system until a correct response is obtained. Lewis and Norman (1986) presented a number of other possible ways for systems to respond to human operator errors. A final possibility is to
use a forcing function — which prevents the behavior from continuing until the problem has been corrected (Lewis & Norman, 1986). This is a standard way of preventing some SB errors from occurring, for example, in operating machinery or plant. Forcing functions operate to prevent a sequence from continuing unless all previous actions have been performed correctly. Examples include interlocked guarding mechanisms and other types of guards, bolts that only fit one way, and machinery that it is only possible to (re)assemble in one correct way. However, forcing functions may be seen as a challenge, a barrier to be overcome (e.g., an interlocked guard designed to prevent access to moving machinery or a deadlock system designed to deter a would-be car thief) rather than as a safety provision. Notwithstanding this problem, it is impossible to prevent all SB errors by forcing functions and it is necessary to rely on the fact that: first, most are detected and corrected by the perpetrator; second, in most cases, consequences of undetected errors are mostly not severe.

Where consequences could be severe, either in safety or cost, there are grounds for installing some form of forcing function within a system. From the descriptions of SB errors outlined in Summary Text 4.3, it should be clear that outcomes of most cases of human error will be benign, that is, they will result in no more than trivial or temporary annoying conditions. Thus, as inherently error-prone living systems, humans will not be strongly motivated to avoid errors in most situations because costs of seeking error-free performance (e.g., loss of speed in using a computer) will not be offset by benefits derived. In any case, checking routines (e.g., spell checkers in word processors, formulae checks in spreadsheets, and logic checks in databases) are now built into most automated systems. Also, as noted earlier, a vital component of human learning is to make errors and to use the feedback on our performance to adjust subsequent behavior (error making being essential for most learning). Problems arise when the consequences of our errors are severe and then it is necessary to design automated checking systems. In exploring links between everyday lapses and those resulting in disasters, the difference usually lies in a unique combination of factors, often including errors, and an unforgiving environment (Reason & Mycielska, 1982). While, because of rapid feedback, SB errors are usually revealed immediately, it is much more difficult to diagnose RB and KB errors because potential consequences may not be evident.

Reason (1997) contrasted delayed-action latent conditions, which have no immediate negative consequences but which are found mainly at higher organizational levels, to the slips, lapses, and mistakes of individuals, or active failures, found mainly at operational level. The latter are generally made by front-line operators — for example, pilots, drivers, control room staff, and machine operators. Consequences of active errors are usually immediate. In contrast, latent conditions are perpetrated by those whose activities are removed in time and space from operational activity, for example, designers, decision makers, and managers resulting in consequences that lie dormant within the system, until triggered by some event. As they accumulate undetected within systems, latent conditions pose the greater threat to the integrity of complex systems. In particular, the more removed individuals are from the front line the greater is their potential for harm. Latent conditions used to be called latent failures. However, because these potential antecedents to incidents may or may not be part of the etiology of an incident or disaster, their categorization as a failure is almost always retrospective. For this reason, Reason (1997) suggested referring to them as latent conditions. The two error types as summarized here are:

1. Active failures — proximal; may not be recoverable
2. Latent conditions — distant but recoverable; usually hidden within an organization until triggered by some event, hard to detect, and could have serious consequences
Incidents occur when triggering events or circumstances, in combination with active failures and latent conditions, produce an unpredicted sequence of steps that results in an outcome that could be classified as a disaster. Reason (1990, 1997) likened such triggering events to resident pathogens within the human body, which when combined with other agents (e.g., stress, emergencies, organizational change) result in incidents or, very occasionally, large-scale disasters. Resident pathogens are most likely in complex, interactive, tightly coupled, opaque systems (Perrow, 1984). For example, a resident pathogen in the human body might be a predisposition to cancer. A latent condition could be exposure to a carcinogen and the active failure, developing cancerous cells. Latent conditions exist at the KB level, which is the most important from a total potential loss point of view.

4.4.1 Error reduction strategies

As general strategies for reducing human error, Sanders and McCormick (1993) identified training, selection, and design approaches (see Chapter 10). As illustrations of selection criteria to reduce errors, Sanders and McCormick suggested perceptual and intellectual abilities and motor skills. However, they cautioned about the following three provisos:

1. It is possible to identify the skills and abilities required (e.g., using task analysis, see Section 4.7.1)
2. Reliable and valid tests exist to measure these abilities
3. There is an adequate supply of qualified people

Of the design approach, Sanders and McCormick noted the following alternatives:

1. Exclusion — making it impossible to make errors
2. Prevention — making it difficult (but not impossible) to make errors
3. Fail-safe — reducing the consequences of errors but without necessarily affecting their likelihood

Other alternatives, such as using procedural checklists, depend upon operators actually using the checklist correctly on every required occasion. Overall, Sanders and McCormick considered that the design approach is usually the most cost-effective as it only has to be done once, whereas selection, training, and other solutions require continuous maintenance and support. Lourens (1989) is among other authors who commend the primary means of reducing slips through improved equipment and job design. As Sanders and McCormick (1993) famously noted, it is easier to bend metal than to twist arms. Comparable error reduction strategies are recommended by Mason (1992), who used Reason’s error typology, and these are outlined in Summary Text 4.9.

In general terms, the way to reduce or minimize KB performance errors, which like RB errors are also mistakes because they occur at the planning stage of behavior, is in principle for the organization or individual to become an effective learner. What this means for organizations is that they should develop systems that enable them to identify and control errors at all levels. This has also been found to be an important feature of safety culture (Ryan, 1991) and means that organizations must be able to respond appropriately to human error occurrences through safety culture (see Reason, 1997 and Chapter 11). An outline example of how such a program could operate in principle is outlined in Summary Text 4.10. It is important that such an exercise is carried out in an open way, such that all workers have an opportunity to become involved and that it is, and is perceived to be, quite separate from
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Summary Text 4.9 Error Reduction Strategies

Reducing *slips and lapses* can most effectively be achieved by design improvements and training.

Reducing the potential for mistakes is best achieved through training — team and individual, overlearning, refreshers, duplication of information, clear labeling, and color coding.

Reducing knowledge-based errors is best achieved by hazard awareness programs, supervision, work plan checks, and posttraining testing.

Reducing violations is most appropriately addressed via motivation, correcting underestimation of risk, balancing perceived risks and benefits, supervision, group norms, and management commitment.


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Summary Text 4.10 Illustration of How Errors within Organizations Might be Identified and Controlled

1. Institute a system for reporting and recording all near miss incidents on a sample basis — for example, using human error diaries to record all human error incidents for a fixed time period.

2. Objectively analyze the incidents recorded to establish antecedents (direct causes or other relevant circumstances) — for example, by interviewing personnel to follow up reported incidents.

3. Involve personnel at all levels within the organization in a continuing improvement program to address issues revealed by the exercise. This should be a joint problem-solving exercise that addresses some aspects of safety culture (see Chapter 11) — shared perceptions of goals at all levels within an organization and promoting effective communication.

4. The resulting change should be controlled and continually monitored by top management so that the organization develops and maintains a positive focus on safety issues — another important aspect of safety culture. Management should thereby be seen to be committed to safety, including reducing human errors that occur through its own decision-making processes.

For managers wishing to take the management of human error seriously, Lourens (1989) recommended the following steps for instituting a safety program:

- Create a human factors database on incidents and injuries
- Reassess operators’ performance regularly
- Study operators’ habits during routine activity
- Introduce computer-based displays of information to provide unambiguous signs
- During group tasks, be aware of risk-enhancing factors in interactions (e.g., risky shift and groupthink — see Chapter 8).
any element of blame (e.g., not linked with any disciplinary procedure). This may be quite difficult for an organization with a tradition of using disciplinary measures as a response to what are frequently labeled as human error failures, but is essential for organizational learning in health and safety (and in other areas) to occur. Change in this area may not happen rapidly, especially where there is a legacy of mistrust to overcome. However, the success of those organizations that achieve injury rates significantly below their industry sector averages shows what can be achieved over time. It is not surprising to an extent that organizations seek to allocate blame to individuals for making errors when typically we often make comparable judgments in respect of our own errors, thinking ourselves as careless or stupid for having made mistakes. One criterion that may be applied is the substitution test (Reason, 1997), which asks whether, in the light of how events unfolded in a given set of circumstances, anyone with the same amount of skill and knowledge would have behaved any differently. If the answer is no, then a generic problem rather than an individual one is indicated. Individual factors in error liability are considered in Chapter 5.

Reason (1993) suggested that most organizational incidents, “have their origins within the managerial and organizational spheres” (p. 8). He argued that incidents occur due to the development of latent conditions, both organizational and technical, which lead to individual unsafe acts (slips, lapses, mistakes, and violations). His model of incident causation matches organizational failures with production elements in organizations: high-level decision makers; line management; workforce; and productive activities and defenses. Fallible decisions are translated into line-management deficiencies, creating preconditions for unsafe acts at operational level (e.g., a workforce lacking training, motivation, or the appropriate equipment and technology to do their jobs well). Individuals’ actions present at incident onset are active failures; because they activate adverse effects of latent conditions lying dormant within a system, these failures may act to trigger an incident rather than cause an incident. Given the almost limitless potential for active failures within a complex system, Reason argued that because only a finite number of latent conditions can be monitored proactively remedial measures should be directed at these rather than at active failures. Reason (1993) identified the following general failure types (GFTs) as common sources of latent failures:

- Hardware defects
- Design failures
- Poor maintenance procedures
- Poor operating procedures
- Error-enforcing conditions
- Poor housekeeping
- System goals incompatible with safety
- Organizational failures
- Communication failures
- Inadequate training
- Inadequate defenses

Safety systems based on Reason’s model have been developed, initially for the oil industry and U.K. railways (described in Reason [1993, 1995]), which focus on proactively identifying andremedying organizational factors, and later for applications within the airline industry and medicine (Reason, 1997, 1998). Organizations in the Australian railway system have also adopted systems based on these ideas (Edkins & Pollock, 1997).
4.5 Human factors

4.5.1 Ergonomic principles

The subject addressing human–system interface issues is ergonomics, also known as human factors, human engineering, or engineering psychology. Major writers in the area consider human factors and ergonomics to be synonymous (Salvendy, 1987; Sanders & McCormick, 1993). Oborne (1995) described human factors as a sister discipline to ergonomics and considered ergonomics to be a way of looking at the world. In this section (and in the book as a whole) human factors and ergonomics are used interchangeably. This section provides a summary of some key issues; readers interested in pursuing these topics further might wish to consult an ergonomics text (Stanton & Young, 1999). In addition to considering the human–system interface, ergonomics is also concerned with the following issues:

- Human dimensions (anthropometry) and other characteristics (e.g., cognitive, spatial ability, and physical, e.g., height)
- The working environment and its effects upon humans
- Effects of systems of work upon humans

In its applications, ergonomics (or human factors) inter alia pursues the following aims:

- Design equipment and working environments so as to match human capabilities to ensure effective operation and to optimize working and living conditions.
- Enhance effectiveness and efficiency of work and other activities, for example, by increasing convenience, reducing errors, and increasing productivity.
- Design work systems so that requirements for human physical and mental well-being are sustained.
- Enhance certain desirable human values, for example, safety, reduce fatigue and stress, and increase comfort, user acceptance, job satisfaction, and quality of life (Sanders & McCormick, 1993).

Failure to apply these principles successfully in workplace design has consequences both for systems and for individuals. Work systems will become less efficient over time, while individuals could suffer health impairments such as physical and psychological stress (see Chapter 7). Successfully applying ergonomic principles, as well as improving efficiency and productivity, is a primary means of reducing workplace risks arising from health and safety hazards. This is essentially done by reducing or eliminating opportunities for human operators to produce uncorrected errors within work systems, while retaining the necessary degree of control to overcome system errors should they occur. Thus, appropriate delegation of function to people and machines is a fundamental aspect of ergonomic design. The basic question to ask is: “should a person or a machine be doing this job?” This issue is addressed next.

4.5.2 Human and machine performance

To help designers answer questions about who does what within systems, ergonomists have considered allocation of function. Fitts (1951) identified key aspects of respective performances of human beings and machines and Singleton (1971) amended Fitts’ list, as shown in Summary Text 4.11. This shows that human beings are best at undertaking some performance elements, while machines (e.g., computers) are superior at others.
### Summary Text 4.11 Comparison of Human and Machine Capabilities for Allocation of Function

<table>
<thead>
<tr>
<th>Property</th>
<th>Human capacity</th>
<th>Machine capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>Inferior</td>
<td>Superior</td>
</tr>
<tr>
<td>Power</td>
<td>Two horse power for ten seconds</td>
<td>Consistent at any level</td>
</tr>
<tr>
<td>Consistency</td>
<td>Not reliable, needs to learn, subject to fatigue</td>
<td>Ideal for: routine, repetition, precision</td>
</tr>
<tr>
<td>Complex activity</td>
<td>Single channel, low throughput</td>
<td>Multichannel</td>
</tr>
<tr>
<td>Memory</td>
<td>Large store, multiple access, best for principles, strategy</td>
<td>Best for literal reproduction and short-term storage</td>
</tr>
<tr>
<td>Reasoning</td>
<td>Good inductive, easy to reprogram</td>
<td>Good deductive, tedious to reprogram</td>
</tr>
<tr>
<td>Computation</td>
<td>Slow, subject to error, good at error correction</td>
<td>Fast, accurate, poor at error correction</td>
</tr>
<tr>
<td>Input</td>
<td>Wide range and variety of stimuli dealt with by one unit (e.g., eye); affected by: heat, cold, noise, vibration, etc.; good: pattern detection, very low signals, signal in noise</td>
<td>Some outside human senses (e.g., radioactivity); insensitive to extraneous stimuli; poor pattern detection</td>
</tr>
<tr>
<td>Overload Intelligence</td>
<td>Graceful degradation</td>
<td>Sudden breakdown</td>
</tr>
<tr>
<td></td>
<td>Can adapt, anticipate, deal with unpredicted/unpredictable strategies without direction</td>
<td>None, cannot switch goals</td>
</tr>
<tr>
<td>Dexterity</td>
<td>Great versatility and mobility</td>
<td>Specific</td>
</tr>
</tbody>
</table>


When designing systems, the ideal is to allocate to humans those activities that they perform best (e.g., problem solving) and to assign to machines the things at which they excel (e.g., computational speed). Other ergonomists have produced similar lists (Chapanis, 1961; Bekey, 1970; Murrell, 1971; Kantowitz & Sorkin, 1987; and, for an evaluation of the potential of such lists, Price, 1985). Chapanis (1965) cautioned against using such lists, regarding them as generalizations. He argued for considering whole systems, including issues such as cost-effectiveness and trade-offs (e.g., in design). It has been argued that when designing a system, it is more useful to think in terms of complementarity and to consider optimum combinations of human and machine in the light of criteria such as flexibility and consistency (see, e.g., Meister, 1985; Kantowitz & Sorkin, 1987). Sanders and McCormick (1993) also argued that allocation of function is not straightforward and outlined a general strategy that includes a team approach to discussing human factors in system design, so as to take account of different viewpoints. Their guidelines are shown in Summary Text 4.12.
Summary Text 4.12 Allocation of Function

Humans are generally better at the following features:

- Sensing very low levels of stimuli — for example, visual, auditory, tactile, olfactory, and taste
- Detecting stimuli against high-noise-level backgrounds — for example, blips on DSE displays with poor reception
- Recognizing complex patterns of stimuli that may vary between presentations — for example, objects in aerial photographs, speech sounds
- Remembering (storing) large amounts of information over long periods — better for remembering principles and strategies than a lot of detailed information
- Retrieving relevant information from memory (recall) and frequently retrieving many related items (but low recall reliability)
- Drawing upon varied experience in making decisions and adapting decisions to situational requirements; acting in emergencies (don’t require reprogramming)
- Selecting alternative modes of operation if certain modes fail
- Reasoning inductively and generalizing from observations
- Applying principles to solutions of varied problems
- Making subjective estimates and evaluations
- Developing entirely new solutions
- Concentrating upon the most important activities when required to by overload conditions
- Adapting physical responses to variations in operational requirements (within reasonable limits)

Machines are generally better at the following features:

- Sensing stimuli outside the normal range of human sensitivity — for example, x-rays, radar wavelengths, ultrasonic vibrations
- Applying deductive reasoning — for example, recognizing stimuli as belonging to a general class
- Monitoring for prescribed events, especially infrequent ones
- Storing encoded information quickly and in substantial quantity
- Retrieving coded information quickly and accurately
- Processing quantitative information when so programmed
- Performing repetitive actions reliably
- Exerting considerable physical force in a highly controlled manner
- Maintaining performance over extended periods
- Counting or measuring physical quantities
- Performing several programmed activities simultaneously
- Maintaining efficient operations under conditions of heavy load and distractions

In applying principles underlying allocation of function it is important to recognize that machines or computers should not be employed simply to deskill human tasks but, in line with ergonomic principles, to support and enhance human capabilities. Thus, as increasing numbers of routine, repetitive, and dangerous jobs become automated, this should be seized upon as an opportunity to release people not only for the tasks and jobs for which their strengths suit them (e.g., decision making, problem solving), but also for those that are more psychologically fulfilling. If this is not done, as discovered by Byrne and Parasuraman (1996), highly reliable, predictable, and automated work environments could induce complacency and decrease vigilance, resulting in operator errors of omission and neglect. In considering the ironies of automation, Bainbridge (1987) noted that while machines may be used to replace unreliable and inefficient human operators, designers’ errors also make a significant contribution to incidents. In an automated plant, operators have to monitor events despite the fact that humans are poor at this type of function (Summary Text 4.12) and thus alarms are needed (i.e., more automation). Bainbridge (1987) pointed out that while humans are very good at long-term decision making and problem solving they do not perform these functions well under stress. The degree of automation in human–machine systems can vary from complete manual control to all system components being controlled by system components, with the human operator perhaps seeing system outputs and able to intervene in emergencies (Endsley & Kiris, 1995). Parasuraman and Riley (1997) described relationships between automated and human system elements, including: workload, skills, confidence, task complexity, perceived risk, fatigue, system state learning, and trust in automation system accuracy and operator accuracy. Bainbridge (1987) noted that the ironies of automation included those listed below:

- Automation can remove easy tasks and make difficult tasks even more so
- Systems designers may leave people to cope with tasks that they cannot automate — for example, restoring a system to a safe state after failure
- Monitoring highly automated systems does not suit human capabilities
- Systems that rarely fail require skills that human operators can rarely practice
- The most automated systems may require the greatest operator training

It is instructive to compare characteristics of human performance with those of automated systems. Summary Text 4.11 and Summary Text 4.12 show general characteristics of human behavior, but within such general human limitations there can be considerable performance variations. For example, while most adults require seven to eight hours’ sleep per night, some individuals require at least nine or even ten hours’ sleep, while others can manage on five or fewer hours. Over a lifetime, these individual differences can make a considerable difference in performance capacity. Chapter 5 reviews individual differences in personality, although humans differ in a wide range of other characteristics. Age and experience are often highly correlated in respect of job or task activity, so it is usually difficult to separate out the effects of one or the other of these variables, for example, as they relate to injury involvement. However, studies investigating this issue (Hale & Hale, 1986) have on balance concluded that it is lack of experience (on a particular job or task) that is the more important factor. There are important implications in this finding for training and supervision of inexperienced workers.

Experienced workers also make errors and generate incidents, but the type of errors that they make tend to be different from those of novices and different strategies therefore need to be applied to their safety, for example, in respect of training. Novice workers are more likely to make errors because they lack certain critical knowledge of a task, procedure, or process (e.g., that one should not add sodium to water, that there is a requirement to
Summary Text 4.13 Clapham Junction Rail Crash

A collision occurred among the 18.18 Basingstoke to Waterloo train, the 06.14 Poole to Waterloo train, and a train of empty coaches southwest of Clapham Junction Station at about 08.10 on December 12, 1988. Thirty-five people were killed and many others injured.

A new signal had malfunctioned, so that the second train was not prevented from occupying the same track as the earlier one and failed to stop the front of the second from running into the back of the first. The driver of the first train had seen the signal change from green to red as he passed it and was obliged to stop and report a signal passed at danger (SPAD). He could not have known that the signal was faulty and that following trains had not also been stopped. The immediate cause of the faulty signal was false feed of current from an old wire in the Clapham Junction relay room. This situation was the result of electrical work done on two separate occasions within the previous two weeks. On the first occasion, the senior technician responsible for the work made basic errors in not cutting back the old wire but merely bending it away. The supervisor, who was involved in other work, had not inspected the senior technician’s work. The second job, undertaken coincidentally by the same senior technician, compounded the initial error as the old wire reverted to its original position when a new relay was being installed. However, the inquiry also identified responsibility among many other parties who had allowed a situation in which such errors could be made and remain undetected when such work was inspected, tested, and commissioned back into service. The supervision and monitoring of poor working practices was criticized for its inadequacy. Malpractice was found to be widespread, indicating a lack of adequate staff training. The Management was criticized for incompetence, ineptitude, inefficiency, and failure (p. 73). Lessons from previous incidents had not been learned and it was concluded that “concern for safety was permitted to co-exist with working practices that were positively dangerous”. This unhappy coexistence was never detected by the management and so the bad practices were never eradicated (p. 163). Ninety-three separate recommendations were made.


use a registered ladder to carry out a job, or that a certain period of time has to elapse before a decontaminated building can be entered). Experienced workers on the other hand, generally know these sorts of things but remain liable to errors that relate to exercising their skills. For example, a skilled fitter or electrician is still liable to slips and lapses, while other factors, such as fatigue or stress, that can result from pressure to complete work on time may also result in errors (a factor in the Clapham rail crash, see Department of Transport, 1989 and Summary Text 4.13 for a brief summary of human factors aspects). Occasionally, these will culminate in fatal injuries. Individuals to a certain extent adapt to adverse physical environments such as temperature extremes or high noise levels, but such physical stressors nevertheless take their toll in respect of long-term deterioration in individual physical and psychological health.

Effects of stress on performance are outlined in Chapter 7. Disruptive stress can increase error probability by a factor of between 2 and 5 (Swain & Guttman, 1983) while higher
levels of stress can result in even more degradation. Stress may be imported from other environments, for example, the home (e.g., ambulance drivers, see Glendon & Coles, 2001; or police officers, see Thompson et al., 2001). It is known that people whose jobs involve driving (e.g., HGV or PSV drivers), already a potentially stressful type of work activity, may be subject to additional stress from domestic and other problems (see e.g., Selzer & Vinokur, 1974; Gulian et al., 1990). Financial worries or other concerns may also impact adversely upon work activities, particularly if support is not readily available.

4.6 Interface design

The fundamentals of interface design may be identified as follows:

- Take account of human limitations
- Fit tasks to human operators
- Reduce or eliminate possibilities for human error

The human–machine interface can be represented diagrammatically, as in Figure 4.3, which shows that display elements, representing communication from machine to human operator and control elements, communication from operator to machine — are part of a rapid feedback loop. Human limitations, which need to be taken account of by the ergonomic designer, are outlined in Summary Text 4.14.

4.6.1 Fitting tasks to human operators

Although human beings are extremely flexible and often willing to endure adverse working conditions, there is a price to pay in terms of health and safety, either long term or short term, for not insisting that the starting point for any design process should be human limitations, such as those outlined in Summary Text 4.14. For example, in designing machinery, machine operations as well as systems of work, potential for operator error and routine
Chapter four: Human error and human factors

Summary Text 4.14 Human Limitations To Be Taken into Account by Designers

- Sense organs (receptors) — For example, vision: the operator should be able to read easily controls, instruments, and displays to prevent fatigue.
- Interpretation — Information received must be organized so that the human information processing system can easily understand it, for example, it must not overload the operator’s short-term capacity or make undue attentional demands.
- Posture — All work processes and systems of work should be designed to allow postures to remain comfortable and to minimize strain; sitting and position of controls and displays is important here.
- Layout — Of the working area should allow adequate movement between operating positions, safe access and egress, and unhindered oral and visual communication with others.
- Comfort — Environmental factors, particularly lighting, ventilation, and relative humidity, should provide for maximum operator comfort.
- Workrate — Movements that are too fast or too slow induce fatigue; repetitive movements are particularly liable to produce adverse physical effects (e.g., work-related upper limb disorders); there should be variety in work rate; if people are working under stress imposed by time constraints, emergency conditions, or other pressures, then they are more likely to make mistakes.
- Fatigue — Design should take account of operator fatigue and the likelihood of mistakes being made; although humans can adapt their performance to compensate for fatigue, errors and injuries are more likely toward the end of a work shift or work period.
- Stress — May be physical (e.g., as a result of noise, vibration, or temperature extremes) or psychological (e.g., resulting from unrealistic deadlines and other work pressures) — see also Chapter 7.

maintenance must be considered (Morgan et al., 1963). A starting point might be to consider principal causes of injury associated with machinery operation (see Booth et al., 1988). The ergonomics of machinery design should take account of the following factors:

- Procedures for job loading and removal
- Systems for changing tools
- Safe removal of scrap and waste material
- Routine maintenance procedures
- Emergency breakdown procedures
- Potential unexpected movement, failure, or start-up
- Safe access to and egress from the area
- Operating space
- Risks to others passing through the area

As humans do not have the physical or cognitive capacity to resist the variety of risks from operating machinery, the accepted way of protecting them is to choose from a range of appropriate guards or safety devices. The development of new technology has meant that
task allocation is an important function not only in designing machinery but also computer systems. Developments in technology have allowed systems a degree of flexibility, called "dynamic task allocation" (DTA) or adaptive control, so that the precise distribution of tasks between operator and computer can be decided during the work activity, for example, the computer could automate tasks when the human operator becomes overloaded. DTA has a number of advantages over traditional systems of task allocation (Parasuraman & Mouloua, 1996), including improved human and system performance. For example, both implicit DTA (where the computer controls task allocation) and explicit DTA (where the operator controls task allocation) have been found to enhance performance in air traffic control tasks under heavy workload conditions (Lemoine et al., 1995).

4.6.2 Ergonomic applications to reduce human error potential

Given that there is potential for human error at different points in human–machine interactions, different considerations apply in reducing human error potential as a factor in injury causation. Using Figure 4.3 as a basis for error-reduction strategies, the remainder of this section identifies points at which errors are possible and outlines guidelines for reducing the likelihood of such errors.

Much research has been undertaken on the display–human receptor interface as a feature of the traditional knobs and dials aspect of ergonomics. Common requirements in interface design are likely to involve correct choice of a particular type of machine display, for example, as in a display panel, which should be based upon its function as far as a human operator is concerned and the nature of the task that is to be performed. Green (2003) provided several examples of poorly matched interface designs and remedies that would enable them to address expectations of human operators. Different types of displays are best suited to different tasks, as shown in Table 4.2 and Summary Text 4.15. From Table 4.2, it may be seen that if precision is the most important feature of the task, then a digital scale would be used, whereas if rate of change is more important, then a moving pointer (analogue) scale would be best. In many cases, a trade-off has to be made because there is more than one requirement, perhaps one for error minimization and a different one for efficiency, in which case a compromise might be a moving scale. There are also nonquantitative aspects of tasks, which require different types of displays. These are outlined in Summary Text 4.16. Other important factors in control design are shown in Summary Text 4.17.

Pertinent information about certain features of a person’s immediate environment is provided by visual displays. For example, several displays in a car provide the driver with information. The windscreen is an example of a real-time display from which the driver obtains visual information on the speed of the car on the road and positions of other vehicles.

| Table 4.2 Acceptability of Quantitative Displays |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Display         | Ease of reading | Precision       | Detecting rate of change | Setting to a reading |
| Digital         | Very good       | Adequate        | Poor                |                  |
| Moving pointer  |                 |                 |                    |                  |
| Moving scale    |                 |                 |                    |                  |

Summary Text 4.15  Respective Merits of Analogue and Digital Displays

<table>
<thead>
<tr>
<th>Function</th>
<th>Analogue display</th>
<th>Digital display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative readings</td>
<td>Best if precise reading is not required or if task has predictive or checking components</td>
<td>Best for accurate reading of slow changing values; poor if task includes predictive or checking components</td>
</tr>
<tr>
<td>Qualitative readings</td>
<td>Best for warnings, checking, and prediction; useful to have visually coded areas</td>
<td>Poor</td>
</tr>
<tr>
<td>Setting and tracking</td>
<td>Best</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Summary Text 4.16  Functional Characteristics of Qualitative Displays

<table>
<thead>
<tr>
<th>Display</th>
<th>Functional characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory</td>
<td>Attract immediate attention — as in an alarm</td>
</tr>
<tr>
<td>Visual</td>
<td>Represent a number of states, for example, using different colors</td>
</tr>
<tr>
<td>Representational</td>
<td>To provide the operator with a model of the system — best for showing spatial or temporal relationships between system elements</td>
</tr>
</tbody>
</table>


One reason why drivers fail to adjust their speed in foggy conditions is that they lose much of this visual information and thus miss valuable feedback on their performance (Chapter 3). The instrument panel display provides selected information about the internal functioning of the vehicle as well as its relationship with the road environment. A moving pointer has been found to be most suitable for showing speedometer readings (Feldman, 1971). Integrating audible sounds with visual displays can improve performance monitoring over visual displays only. An auditory display acts as a warning device conveying qualitative information. For example, a smoke detector emits an audible sound when there is smoke in the vicinity or the sound emitted tells an operator that something mechanically is wrong when a wheel bearing in a machine is deteriorating. For further information on warnings, see for example, Green (2004a), Stanton (1994), and Stanton and Edworthy (1999). In contrast, quantitative information, such as a numerical reading telling us the speed at which a car is traveling, is normally associated with a visual display. However, quantitative information can also be communicated through the auditory mode (e.g., clock chimes or Morse code), while a visual display can provide low-order qualitative information, for example a temperature gauge, which gives a hot or cold reading.

The branch of ergonomics concerned with human cognition, that is, representing systems in the human mind and human understanding of those systems, is cognitive ergonomics. Systems design needs to go beyond traditional knobs and dials aspects and
Summary Text 4.17 Factors Important in Control Design

- Feedback — for example, to body or sense organs
- Resistance — to guard against inadvertent operation of control
- Size — relative to force required for operation
- Weight — relative to operator’s position
- Texture — issues of slip, grip, and glare
- Coding — up to a maximum of about 11
- Coding by shape — simple forms better than complex ones
- Coding by texture — for example, coins need to have many distinguishing features
- Coding by size — minimum 20% difference between each; shape or texture usually better
- Coding by color — needs to be seen by the operator
- Location — for example, foot pedals in a car
- Nature of task — for example, design of instruments and displays
- Compatibility — for example, spatial between displays and controls


Consider cognitive processes in relation to understanding machine or process inputs — for example, in applying cognitive ergonomics to driving (Groeger, 2000). There is strong evidence for stable individual differences in error propensity, which seem to be linked to cognitive style. This incorporates coping with stress (see Chapter 7) and appears to have to do with self-control and attentional spare capacity (see Chapter 3). Different cognitions require different approaches depending upon where the potential for misunderstanding and error is likely to occur, which are as follows:

- Knowledge — is dependent upon a person’s experience and education and therefore cannot readily be improved in the short term; a lengthy induction period is required.
- Problem-solving ability — to an extent is associated with knowledge and experience, but a person can be trained for specific types of problems (e.g., rules-based).
- Memory — is related to experience but can be largely compensated for by providing information in appropriate format (e.g., log files on a computer, printouts of previous system states) as required.
- Perception — is related to understanding a system and having an accurate representation of it (Chapter 3); this can be assisted by training.
- Decision-making ability — this combines the above cognitions and depends upon experience and judgment.

Notwithstanding the advantages already noted (Summary Text 4.11 and Summary Text 4.12) of humans making decisions, they are still subject to a number of biases, analogous to attributional biases reviewed in Chapter 3 and of groupthink, discussed in Chapter 8. Biases relevant to decision making were identified by Wickens (1992) and are shown in Summary Text 4.18. Given individual differences in the range of cognitive abilities outlined above, selection procedures may play a part in increasing the likelihood that a suitable person will be selected. Principles of training are considered in Chapter 10.
Summary Text 4.18 Decision-Making Biases

- Greater weight given to early compared with later information (primacy effect)
- Less information is extracted from sources than should be
- Subjective odds for two alternatives are poorly assessed
- More information makes people more confident but not necessarily more accurate
- We tend to seek more information than we can absorb adequately
- We tend to treat all information sources as equally reliable — though actually they are not
- We are only able to consider a maximum of three or four hypotheses at a time
- We tend to focus upon a few critical attributes and choices at a time
- We tend to seek information supporting chosen actions and to avoid testing or disconfirming evidence
- A potential loss is seen as having greater consequences than a gain of the same magnitude and thus exerts more influence on decision making

We have an optimistic bias, favoring less extreme outcomes. This results in the order of perceived likelihood of outcomes shown below:

<table>
<thead>
<tr>
<th>Most likely</th>
<th>Least likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>mildly +ve;</td>
<td>mildly −ve;</td>
</tr>
<tr>
<td>highly +ve;</td>
<td>highly −ve</td>
</tr>
</tbody>
</table>


Carrying out required activities engages a wide range of human movements in an almost infinite variety of combinations. In seeking to reduce human error, design factors need to take account various human factors that are as follows:

- Muscle fatigue — Either from continuous strain, cold, overexertion, or repetitive movement, any of which can lead to error.
- Awkward postures — The possibility of unnatural postures should be designed out of systems.
- Kinetic adjustments — Some skilled jobs require these to a fine degree (e.g., “shoe makers’ dance,” attributed to the complex movements required to operate shoe-making machinery) and they are life-preserving in the case of lumberjacks and some other jobs; generally, design of machines and processes should allow for a solid base for human operation.
- Skills limitations — Resulting from innate abilities, personal disposition, and training received.

In reading displays or operating controls, the display/control interface is a vital consideration. Expectation or stereotype (inbuilt expectation — see Chapter 3) will affect how we respond to the display–control interface. For example, in the United Kingdom people expect a switch in the up position to mean off, while in the United States the up position means on. Similarly, we normally turn knobs clockwise to increase power, light, or current. Norman (1988) provided an insightful and occasionally amusing account of people’s ways of approaching and thinking about everyday things. Summary Text 4.19 shows directions of movement
Summary Text 4.19 Direction of Movement Stereotypes for Controls

<table>
<thead>
<tr>
<th>Function</th>
<th>Control movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Down, right</td>
</tr>
<tr>
<td>Off</td>
<td>Up, left</td>
</tr>
<tr>
<td>Right</td>
<td>Clockwise, right</td>
</tr>
<tr>
<td>Left</td>
<td>Anticlockwise, left</td>
</tr>
<tr>
<td>Up</td>
<td>Up, rearward</td>
</tr>
<tr>
<td>Down</td>
<td>Down, forward</td>
</tr>
<tr>
<td>Retract</td>
<td>Rearward, pull; anticlockwise, up</td>
</tr>
<tr>
<td>Extend</td>
<td>Forward, push; clockwise, down</td>
</tr>
<tr>
<td>Increase</td>
<td>Right, up, forward</td>
</tr>
<tr>
<td>Decrease</td>
<td>Left, down, rearward</td>
</tr>
</tbody>
</table>

Summary Text 4.20 Common Deficiencies in Interface Design

<table>
<thead>
<tr>
<th>For displays</th>
<th>For controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not there!</td>
<td>Inaccessible</td>
</tr>
<tr>
<td>Give incorrect information</td>
<td>Too difficult to operate</td>
</tr>
<tr>
<td>Unreliable (therefore ignored)</td>
<td>Operable accidentally</td>
</tr>
<tr>
<td>Not (readily) visible</td>
<td>Contrary to convention/stereotype</td>
</tr>
<tr>
<td>Incompatible with controls</td>
<td>Incompatible with displays</td>
</tr>
<tr>
<td>Contrary to convention/stereotype</td>
<td>Inadequately differentiated (confusing)</td>
</tr>
<tr>
<td>Inadequately differentiated</td>
<td></td>
</tr>
<tr>
<td>Information irrelevant (causes confusion)</td>
<td></td>
</tr>
<tr>
<td>Not legible (e.g., poorly illuminated)</td>
<td></td>
</tr>
</tbody>
</table>

stereotypes for controls. However, stereotypes or movement compatibilities do not always apply (Petropoulos & Brebner, 1981). For example, in releasing fluid (e.g., water, gas) under force, we turn taps anticlockwise to increase flow. Violations of our expectations of what should happen increases error likelihood. Under the stress of an emergency, poor design could increase error probability by up to 1000 times (MacKay & Whittington, 1983). Common deficiencies in interface design are identified in Summary Text 4.20. Research has shown that different types of controls are better for different types of activities or tasks. Table 4.3 is derived from MacKay and Whittington’s (1983) review.

As with display devices, there may be design trade-offs in system controls. However, functions, expectations, and performance characteristics should be a good guide to ergonomic principles of control design. Taking controls and displays together, probably the most important single critical aspect is compatibility between these system components. Compatibility refers to the extent to which relationships are consistent with human expectations. In compatible systems, learning and reaction time is faster, fewer errors are made and user satisfaction is higher (Oborne, 1995). However, some compatibilities are stronger than others, that is, some expectations are shared by a higher percentage of the population than others are. Thus, it may be necessary to violate one compatibility relationship in order
### Table 4.3 Performance Characteristics of Different Types of Controls

<table>
<thead>
<tr>
<th>Control type</th>
<th>Performance characteristics rating for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speed</td>
</tr>
<tr>
<td>Push button (hand)</td>
<td></td>
</tr>
<tr>
<td>Toggle switch</td>
<td></td>
</tr>
<tr>
<td>Select switch</td>
<td></td>
</tr>
<tr>
<td>Knob</td>
<td></td>
</tr>
<tr>
<td>Thumbwheel</td>
<td></td>
</tr>
<tr>
<td>Small crank</td>
<td></td>
</tr>
<tr>
<td>Large crank</td>
<td></td>
</tr>
<tr>
<td>Handwheel</td>
<td></td>
</tr>
<tr>
<td>Horizontal lever</td>
<td></td>
</tr>
<tr>
<td>Vertical lever</td>
<td></td>
</tr>
<tr>
<td>Keyboard</td>
<td></td>
</tr>
<tr>
<td>Push button (foot)</td>
<td></td>
</tr>
<tr>
<td>Foot pedal</td>
<td></td>
</tr>
</tbody>
</table>

- Good
- Moderate
- Poor
- Very poor
- Not applicable


### Summary Text 4.21 Compatibilities between Displays and Controls

- Spatial — for example, control knobs and display dials lined up
- Movement — for example, clockwise rotation of knob to increase something
- Cognitive — what is expected from the user in terms of what can be done, for example, linguistic, memory, or perceptual
- Mobility — better to use auditory presentations and vocal response for vocal task; for spatial task, better to use visual presentation and manual response (Wickens et al., 1983)
- Conceptual — for example, does the symbol seem to represent something we are already aware of, such as an outline of an airplane to represent an airport?


To take advantage of another (Bergum & Bergum, 1981). Relationships between displays and controls should be standardized where possible, and be logical and explicable. If there are no standards or obvious relationships, then empirical work should be conducted to match user expectations. A summary of compatibilities is given in Summary Text 4.21.

To conclude this overview of ergonomic applications, Pheasant’s five ergonomic fallacies (Pheasant, 1995), listed below, are a reminder of the problems that those seeking good ergonomic design features may encounter.

1. Design is OK for me and therefore OK for everybody
2. Design is OK for “average” and therefore OK for everybody
3. People are adaptable and variable so need not/cannot cater for this in design
4. Purchases are made on style not design criteria, so ignore expensive ergonomic applications
5. Ergonomics is intuitive/common sense, so data are not needed

For those implementing ergonomic interventions, Koningsveld et al. (2005) reviewed 12 interventions and found that those that were most successful were characterized by direct worker participation, strong management support, provision of cost-benefit data, step-by-step approach, and early checking for side effects amongst others.

4.7 Techniques for reducing human error/increasing human reliability

This section considers a sample of techniques that have been used in various types of workplace to reduce human error and to increase human reliability. We first consider task analysis as the basis for many human error reduction approaches, before describing some techniques that are based upon task analysis.

4.7.1 Task analysis

Task analysis (TA) is a formal methodology, derived from systems analysis, which describes and analyses performance demands made upon humans within a system. The goal is to achieve integration of human and machine system components (see discussion on allocation of function, Section 4.5.2). There are several texts on task analysis (for a review see Diaper & Stanton, 2004). Many varieties of TA exist, for example, Astley (1991) identified over 80. Figure 4.4 gives a general overview of typical stages in a TA process. Embrey (2000a) distinguished between action-oriented and cognitive TA techniques, describing some examples of each. While TA itself is not a technique for reducing human error or for improving human reliability, some form of TA is the basis for most techniques with this aim.

Task analysis is based upon the principle that the task is the basic unit of behavior at work (or elsewhere). Task performance is described in terms of its goals and the plans needed to achieve these goals. One of the most commonly used forms of TA is hierarchical task analysis (HTA). HTA begins with a statement about the overall goal of the task and at each level these goals are analyzed in more detail, forming a hierarchical structure. Operational statements represent tasks by indicating that an action (or a series of actions) is carried out to achieve a task goal. Main operations are broken down into constituent subtasks or subordinate operations, typically between two and six. The process continues until each task is broken down into its component subtasks up to the point at which the level of detail required is reached. In deciding upon a suitable criterion for stopping the task breakdown process, reference is made to applications planned for the task analysis — Figure 4.4 gives some examples. For example, in using task analysis as a basis for defining errors with the aim of finding ways of reducing them, the analysis would proceed to the point at which separate human actions could be identified for which errors were possible. In an HTA all tasks are uniquely numbered for identification using hierarchical serial numbers. Plans indicate the sequencing of operations as well as other features, for example constraints, alternatives, and conditions. Plans are specified for each superordinate task, which is broken down into subtasks. Subtasks that require no further breakdown are underlined to indicate this. Many variations and enhancements on this basic approach are possible, including using a tabular format.

HTA is the basis for both qualitative and quantitative forms of human reliability assessment (HRA). Examples of qualitative HRA techniques are described in the next
two subsections, and some other approaches to HRA are considered in the remaining subsections under this heading.

4.7.2 Task analysis for error identification (TAFEI)

The TAFEI technique takes a systematic approach to human error occurrences in relation to particular operational sequences. The method, developed by Baber and Stanton (1994), extends the psychological approach to human error (Reason & Mycielska, 1982; Reason,
TAFEI treats humans within systems as active (cognitive) interpreters of stimuli and uses the notion of affordances, in which the appearance of an object defines its use. For example, a handle is for pulling, a plate (e.g., on a door) is for pushing, and a knob is for turning (see Summary Text 4.19). In Baber and Stanton’s ergonomic approach, design (e.g., of machines or layout) is critical for clarity in respect of performing correct procedures. TAFEI can be used in closed systems where humans interact with equipment that has a finite number of possible states that can all be defined. Like practically all attempts to deal with human error from a human factors perspective, TAFEI is based upon task analysis, in this case HTA. TAFEI can be used when humans operate within systems in a relatively fixed location, for example, an individual operating a piece of equipment or machinery. The TAFEI methodology has the following stages:

1. Define work system components and appropriate media
   2a. Describe human components using HTA
   2b. Describe other system components using a system state diagram (SSD)
3. Map 2a onto 2b to define legal transitions
4. Define illegal transitions as possible or impossible and in terms of error types
5. (Re)design systems to reduce errors

The SSD shows the state of the system corresponding with each of the first six main steps in the task analysis and the expected next action, indicated by a line (called a transition) from one system to the next. From the SSD, it is possible to derive a transition matrix showing the stages represented by the SSD indicating which transitions are impossible (e.g., because of forcing functions or other system features) and which are possible. Of those that are possible, some will be legal transitions — those that follow the laid down procedure or acceptable versions of it. The remainder will be illegal transitions because while they are possible, they are undesirable because they would cause the system to malfunction — that is, they would be classed as errors. At least some illegal transitions will be violations, although TAFEI analysis may reveal other illegal transitions that had not previously been considered by system designers or operators. Illegal transitions represent error potential at the human–machine interface. TAFEI allows potential errors to be identified as a first step to redesigning a system to eliminate them or to reduce either their likelihood or occurrence or their consequences should they occur, that is, to reduce human error risk.

TAFEI can provide a useful picture of interactions between human operators and machine components within a system in respect of possible actions and possible errors. From the information gleaned from such an analysis possible errors that are critical to the safe and efficient operation of the system may be tackled, usually by redesign of the system, for example, equipment and rules and procedures.

### 4.7.3 Predictive human error analysis (PHEA)

This technique, developed by Embrey (1994), typifies a systematic approach to identifying and reducing human-error potential in systems in line with a risk management approach, effectively taking the form of a human error risk assessment. The purpose of PHEA is to identify human interactions within a system that are likely to give rise to human errors with potentially serious consequences. The main objectives are:

- Representing operations performed by people in human–machine systems
- Determining what can go wrong
- Assessing consequences for the system
- Generating strategies to prevent error or to reduce the impact of error
PHEA can be used in designing new products and systems so that human–machine mismatches, which are likely to lead to errors, are identified and eliminated at the design stage. It can also be used in risk assessments in which predicting human intentions and actions that could initiate, compound, or resolve a critical system state is vital. PHEA can also be used in incident investigation, where causes of human errors need to be determined so that effective error reduction strategies can be devised and implemented. The PHEA technique has the following five main stages:

1. Problem definition
2. Task analysis
3. Human error analysis
4. Consequence analysis
5. Develop error reduction strategies

The problem definition stage requires considering types of human interactions within a system that could lead to incidents or injuries. These could be either active failures or latent conditions and include the following:

1. Maintenance/testing errors affecting safety system availability
2. Operator errors initiating an incident
3. Recovery actions by operators that can terminate an incident
4. Operator errors that can prolong or aggravate an incident
5. Actions enabling operators to restore unavailable systems

The TA stage uses HTA and the human error analysis stage uses the TA output as a basis for determining the types of error that could occur at each point. This stage uses a classification system based upon six categories of errors, shown in Summary Text 4.22. The classification is applied to each task step in turn and feasible errors are identified. Consequence analysis requires detailed knowledge of the system and its functioning and seeks to determine system consequences of human errors identified at the previous stage. Where consequences are negligible there is no requirement to proceed further with the analysis, but where they are unacceptable the information goes to the next stage. At this stage too, the possibility of errors being recovered at future task steps is considered. For a task step where no recovery is possible and severe consequences are likely, particular attention needs to be given to the possibility of an error (low, medium, or high — for example, on the basis of incident data, near hits or injuries, or from expert judgment). The potential error is then classified as critical or noncritical should it occur. Critical errors with a high probability require high priority attention.

Further analysis may be undertaken of performance influencing factors (PIFs), sometimes called performance-shaping factors. These can increase or decrease human error likelihood and include the following:

- Corporate factors (e.g., management, financial pressure, safety audits)
- Process factors (e.g., technology, workplace hazards)
- Machine interface factors (e.g., controls, displays, compatibilities)
- Environmental factors (e.g., work patterns, physical conditions)
- Equipment factors (e.g., PPE, tools, plant)
- Individual factors (e.g., experience, knowledge, personality, health)

The above factors can all affect human performance — some are external to the individual (e.g., equipment design, work environment, rules, and procedures) and others internal...
Summary Text 4.22 Human Error Analysis — Error Categories

Planning errors — associated with performing a sequence of actions

- Plan preconditions ignored
- Incorrect plan executed
- Correct but inappropriate plan executed
- Correct plan executed too soon/too late
- Correct plan executed in wrong order

Action errors — associated with performing observable actions

- Operation too long/too short
- Operation mistimed
- Operation in wrong direction
- Operation too little/too much
- Misalignment
- Right operation on wrong object
- Wrong operation on right object
- Wrong operation on wrong object
- Operation mistimed
- Operation incomplete

Checking errors — associated with performance checks

- Check omitted
- Check incomplete
- Right check on wrong object
- Wrong check on right object
- Wrong check on wrong object
- Check mistimed

Retrieval errors — associated with retrieval of information from memory, paper, or screen

- Information not obtained
- Wrong information obtained
- Information retrieval incomplete

Information communication errors — associated with communicating information to, or receiving information from, other parties

- Information not communicated
- Wrong information communicated
- Information communication incomplete

Selection errors — associated with a selection from alternatives

- Selection omitted
- Wrong selection made
(e.g., skills, motivation, experience, and stress). Information from a PIF analysis can be used to determine which errors are most likely and help to develop error reduction strategies. In a study of performance influencing factors affecting errors in high-voltage switching, Glendon et al. (1994) found a total of eleven factors affecting performance. The most important factor was work pressure, followed by procedures and work relationships.

4.7.4 Reason’s generic approach

Reason (1997) identified maintenance as a particularly vulnerable area for human error impacting upon large-scale systems, identifying several well-known examples of where maintenance failures resulted in disasters. Partly because of increasing automation and reliability in operational processes, maintenance failures involving human intervention are liable to be recognized as the origin of an increasing proportion of system failures. Higher error rates than in operational activities are also likely to result from inherent features of maintenance activities, for example, while there may be relatively few ways to take something apart, there could be several ways of reassembling it only one of which is likely to be correct. Maintenance errors are also likely to have a lower detection/recovery rate than operational errors. Reason recommends the checklist of items listed in Summary Text 4.23 as a way of increasing the likelihood that maintenance errors will be detected and corrected. Reason pointed out that, in turn, maintenance failures tended to result from upstream organizational factors or latent conditions.

4.7.5 Quantified human reliability assessment (HRA)

Reliability is the probability of successful performance. Human reliability and machine reliability together comprise system reliability. Human reliability is the complement of human error and emphasizes the importance of humans in complex systems. Reviews of

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**Summary Text 4.23 Reminders for Reducing Maintenance (and Other) Errors**

- **Conspicuousness** — attract operator’s attention at critical times
- **Contiguity** — locate as closely as possible to relevant task step
- **Context** — provide adequate information about carrying out the next step
- **Content** — inform operator what has to be done
- **Check** — allow operator to check number of correct actions in task performance
- **Comprehensiveness** — work effectively for wide range of steps
- **Compelling** — block further progress until prior step is completed or if parts are missing
- **Confirmation** — continued visibility after step performance
- **Concluding** — should be removable following action and its checking
- **Components** — design should ensure that these can only be installed correctly
- **Contact** — eliminate hands on human contact as far as possible

Humansafetyandriskmanagement


HRA techniques attempt to quantify the probability of human errors occurring in specific operations, but without any theory of why such errors occur — a behavioral rather than a cognitive approach to human error. HRA draws upon a wealth of experience and expertise using expert judgment and quantified analysis in making predictions about human error potential. The various HRA techniques use different combinations of expert judgment and database material to assess human reliability in situations where the probability of an error may be small but where the consequences of such errors could be catastrophic and expensive. Examples of industries where HRA may be appropriate include power generation and distribution, chemical and other process industries, and other sectors involving high risk (e.g., mass transport systems or places where large numbers of people are exposed, as at mass leisure events).

HRA is analogous with Probabilistic Risk Assessment (PRA), used to assess hardware reliability within the technical tradition (see Chapter 2). The objective of HRA, like PRA, is to arrive at a risk assessment that can be used as a basis for control measures to be implemented that will reduce either or both the probability of human errors occurring, or if such errors do occur, to mitigate their consequences. HRA models task sequences, which are then combined mathematically to determine the error probability of the whole task. It is a useful diagnostic tool in assessing detrimental effects of humans on systems, involving the following three steps:

1. Task analysis.
2. Estimating number of errors from empirical and/or expert judgment data.
3. Combining the above with error probabilities for machinery and equipment, for example, in a fault tree or an event tree. Embrey (1992) provided an example of incorporating management and organizational influences into PRA, using the Clapham Junction disaster as a case study (see Summary Text 4.13). Glendon’s (2003) case illustration from the water industry showed how human factors and organizational knowledge could be incorporated into risk management in the form of a fault tree analysis for dam spillway radial gate operations, involving both human factors and engineering components.

HRA methodology involves identifying points in a sequence of tasks or operations at which human error could lead to loss, either in the form of life or limb or material damage, usually on a large scale, for example, of nuclear power plant. A commonly used HRA method, the Technique for Human Error Rate Prediction (THERP), was developed mainly to assist in determining human reliability in nuclear power plants. THERP uses detailed procedures for analyzing a task and applying tables of human reliability estimates to determine the overall reliability of the task. For descriptions of THERP and other HRA techniques, see Health and Safety Commission (1991), Kirwan (1992a, 1992b), Miller and Swain (1987), and Swain and Guttman (1983). The next stage is to assign probabilities to each of the identified potential errors, either on the basis of empirical data or whatever other evidence is available, for example, past events or expert judgment. This aspect of HRA is the most problematic because probability judgments often have to be made on inadequate data. Other aspects of the risk equation are then considered, numbers at risk, exposure time, and potential consequences (worst possible case). These are weighted and combined with probability ratings for the various possible errors to arrive at a risk rating for each task or operation. These may then be rank ordered to produce a list of items requiring control measures. The resulting scale, if reasonably valid for the tasks being considered, should provide a good measure of the relative importance of the risks and hence of the priorities for action.
Summary Text 4.24 Illustrative Performance Influencing Factors (PIFs)

<table>
<thead>
<tr>
<th>Internal PIFs</th>
<th>Skill level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional state</td>
<td>Social factors</td>
</tr>
<tr>
<td>Intelligence</td>
<td>Strength/endurance</td>
</tr>
<tr>
<td>Motivation/attitude</td>
<td>Stress level</td>
</tr>
<tr>
<td>Perceptual abilities</td>
<td></td>
</tr>
<tr>
<td>Physical condition</td>
<td>Task knowledge</td>
</tr>
<tr>
<td>Sex differences</td>
<td>Training/experience</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>External PIFs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate workspace and layout</td>
<td></td>
</tr>
<tr>
<td>Poor environmental conditions</td>
<td></td>
</tr>
<tr>
<td>Inadequate design</td>
<td></td>
</tr>
<tr>
<td>Inadequate training and job aids</td>
<td></td>
</tr>
<tr>
<td>Poor supervision</td>
<td></td>
</tr>
</tbody>
</table>


It is important that the control measures component of the risk management sequence is implemented as part of the HRA approach. Control measures may be categorized as being either ergonomic — relating to workplace layout, the environment, or to the human–machine interface; or individual — relating to particular operators undertaking those tasks or operations. These latter are sometimes referred to as PIFs or performance shaping factors (PSFs), which are much the same as used in the PHEA technique described earlier. Examples of PIFs are shown in Summary Text 4.24. According to Miller and Swain (1987), PIFs include any factor that can influence human performance. PIFs may be internal to the individual or external, relating to the environment. External factors are considered to have the greater impact (Miller & Swain, 1987). Most of the PIFs listed in Summary Text 4.24 are discussed in various places in this book.

4.7.6 Influence diagrams and model of accident causation using hierarchical influence network

This hierarchical approach to understanding incidents was pioneered by Embrey (1992) and involves incorporating human factors into an event tree for analyzing a system failure. Embrey’s generic accident causation model postulates different levels of influence upon a top event. At the first level, these can be divided into human, hardware, and external failures. Human errors can be broken down into active, latent, and recovery types, while hardware failures could also be due to human factors, for example, violations or sabotage. At the next level, typical influencing factors include training, procedures, supervision, responsibilities, production/safety tradeoffs, and matching demands with resources. The base level of causal influences includes such features as risk management, design, communication, HRM, and operational feedback. Linkages can exist between any of these factors, depending upon the particular incident to be investigated, salient factors involved, and empirical data on impacts of one feature upon another.

A component of this approach is the influence diagram, which seeks first to identify all the factors that could lead to human error in a particular set of circumstances, for example
time pressure, training, experience, staffing levels, experience, and operational feedback. On the basis of previous data or best estimates, probabilities are then assigned to the various factors, and as for an engineering fault tree, an overall probability for human error for a particular task or job over a given time period can be calculated. Wright et al. (n.d.) and Wright and Embrey (2000) provided an example of the use of an influence diagram for determining the likelihood of a signal passed at danger (SPAD) at a particular location within a rail network.

4.7.7 Human factors investigation tool (HFIT) for accident analysis

Motivated partly by their observed lack of a strong theoretical framework for most safety audit and incident reporting systems, Gordon et al. (2005) described the initial stages of developing this incident analysis tool based upon generic approaches proposed by Kontogiannis (1999) (error recovery), Rasmussen et al. (1981) (human malfunction), and Wickens (1992) (human information processing), as well as threat management (Helmreich et al., 1999), situation awareness (Endsley & Garland, 2000), and several proprietary systems. As with Embrey’s influence diagram, the HFIT model operates at three levels (1) initial threats to safety from the environment, (2) situation awareness, and (3) action errors. An intervening error recovery process can moderate the second and third stages. Threats to system safety could include a wide range of elements, including procedures, personal factors, training, communication, and supervision. Situation awareness includes many cognitive factors, including detection, perception, memory, and decision making. Action errors include those discussed earlier in this chapter, such as omission, timing, sequence, selection, violations, and communication. The hierarchical form of the model means that each element can be broken down into sub-elements. The authors suggested that threats and situation awareness are most appropriately interpreted at a generic level, while error recovery is likely to be specific to a task or process.

4.7.8 Overview

Other HRA techniques exist apart from those described in this chapter (see e.g., Reason, 1990, 1997) and doubtless others will continue to be produced to meet the needs of particular processes, organizations, or industry sectors. To reduce errors using HRA techniques, as well as training, supervision, selection, and design control measures, it is important for workers to participate in the process — this is true for all the techniques described. Those who work with the equipment and who are liable to commit the errors are most likely to have ideas about preventing them. It is important to conduct such analyses in a blame-free environment, accepting worker representatives as part of a quality team. Rasmussen (1999) argued that rather than designing interfaces to match operators’ mental models, human factors engineering should seek to create interfaces that generate and maintain effective and safe mental models in the minds of decision makers. Known as ecological interface design, this approach focuses more on the macro system of which each human–workstation interface is a part.

Criticisms of the human reliability approach include the following:

- Human behavior is so variable that a single estimate cannot be assigned to it (Meister, 1985) and thus an illusory level of precision is given to human variability
- Not all errors result in failure (Adams, 1982)
- It is inappropriate for continuous tasks such as monitoring and tracking (Regulinski, 1971)
Despite being based upon expert judgment, it is ultimately subjective and requires interpretation (Sanders & McCormick, 1993).

Like most human reliability techniques, HRA requires more testing and experience if it is to become widely accepted and used as a tool for assessing human reliability in complex systems. Nevertheless, it can provide useful data for guiding decision making on risk (Meister, 1985).

4.8 Conclusions

Due to its survival value through our evolution, human error is a natural and all-pervasive component of our being. While a small proportion of errors may result from unconscious needs or motives, the overwhelming basis for error-related behavior is cognitive. An important task for safety and risk scientist practitioners, and other parties such as line managers and HR specialists, is to control the worst effects of human error upon workplace losses through ergonomic, managerial, and HR applications. Errors are essential for learning because of the feedback that they provide and evidence suggests that we learn best if we are allowed to make errors. The same principle applies to organizations — we should not blame people for making errors, but accept these as a natural human feature and develop systems to learn from them. Many incidents and injuries are attributed to human error. However, if a large proportion (say 80 or 90%) is so attributed the term becomes little more than a convenient label, which may hinder attempts to investigate a comprehensive range of factors associated with incidents and injuries.

Through research and applications, understanding of human error and its control is rapidly increasing and is amenable to workplace implementation. One of the main barriers to this implementation, which is also one of the potentially damaging forms of human error, is that residing within systems — for example, poor rules and procedures, inability of an organization to learn from its own and others’ mistakes, and inadequate managerial decision making. In order to categorize human error types, a generic classification is needed so as to be relevant to the widest possible range of situations — one that is derived from skill, rule, and knowledge-based performance levels has been shown to be valid and useful. However, empirically based classifications, derived from particular environments (e.g., different forms of transport), should also be used as these are likely to reflect actual problems encountered in particular environments. Major catastrophes are very difficult to guard against because they typically involve a combination of factors, any one of which by itself would probably not cause a serious problem. It is necessary to address underlying factors in particular latent conditions and resident pathogens within systems. These relate to organizational structures, high-level decision making, and features that could trigger a major incident.

Humans will continue to be needed as monitors of complex systems (despite their poor monitoring capacity compared with machines) because they are very good at detecting errors and at taking effective action to resolve problems. A basic principle is to ensure that humans and machines monitor the other’s actions. In allocating functions between people and machines, it is important to consider not only the respective advantages of the performance of each type of system component but also the nature of the total system design and the fact that humans require work that is personally fulfilling. A variety of techniques is available for human error reduction, based upon TA and systematic approaches to identifying potential sources of human error and its correction.
chapter five

Personality and risk liability

This chapter focuses on personality and other individual differences, those characteristics that make us unique and that we share to some extent with other people and the influence that these have in terms of risk liability. After considering the concept of accident proneness and reviewing the role of personality traits in injury involvement, discussion turns to personality in the work environment, with particular emphasis on personnel selection.

5.1 Introduction

A person is like some other people, all other people and no other people

(after Kluckholn & Murray, 1953)

Why are we interested in personality and risk? In psychology, the individual is the prime focus of attention; the ways in which we are similar to, and different from, other people and what makes each of us unique is a particular blend of measurable individual characteristics. If we can better understand the nature of these characteristics (or traits or dimensions) and link them with particular job requirements, then first of all we should be better able to predict job performance, including safety requirements, and second we should be better able to select for, and tailor training toward, those individual characteristics. Thus, understanding relevant aspects of personality should help in managing this particular aspect of human resources.

Evolution has equipped us with that most precious of natural human resources — diversity. This diversity enables, even requires us to perceive risk differently, and to be predisposed to differential risk taking. To deny our diversity, or to assume that the same social, economic laws govern us all, is to deny a vital aspect of our humanity. This diversity cannot be regulated for, nor can it be readily assessed in a general sense, although this chapter describes many attempts to measure the diversity that exists between individuals and, much more problematically, some of the ways that have been prescribed to deal with it.

Personality can be defined as those relatively stable and enduring features of an individual that distinguish each of us from other people, and that forms the basis of our predictions of other people’s future behavior (Pervin & John, 1999). This approach to personality follows from the discussion of attribution theory in Chapter 3. For example, having consistently observed a person as being a safe driver, we may conclude that he or she has
personality traits that encapsulate such a quality. Each of us possess a unique combination of traits (e.g., honesty, perseverance, and assertiveness), which we share with others to a greater or lesser extent. This chapter considers some of the main approaches to the study of this area, including the current dominant view of the major dimensions of an individual’s personality. Discussion in the first part of the chapter focuses upon the concept of accident proneness and the contribution of the big five personality dimensions to accident liability.

The objectives of this chapter are as follows:

- Provide a contemporary view of the trait approach to personality
- Examine relevant aspects of personality in workplace and driving contexts
- Consider the evidence for accident proneness
- Determine which, if any, aspects of personality may be identified in applications and interventions when managing risks arising from human behavior

### 5.2 Models of personality and the “big five”

Although psychology incorporates a number of approaches to personality, the dominant one focuses on traits. Traits are dimensions of personality along which each individual is located. For example, we might describe one person as very outgoing, another as very reserved, and a third as somewhere in between. An individual’s personality comprises the aggregate of their scores on each trait. A trait summarizes past behaviors and predicts future behaviors (Cook, 2004). The first major attempt to identify the main personality traits was that of Cattell (1965) who found 16 such traits or personality factors, hence his well-known 16PF. Cattell’s 16 personality factors are shown in Summary Text 5.1.

While debate continues on the number of essential personality traits (Hough, 1992), many psychologists now accept that there are strong grounds for accepting five basic personality dimensions, sometimes adding a sixth individual difference, intelligence. The idea that there are five main personality dimensions is not new (Fiske, 1949; Tupes & Cristal, 1961), but the labeling of these as the big five by McCrae and Costa (1985, 1987) spawned great interest and continuing debate, not least because of the considerable overlap of these with other studies and approaches. The big-five personality factors, as described by a number of writers (Brand & Egan, 1989; McCrae & Costa, 1989; Barrick & Mount, 1991; Costa et al., 1991; Costa & McCrae, 1992a, 1992b; Goldberg, 1992, 1993; Deary & Matthews, 1993; Hendruks, 1997) are as follows:

1. Extraversion (vs. introversion)
2. Neuroticism (vs. stability)
3. Openness to experience
4. Agreeableness
5. Conscientiousness

While there is some modest overlap (intercorrelations) between the five main dimensions, they are generally held to be distinct. More detailed lists of characteristics, derived from a number of studies, are shown in Summary Text 5.2. The big-five personality factor model can assimilate other structures and is appropriate for organizing a range of traits that are useful as a description of normal personality and in clinical psychology (Costa & McCrae, 1992a).

Extraversion is related to a range of functions, including perception, attention, memory, and other cognitive processes (Eysenck & Eysenck, 1985). Many individual differences
### Summary Text 5.1 Cattell’s Sixteen Personality Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>High-score description</th>
<th>Low-score description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Outgoing, warm hearted, easy going, participating</td>
<td>Reserved, detached, critical, cool</td>
</tr>
<tr>
<td>B</td>
<td>More intelligent, abstract thinking, bright (higher scholastic mental capacity)</td>
<td>Less intelligent, concrete thinking (lower scholastic mental capacity)</td>
</tr>
<tr>
<td>C</td>
<td>Emotionally stable, faces reality, calm (higher ego strength)</td>
<td>Affected by feelings, emotionally less stable, easily upset (lower ego strength)</td>
</tr>
<tr>
<td>E</td>
<td>Assertive, independent, aggressive, stubborn (dominance)</td>
<td>Humble, mild, obedient, conforming (submissiveness)</td>
</tr>
<tr>
<td>F</td>
<td>Happy go lucky, heedless, gay, enthusiastic</td>
<td>Sober, prudent, serious, taciturn</td>
</tr>
<tr>
<td>G</td>
<td>Conscientious, persevering, staid, rule bound (stronger superego strength)</td>
<td>Expedient, a law unto himself, bypasses obligations (weaker superego strength)</td>
</tr>
<tr>
<td>H</td>
<td>Venturesome, socially bold, uninhibited, spontaneous</td>
<td>Shy, restrained, diffident, timid</td>
</tr>
<tr>
<td>I</td>
<td>Tender minded, dependent, over protected, sensitive</td>
<td>Tough minded, self-reliant, realistic, no-nonsense</td>
</tr>
<tr>
<td>L</td>
<td>Suspicious, self-opinionated, hard to fool</td>
<td>Trusting, adaptable, free of jealousy, easy to get on with</td>
</tr>
<tr>
<td>M</td>
<td>Imaginative, wrapped up in inner urgencies, careless of practical matters, bohemian</td>
<td>Practical, careful, conventional, regulated by external realities, proper</td>
</tr>
<tr>
<td>N</td>
<td>Shrewd, calculating, worldly, penetrating</td>
<td>Forthright, natural, artless, sentimental</td>
</tr>
<tr>
<td>O</td>
<td>Apprehensive, worrying, depressive, troubled (guilt proneness)</td>
<td>Placid, self-assured, confident, serene (untroubled adequacy)</td>
</tr>
<tr>
<td>Q1</td>
<td>Experimenting, critical, liberal analytical, freethinking (radicalism)</td>
<td>Conservative, respecting established ideas, tolerant of traditional difficulties</td>
</tr>
<tr>
<td>Q2</td>
<td>Self-sufficient, prefers own decisions, resourceful (self-sufficiency)</td>
<td>Group-dependent, a “joiner” and sound follower</td>
</tr>
<tr>
<td>Q3</td>
<td>Controlled, socially precise, self-disciplined, compulsive</td>
<td>Casual, careless of protocol, untidy, follows own urges (low integration)</td>
</tr>
<tr>
<td>Q4</td>
<td>Tense, driven, overwrought, fretful</td>
<td>Relaxed, tranquil, torpid, unfrustrated</td>
</tr>
</tbody>
</table>

Summary Text 5.2 Descriptions of the Big Five Personality Dimensions

1. Extraversion (vs. introversion): Venturesome, assertive, energetic, spontaneous, talkative, frank, enthusiastic, uninhibited, sociable, outgoing, affiliative, socially confident, controlling (others), lacking emotional control, persuasive, warm, gregarious, active, excitement seeking, positive emotions.


3. Openness/intellect (or tender-minded vs. tough-minded): Affectionate, trusting, understanding, aesthetic, sensitive, feminine, imaginative, unusual, intellectual, tolerant, culture oriented, responsible, open, conceptual, innovative, change oriented, independent, behavioral, fantasy, feelings, actions, ideas, values.


5. Conscientiousness (vs. impulsiveness): Conforming, general inhibition, conventional, careful, self-controlled, orderly, compulsive, obsessive, productive, cognitively structured, striving to achieve, responsible, superego strength, plans ahead, persevering, disciplined, precise, industrious, detail conscious, competent, dutiful, self-disciplined, deliberate.

Note that opposite lists would be applied to the other end of each of the five dimensions (in parentheses).


emerge between extraverts and introverts, this being the most studied dimension of personality and some of these are shown in Summary Text 5.3. In seeking to explain some of these differences, Matthews et al. (1990a, 1990b) postulated that extraverts have greater processing resource availability, being generally faster. However, extraverts seem to deal with complexity by adopting somewhat counterproductive impulsive strategies (Matthews, 1993). Extraversion is also associated with sensitivity to signals of reward and punishment (Gray, 1981), suggesting that extraverts pay greater heed than introverts do to these forms of social cues. A greater availability of resources for verbal processing might account for extraverts’ greater social interests and skills (Matthews, 1992a; Wickens, 1992). It has been suggested (Humphreys & Revelle, 1984) that it is impulsiveness rather than extraversion that affects performance (as impulsive individuals tend to rush into situations rather than giving a considered response), and some evidence for this is outlined in Summary Text 5.4. Conscientiousness has been found to be closely aligned with motivation (see Chapter 3) and is related to performance (Barrick & Mount, 1991) and intelligence (Goff & Ackerman, 1992). This factor has also been called dependability, including planning, responsibility, and carefulness (Hough et al., 1990). Openness to experience is related to learning capacity and other abilities (McCrae & Costa, 1985) and to training proficiency.
Summary Text 5.3 Differences between Extraverts and Introverts

Conditioning

- Extraverts are more difficult than introverts to condition (Eysenck, 1977).
- Effects of conditioning wear off more quickly in extraverts (Eysenck, 1977).
- Extraverts are harder to condition to socially acceptable behavior and are more likely to break moral codes and behave antisocially (Eysenck, 1977).
- Extraverts condition more readily to rewards, introverts to punishments (Gray, 1981).

Perceptual tasks

- Compared with introverts, extraverts detect a lower proportion of visual (in particular) and auditory signals in vigilance tasks (Davies & Parasuraman, 1982).
- In tasks demanding attention, introverts are superior at vigilance and it seems that extraverts have poorer visual perception — for example, poorer perception of flicker (Davies & Parasuraman, 1982).
- Extraverts’ attention is poorer when driving for long spells, but their driving is improved by playing the car radio (Fagerstrom & Lisper, 1977).
- Extraverts recover less quickly from glare and cannot maintain concentrated effort without repeated involuntary rest pauses (Eysenck & Eysenck, 1985).

Other cognitive tasks

- Extraverts are superior on more demanding tasks such as those requiring two tasks to be done simultaneously and are also more resistant to distraction (Matthews, 1992a).
- Extraverts perform better than introverts on more difficult tasks and worse than introverts on easier tasks (Eysenck 1981; Eysenck & Eysenck, 1985; Matthews et al., 1990a).
- While extraverts tend to do better on demanding but relatively straightforward information processing tasks, introverts may do better at problem solving tasks that are complex as well as difficult (Matthews, 1993).
- Extraverts have better short-term retention and recall than introverts do (Eysenck, 1982; Dickman & Meyer, 1988).
- Introverts have better long-term retention (Matthews, 1992a).

Arousal and stress

- Extraverts perform better than introverts in highly arousing conditions (e.g., noise) but worse than introverts in de-arousing conditions — for example, a quiet room (Eysenck & Eysenck, 1985).
- Extraverts’ performance is facilitated by caffeine, while introverts’ performance is impaired by caffeine (Lieberman, 1992).
• Introverts perform better in de-arousing conditions such as sleep deprivation (Corcoran, 1972) and alcohol ingestion (Jones, 1974).
• Extraverts perform better than introverts under high-stress conditions while introverts perform more efficiently at low levels of stress, this finding being consistent for different sources of stress — for example, noise, caffeine, anxiety, and incentives for performance (Eysenck & Eysenck, 1985).

Summary Text 5.4 Effects of Impulsiveness

• Caffeine can facilitate the performance of impulsive individuals (measured on the EPI [Eysenck Personality Inventory] impulsiveness scale) and impair the performance of nonimpulsives taking complex cognitive tests in the morning — the effect is the opposite way round in the evening (Revelle et al., 1980, 1987).
• High impulsives seem to be lower in arousal in the morning and higher in arousal in the evening (Revelle et al., 1987).
• In carrying out tasks, high impulsives respond faster and less accurately than do low impulsives — that is, they trade speed for accuracy (Edman et al., 1983).
• High impulsives respond more slowly than do low impulsives when extensive processing is required — for example, when task requirements are complex (Barrett, 1987).

Approximately 40% of the variation in personality is genetically based (Eysenck, 1990; Costa & McCrae, 1992a; Plomin & Caspi, 1999). Dimensions of the five-factor model of personality have been found in many different cultures, suggesting a biological foundation for these traits (Costa & McCrae, 1992a). The genetic influence on neuroticism has been estimated at 41%, extraversion at 53%, openness to experience at 61%, agreeableness at 41%, and conscientiousness at 44% (Jang et al., 1996). Stelmack (2004) provided comprehensive coverage of the biological basis of personality. The genetic foundation to personality suggests that traits are enduring dispositions (Deary & Matthews, 1993). These authors argued that although the environment filters the expression of personality traits — for example, social situations — the reasonable degree of consistency for behavior across situations shown by a number of studies argued for the relative durability of personality traits. A longitudinal study revealed stability coefficients of 0.67 for neuroticism, 0.81 for extraversion, 0.84 for openness to experience, 0.63 for agreeableness, and 0.78 for conscientiousness (Costa & McCrae, 1992a).

Dimensions of the five-factor model of personality have been found in many different cultures, suggesting a biological foundation for these traits (Costa & McCrae, 1992a). However, it appears that there are cultural differences in the way in which personality
dimensions are perceived. Thus, Bond and Forgas (1984) found that conscientiousness was
more important to a Hong Kong Chinese sample, while extraversion was more important
to a sample of Australians. Yang and Bond (1990) found a big five for Taiwanese, but not
one-to-one correspondence with the U.S./U.K. dimensions.

Mischel (1968) and others have criticized the trait approach on the grounds that cor-
relations between personality traits and behavior are very modest and that much of our
behavior is socially shaped. The truth as usual lies between extremes, so that social
situations shape a person's behavior to an extent, but are also partly determined by
the individual seeking out or exploiting certain social factors. For example, aggressive
children expect others to be hostile, which may elicit the (expected) hostile behaviors
(Dodge, 1986) and we may all be prone to self-fulfilling expectations (see Chapter 3).
The midway interactionist view of personality maintains that to some extent situations
determine how people behave, but at the same time, people have some influence over
events in their environment and they also help to create the situations that surround
them. Thus, personality and environmental influences interact to produce observed
behavior.

More enduring personality traits should be distinguished from mood states, although
there are correlations between mood and some personality traits — for example, extraver-
sion and neuroticism (Matthews, 1992b). Matthews et al.'s (1990c) model of mood has the
following three components:

1. Hedonic tone (pleasure vs. displeasure dimension)
2. Energetic arousal (energy, activation, and positive effect)
3. Tense arousal (tension, stress, and negative effect)

The big-five personality factors and their associated behavior patterns brought together
much previous work on personality. Of the other main approaches to personality, summa-
ries of five of these are shown in Summary Text 5.5. Textbooks on personality give further
details of these and other approaches (Pervin & John, 1999), while McKenna (2006) provided
a business context for the study of personality.

5.3 Accident proneness

Of all the presumed personality traits, accident proneness — if it is a valid construct, is
likely to be of greatest interest to safety and risk scientist practitioners. However, the fact
that accident proneness has never emerged as a personality trait or type in any general study
of personality should be sufficient to ring alarm bells in respect of whether this is a genuine
personality trait. Indeed, the notion of an accident is problematic, so the supposed trait
might more appropriately be described as injury proneness. However, in this section for
convenience we refer mostly to the better-known concept of accident proneness. Intuitively,
some people may feel that there is such a trait as accident proneness and may even have
stories to support such a feeling. One of the authors was told of an apprentice fitter in a large
transport company who had several work injuries until one day he had a fatal injury and of
the guilt of his colleagues in not taking action before this happened. A factory manager, faced
with a high incidence of lifting and handling injuries is reported as saying, "unfortunately,
the majority of our people are accident prone" (Lindsay, 1980). Wong and Hobbs (1949)
described accident prone workers as individuals who showed most frequent errors in their
work, had the poorest attendance, and were vocational misfits given to inattention and
worry and demonstrating unwillingness to accept supervision. In addition, they tended
to be foolhardy, foolish in the sense of being impulsive and not stopping to think, easily
Summary Text 5.5 Summaries of Nontrait Personality Theories

- Person centered (e.g., Carl Rogers): is concerned with how the individual perceives and experiences the self and the world (phenomenological approach). Part of the humanistic, human potential movement, emphasizing self-actualization and the fulfillment of growth potential.
- Cognitive theory (e.g., George Kelly’s personal construct theory): is concerned with how the individual perceives, interprets, and conceptualizes events and the environment. The individual is a scientist who develops a unique set of theories (constructs) to predict events (Fransella & Bannister, 1977).
- Behavioral approaches (e.g., B. F. Skinner, J. B. Watson): are based upon principles of learning — conditioning and stimulus–response learning. The role of situational and environmental variables in determining behavior is recognized — being concerned with what is observable (contrasts with phenomenological, humanistic, and trait approaches to personality).
- Social–cognitive theories (e.g., Albert Bandura, Walter Mischel): emphasize social origins of behavior and the importance of cognitive processes. Particular attention paid to how people learn complex patterns of behavior, how individuals achieve goals (self-efficacy), and sees people as active agents in influencing events in their lives (contrasts with being the passive victim of possessing certain personality traits).
- Psychographic (lifestyle) approaches: psychographics is used to segment consumer markets and provides marketers with general consumer profiles, analogous with personality types. Probably the best-known exposition of consumer psychographics is the values and lifestyle (VALS) typology. The original typology portrayed nine consumer groups (market segments) within four main categories (need-driven, outer-directed, inner-directed, and integrated) to reflect their consumer orientation (Mitchell, 1983; Holman, 1984). A revised VALS typology portrays three general consumer groups divided into eight segments (Graham, 1989; Schiffman & Kanuk, 2000). Consumers are characterized on two main dimensions (analogous with trait or type theories in personality) — available resources (abundant–minimal) and primary orientation (principle — guided by beliefs; status — guided by social approval; action — guided by activity, variety, and risk taking).

The concept of accident proneness initially developed from work by Greenwood and Woods (1919) in U.K. munitions factories during the First World War. They found that some workers had more than their fair share of injuries, but drew no firm conclusions about personality. Farmer and Chambers (1926) examined the injury record of a large group of drivers and found that a subset of this group reported a disproportionate number of injuries. They administered psychological tests, including personality tests, to both injury-free and injury-repeater groups. The outcome of the tests was not clear-cut in distinguishing between the two groups, but nevertheless they confidently announced that, accident proneness was no longer a theory but an established fact. As a result, the term accident prone entered the
vocabulary, and was defined by Farmer and Chambers as a personal idiosyncrasy of relative permanence that predisposed individuals supposedly possessing it to a relatively high accident rate. What this meant was that certain durable personality characteristics associated with accident prone individuals caused them to have mishaps or injuries, regardless of environmental circumstances. Thus, the concept of accident proneness had the following two central tenets:

1. People exposed to equivalent hazards did not have equal numbers of injuries
2. Observed differences in personal injury rates resulted from enduring individual differences

The term accident repeater has been suggested as a recommended alternative to being accident prone because it removes something of the notion of an attribution being made in respect of an individual’s personal characteristics. While accident proneness relates to supposed personal characteristics, the term accident repeater refers to an observed behavioral outcome, both of being “accident prone” and of having many injuries (i.e., a purely statistical phenomenon).

The search for personality characteristics that might affect injury involvement has a long history, with various personality traits being associated with accidental injury repeaters. For example, high injury rates were found to be associated with low trust, low optimism, resentment, and negative employment attitudes (LeShan, 1952) and also with high impulsiveness and risk-taking (Kunce, 1967). There is some evidence that extraverts have more injuries than introverts do (Fine, 1963; Craske, 1968), although this may be due partly to a reporting effect — that is, extraverts also report more of their injuries (Powell et al., 1971). In a study of offshore oil and gas industry workers, Sutherland and Cooper (1991) found that while extraverts reported having more injuries than introverts did, the difference was not significant. However, they found that workers who scored highly on the Eysenck personality inventory (EPI) neuroticism scale did report significantly more injuries than more stable individuals did, and suggested that both the neuroticism and the extraversion–introversion dimensions needed to be considered in respect of personal injury experience. Shaw and Sichel (1971) used Eysenck’s personality model as a basis for relating personality characteristics to injury liability and found some relationship.

A major problem with the concept of accident proneness as a single personality trait is that many characteristics (e.g., aggression, hostility, as well as hyperactivity) have been associated with injury repeaters. Where one encounters many and varied characteristics, it is difficult to graft them into a single personality type. Being unable to produce any overall stable profile of the accident prone person, it is obviously not possible to use a reliable yardstick in establishing whether someone has an injury prone personality. Reflecting on the relationship between personality and accidents, Hale and Glendon (1987) pointed out that in a limited number of studies, personality factors were related to injuries, but that correlations were often very low and nonexistent for some specific tasks. The evidence is more substantial for driving tasks than it is for industrial tasks (see later discussion in this chapter), perhaps because personality has a freer hand when people are behind the wheel of a car than when they are performing most industrial tasks. Thus, it is not so much that an individual’s personality changes, but rather that some of its alternative forms may be manifested. Willett (1964) noted that once behind the wheel of a car, people are able to let all of their unfavorable and antisocial traits show, with little fear of popular disapproval. Signori and Bowman (1974) claimed that both crashes and driver behavior were dependent not only on driver skill and the driving environment, but also on the driver’s personality. While driving offences are not homogeneous, for example, in their severity, they may be separated in the public mind from other criminal offences, for example, being perceived as
bad luck or accidents. However, in a study of 653 driving offenders, Willett (1964) found that 151 had criminal records for nonmotoring offences, 60 more were known to the police for other reasons, and 157 had previous motoring offences. Thus, over half the offenders had previously exhibited some form of criminal or antisocial behavior. The personalities of crash-repeating drivers have been studied by a number of authors and have been found to include larger than expected proportions of aggressive, ruthless, psychopathic, impulsive, and neurotic individuals—see for example, McGuire (1976), and Tillman and Hobbs (1949).

In a review, Beirness (1993) identified six broad dimensions of personality that appeared to be strongly and consistently related to driving behavior and crash involvement: thrill seeking, impulsiveness, hostility/anger, emotional instability, depression, and locus of perceived control. High levels of these traits predispose individuals to high-risk driving and reacting to driving situations that place them at higher risk of crash involvement. Beirness noted that personality factors have been shown to account for 10 to 20% of the variance in vehicle crashes, and up to 35% of the variance in risky driving. In a large sample of Norwegian drivers, Iversen and Rundmo (2002) found that those scoring high on sensation seeking, normlessness, and driver anger reported more frequent risky driving compared with those who scored low on these traits. They were more often involved in speeding and traffic rule ignorance violations. Drivers involved in risk-taking behavior experienced near-hits and crashes resulting in injuries and material damage more often than other drivers did.

Extraversion–introversion and neuroticism have been found to correlate with driving offences and vehicle crashes as shown in the following list:

- Driver inconsistency has been associated with neuroticism and extremes of extraversion and introversion (Venables, 1956; Singh, 1978).
- Extraverts have significantly more vehicle crashes and violations than introverts do (Fine, 1963; Craske, 1968; Smith & Kirkham, 1981).
- Multiple crash drivers are less likely than single crash or crash-free drivers to be extraverts (Pestonjee & Singh, 1980).

An alternative approach to identifying personality factors associated with vehicle crash involvement has sought to identify driver types. Using a rudimentary risk management approach, these have been from a perspective of seeking to identify subsets of drivers particularly at risk, either in specific circumstances or as categories of drivers within an age cohort. While much of the literature on this approach is fairly recent, the idea is not new. For example, Quenault (1967, 1968) identified different driver groups on the basis of their violating characteristics and classified driving styles and safety by considering violating behaviors. These were labeled safe, dissociative active (aggressive drivers who ignored other road users’ rights), dissociative passive (unaware of what was going on around them), and injudicious (poor at monitoring their own behavior and prone to making faulty judgments in maneuvers such as overtaking). Other researchers have developed taxonomies that describe different driver types. Rolls and Ingham (1992) described stylized portraits of safe and unsafe young male drivers. From survey data on drivers’ reactions to speed cameras, Corbett (2000) identified four driver types: conformers (who drove within signed speed limits), deterred (reduced speed to avoid detection), manipulators (slowed down only when approaching a speed camera), and defiers (undeterred by speed cameras). Using cluster analysis on personality and driving related measures, Donovan et al. (1988) found three clusters of high-risk drivers, Wilson (1991) identified four high-risk driver clusters, Deery and Fieldes (1999) identified five young driver subtypes, two of which were deemed to be high risk, while two of Ulleberg’s (2002) six novice driver clusters were considered to be
high risk in traffic. Personal characteristics of high-risk driver groups included high impulsiveness, sensation seeking, thrill seeking, hostility, driving-related aggression, personal problems, depression, anxiety, low altruism, poor emotional adjustment, irresponsibility, and rebelliousness.

Noting that the relationship between reported violations and crashes might be more complex than is suggested by some studies, in an observational study of over 2700 drivers on a Queensland motorway, Glendon and Sutton (2005) confirmed findings from studies using different methodologies that violations are more frequent among males and younger drivers (Jonah, 1990; Parker et al., 1992b, 1995; Lawton et al., 1997; Yagil, 1998). However, nearly 56% of drivers were observed to be violating when their driving behavior was observed, and in many cases, these were multiple violations. Aside from the general finding that younger drivers were more likely than older drivers to be violating, virtually no other variable consistently predicted drivers’ violating behavior. On the basis of their observed violating behaviors, Glendon and Sutton identified five driver groups (see Summary Text 5.6). Consistent with Zaidel’s (1992) notion of driving culture, the widespread observation of drivers’ violating behaviors in this study indicates that violating is a cultural norm for a substantial proportion of the motorway driving population (at least in Queensland).

In free-flowing traffic conditions, in which drivers are essentially able to drive as they would wish to, driving violations are not related solely to driver age and gender differences (e.g., as found by many driving studies, Jonah, 1990; Lawton et al., 1997; Kontogiannis et al., 2002; Mesken et al., 2002), but also to whether the driver is driving alone, number and type of passengers, vehicle age, and the type of vehicle driven. Baxter et al. (1990) found similar moderating effects upon speeding intention for drivers with a single passenger compared with solo drivers’ speeding intentions. Parker et al. (1992b) found that the presence of a passenger of the same age and sex as the driver moderated drivers’ stated intentions to violate, including tailgating, and that in daytime drivers indicated that the presence of a passenger would make them less liable to violate, while the opposite would be true for night driving. Clearly many aspects of driving behavior and the driving environment influence a driver’s crash liability.

In the aviation field, researchers have also sought relationships between personality and incident involvement. In a review of studies, Farmer (1984) found some evidence that extraversion and neuroticism traits were involved in aviation incidents, although the data were not clear cut, while Sanders and Hoffman (1975) and Sanders et al. (1976) also had difficulty in obtaining stable correlations between personality traits and incidents. In a study of 149 RAF (Royal Air Force) incidents, Chappelow (1989) designated 23% at least in part due to personality factors. In these 34 cases, the personality of a crew member or other relevant person was considered to be a possible contributory factor. Terms used to describe these individuals in their personal records included: underconfident, nervous, and prone to overreact. Other descriptions included: overconfident, reckless, disregards rules, and deliberate excitement seeking; although it appears that these were only revealed in a trawl of incident-involved crew members’ records. However, it is unclear as to whether this analysis was based upon a systematic appraisal of the personalities of incident-involved aircrew and there is no indication as to whether this group was compared with a matched group of nonincident involved crew. It is interesting that personality factors were considered to be important in such a large number of cases.

Another category of incident causes, cited by Chappelow (1989), was overarousal (e.g., being overloaded through having to cope with a large number of stimuli at once) and, in 12 of these cases, a crew member’s personality was also considered to be a contributory factor, particularly a lower than average tolerance for stress. Predisposition to anxiety was also judged to have contributed to other incidents. These findings are
Summary Text 5.6 Driver Groups Identified by Glendon and Sutton (2005)

Group 1: Nonviolating drivers. As 44% of drivers in this study were observed not violating, this figure represents an upper limit of the size of this group. The true size of the nonviolating group of drivers is likely to be smaller than this, as at least some members migrate into one or more of the violating groups. Drivers in this group tended to be older and to be traveling with one adult passenger.

Group 2: Commercial violators. This appeared to be a fairly distinct group—around 10% of the sample. They comprised mainly younger and intermediate age drivers of older commercial vehicles—trucks, utility vehicles, buses, etc. Their violations were mainly obstructed view, unsafe load, using cellular (mobile) phone, and polluting.

Group 3: Tailgaters. In nearly 55% of cases in which there was a lead vehicle, this was being tailgated. However, as in only just over 19% of cases was a vehicle following a lead vehicle at more than two seconds distance, it is possible that the potential tailgating (close following) driver group could be at least 80% of all drivers in this jurisdiction. A marked feature of this particular violation is that it is predicted by virtually no other variable, although solo drivers seemed to be slightly more prone to tailgate. As a broad driving cultural phenomenon (Zaidel, 1992) tailgating was found more or less equally among all age groups, both genders, and among drivers of all vehicle types and ages.

Group 4a: Speedsters. In this study, 38% of drivers were observed to be exceeding a signed speed limit, again indicating a widespread phenomenon, although one that could not be classified as a homogeneous violation—people speed for different reasons. Drivers in this group were more likely to be male and younger and were also much more likely to be driving newer private-use vehicles, particularly sedans—standard sized sedans were likely to be observed speeding at all rates over signed speed limits, while small sedans were more likely to be observed speeding up to 10% over the signed limit—reflecting the relative capacity of these vehicle types. While solo drivers were more likely to be observed exceeding the top speed limit—110 kph in this study, less intuitively, drivers with one or more children in their vehicle were more likely to be observed exceeding other speed limits. The respective risks selected by these subgroups might reflect on the one hand pressure upon professional drivers to reduce the amount of time spent traveling between appointments or between work and domestic locations. For drivers involved with childcare, their speeding behavior could reflect the urgency of transporting children to and from school, fitting such activity within an already full schedule, or other motivations. Various antecedents can generate the same observable behavior.

Group 4b: Judicious speeders. While a substantial proportion of speeding drivers were also observed violating in some other way, a small group—around 6% of all drivers, were separately identified on the basis that they were driving within 10% in excess of the signed speed limit but were not violating in any other way. In other respects they were similar to Group 4a. For drivers in this group it is possible that an implicit (sub)-cultural driving behavior is that it is acceptable to drive up to
10% over a signed speed limit. While cognitive states can only be inferred from a purely behavioral study, it might be that drivers in this group consider that they can safely drive within 10% above a signed speed limit, and are alert to the presence of police radar or speed cameras such that they can quickly reduce their speed to within the signed limit should this be necessary. Drivers in this group, while essentially law abiding, in the case of driving may make a reasoned case for accepting risks associated with exceeding the speed limit by a certain amount in order to obtain benefits of faster travel. As noted by Reason et al. (1990), risk/benefit trade-offs are among motivational factors likely to play a significant role in committing violations. Drivers in this group were most likely to be using their headlights, perhaps indicative on the one hand of a sense of urgency, and on the other as a safety feature.

suggestive of a high-neuroticism score, but no evidence is presented to confirm or refute this supposition. However, the author tentatively concluded that it seemed likely that both unstable introverts and unstable extraverts had their own idiosyncratic risks, also drawing attention to the difficulty of demonstrating a simple relationship between the extraversion–introversion dimension and accident proneness. Chappelow (1989) concluded that two distinct classes of personality problem were discernible from the data. One involved overarousal in response to emergencies or other demanding circumstances, and appeared to be the province of unstable introverts; the other involved excitement seeking and disregard of risks by unstable extraverts.

Rigorous statistical testing of the accident proneness hypothesis has shed doubt on its validity (e.g., Smeed, 1960). Hale and Hale (1972) argued that it was an artifact of inadequate control of confounding factors such as age, tenure, occupation, and exposure to risk. It can readily be acknowledged that certain people are more liable than others to have injuries; for example, Mayer et al. (1987), in a study of over 7000 accidents, found that 3.4% of the workers in an oil manufacturing plant had 21.5% of the minor injuries and that many more workers suffered repeat minor injuries than would have been predicted by chance; the differences for major accidents (i.e., involving severe injuries) were less striking, but still significant. However, the authors noted that this was a statistical phenomenon that described the problem but did not explain it. Caution should therefore be exercised when seeking to attribute specific personality characteristics to those with high injury-repeat rates. Of accident (injury) repeaters, Reason (1974) described accident repeaters as members of a club with an ever-changing membership, where new members join and long-standing members cease to qualify. It is possible that in some people accident proneness is a passing phase, while in others it is more enduring. Miner and Brewer (1983) described accident proneness as a transient personality maladjustment that particularly affects young people rather than a permanent trait, where, "the major motivation behind the repeated accidents themselves appears to be a desire to impress others by resorting to sudden and very risky decisions and behavior" (p. 1004). In her review of over 80 accident proneness studies, Porter (1988) pointed to the difficulty of using a statistical approach to study human characteristics that caused accidents and reinforced Reason’s contention that the accident-prone group is a shifting one. This suggests that accident proneness is not an enduring trait that attaches to an individual. If it does exist, accident proneness is unlikely to be a single personality trait, more a combination of factors and circumstances.
There are many problems with the concept of accident proneness, for example, whether it is a single personality trait or a number of different personality traits (Shaw & Sichel, 1971) or, whether it is stable across situations or over time (Adelstein, 1952; Shaw & Sichel, 1971; Guilford, 1973). In light of these, and other, difficulties outlined above, some researchers have concluded that it is not possible to isolate injury prone individuals: Wagenaar and Groeneweg (1987) considered that psychologists were talking moonshine if they claimed that accident-prone people can be removed through psychological testing. By accepting that some people are endowed with an accident-prone personality, the next step would be to create a personality profile of accident repeaters, and establish traits that were common to all of them. Personality tests could then be used to screen out job applicants whose personality profile matched that of the typical accident-prone person. However, in practice this approach has proven to be elusive and, even if researchers had been successful in their endeavors, the incentive to falsify personality tests would be overwhelming, as there are likely to be few who would wish to project the image of an accident-prone person. While faking can be a problem in using personality tests, there are ways of dealing with this, see for example, Cook (2004), who also describes a number of personality inventories and their application in work settings.

In an attempt to identify individual accident-prone characteristics (in addition to personality traits), over the years various tests have been administered, including those to measure psychomotor skills, visual skills, perception, attention, intelligence, life events, and specific types of stresses.

There is some evidence to support performance differences based on individual characteristics. Boyle (1980) used the found experiment technique, to show that individuals were differentiated with respect to their injury rates, with controls for ambient risk levels, exposure to risk, age, and job experience. Boyle found a significant correlation between reported injuries in the first and second halves of the 8-year period over which records had been kept. Porter and Corlett (1989) found two distinct groups of individuals based on responses to their accident proneness questionnaire. These two groups were distinguished by their beliefs about their own accident proneness. One group (accident prone) believed that they were prone to everyday minor incidents (such as tripping, cutting or bruising oneself, or breaking an object); the second group (nonaccident prone) believed they were not prone to such incidents. Accident-prone participants performed significantly worse on the primary task (a computer based unidimensional tracking task) of a dual task experiment. Such a performance deficit may be related to individual differences, but not necessarily related to personality traits.

While major life events seem to be associated with accidents (Selzer & Vinokur, 1974), the effects of these are likely to be temporary, and therefore it is difficult to establish measures on this basis. Those who are most vulnerable to stressors are most likely to be the injury-prone group. The underlying personality factor is likely to reflect attitude to life, described as a person’s underlying cognitive architecture, basically the way in which he or she sees the world and adjusts in the light of life experiences. Approaches to the accident problem from the perspective of the individual that are exclusively concerned with personality tend to ignore underlying cognitive processes, for example, to do with coping, although less emotionally stable people are more liable to the adverse impact of stress. This theme is revisited in Chapter 7. Reviewing the effects of personality factors through motivational influences, Hale and Glendon (1987) noted that the personality factors outlined below had been linked with accidental injuries (Surry, 1969; Hale & Hale, 1972).

- Aggression — which predisposes people to be unwilling to endure inconvenience and frustration, for example, arising from safety precautions.
• Anxiety — which can result in more obsessive checking of actions and a lower tolerance for danger; this could be positive in increasing caution but negative in interrupting the smooth flow of routine actions.

• Extraversion — which leads individuals to seek out sensations, including risk, and because of their lower response to feedback, they learn caution more slowly (Eysenck, 1964).

Of the other factors listed above that have been examined, many have been found to be associated with accidents. The best predictors of accident liability (a tendency to have accidents, independently of any personal ascription, such as accident proneness) according to Porter’s (1988) exhaustive study, appear to be poor attention and experience of recent major life events. This raises the issue of whether the concept of accident proneness is required at all, for if accidents can be explained by reference to such factors as attention and life events, then accident proneness as a hypothetical psychological construct is redundant and only has descriptive statistical value.

In conclusion, it is almost certain that a combination of factors is responsible for the phenomenon that has been labeled as accident proneness and that different clusters of factors attach to each individual. No personality trait for accident proneness has ever been isolated and it is unlikely to be worth looking for. Porter (1988) considered that to unravel some of the confusion surrounding the accident proneness concept, it is necessary to identify the following two distinct types described:

1. A reasonably stable characteristic, for which individuals cannot identify the cause (but which is likely to be associated with a combination of factors such as poor attention and possibly a variety of personality factors).
2. A temporary state, due to an obvious stress, which the individual can easily identify.

While it may be difficult to intervene to prevent injuries to those in the second of these categories, apart from counseling, for example, solutions to the first category may lie in attending to a combination of workplace and human resource management factors, including ergonomic design, training and refreshing, safety procedures, adequate supervision, job transfer and monitoring systems, and selection and appraisal. In other words, it is one more facet of managing the risks — and the human beings who are exposed to those risks, the theme of this book.

5.4 “Big-five” personality characteristics and injury liability

Despite skepticism about the concept of accident proneness, there is a body of empirical work that links some personality traits with injury involvement (e.g., West et al., 1991). An early literature review by Keehn (1961) concluded that extraversion, possibly accompanied by neurosis, is associated with higher injury liability. Hansen (1988) identified the following six personality characteristics listed here as having some empirical support for an association with greater accidental injury involvement:

1. External locus of control
2. Extraversion
3. Aggression
4. Social maladjustment
5. Neuroticism
6. Impulsivity
Many studies that have examined the relationship between personality and injury involvement have focused upon vehicle crashes. A meta-analysis conducted by Arthur et al. (1991) reviewed this literature and found small–moderate effect sizes for four personality categories: locus of control (0.20), (dis)regard for authority (0.16), general activity level (0.07), and level of distress (0.02).

One of the difficulties with personality studies is that they have lacked a coherent taxonomy, resulting in a wide variety of personality traits being measured, using a mixture of different methods. Up until the 1970s studies typically used questionnaires (e.g., Katz adjustment scales), projective tests (e.g., Rorschach, TAT [thematic appreciation test]), and clinical interviews, whilst more recent studies favor personality inventories, such as 16PF and the Big Five. The personality traits measured include: extraversion, neuroticism, social maladjustment, aggression, impulsivity, locus of control, Type A behavior, sensation seeking and, more recently, positive/negative affectivity. To clarify findings from the literature, Clarke and Robertson (2005) conducted a meta-analysis of personality and injuries (in both occupational and nonoccupational contexts), using the big five taxonomy to categorize personality traits. Low conscientiousness and low agreeableness were found to be valid and generalizable predictors of accident involvement (regardless of accident context), with corrected mean validities of 0.27 and 0.26, respectively. Extraversion was found to be a valid and generalizable predictor of vehicle crashes, but not of occupational injuries. The following sections review evidence relating personality to occupational injuries and road vehicle crashes, considering each of the big five personality dimensions in turn.

### 5.4.1 Extraversion

The meta-analysis conducted by Clarke and Robertson (2005) revealed that whilst extraversion was not significantly related to occupational injuries, it was a valid and generalizable predictor of road vehicle crashes. This finding reflected results from previous studies, which have suggested that extraversion is linked with crash involvement on the road (Fine, 1963; Smith & Kirkham, 1981; Arthur & Graziano, 1996) and a large-scale analysis of data collected on traffic fatalities across 34 nations conducted by Lajunen (2001), which suggested that extraversion is associated with fatal vehicle crashes, but not with occupational injuries. A few studies have found the opposite effect, with introverts being significantly more likely to experience injury (Pestonjee & Singh, 1980; Roy & Choudhary, 1985). However, it is possible that these findings may be linked to national culture, as the latter studies all involved Indian participants, whereas empirical support for extraverts having greater injury liability derives from studies with Western samples, including those from the United States, United Kingdom, and Australia.

The possible mechanism by which extraverts have higher injury liability is unclear. One explanation is that because extraverts have a lower level of vigilance, they will be less involved in tasks and, therefore, be more liable to have injuries (Eysenck, 1962). The finding that extraverts seek changes in self-stimulation to a far greater extent than introverts do and, therefore, demonstrate significantly poorer performance on vigilance tasks, has been largely validated (Koelega, 1992). In particular, there is significant evidence to support a decrement in performance under monotonous conditions, such as motorway driving, and that extraversion may mediate the relationship between fatigue and driving errors (Verwey & Zaidel, 2000). In addition to the role of vigilance, another mechanism relating extraversion to crash involvement concerns the lower level facet of sensation seeking. High sensation seekers have a greater tendency to take risks when driving, due to their increased need for novelty and thrills, and therefore have greater crash liability (Jonah, 1997).
Thiffault and Bergeron (2003) found that high-sensation-seeking extraverts could be more sensitive to road monotony and thus more prone to fatigue-related driving errors.

Extraversion is a fairly broad personality category that includes a number of lower level facets, including warmth, gregariousness, assertiveness, activity, excitement seeking, and positive emotions (Costa & McCrae, 1985; Summary Text 5.2). Some authors (Hough, 1992) have suggested that extraversion should be subdivided, for example, into affiliation (sociable, gregarious, and outgoing), achievement (ambitious, confident, and hardworking), and potency (forceful, optimistic, and vital) facets. A number of lower-level facets have been investigated with regard to crash liability. Loo (1979) found that impulsiveness was related to risky driving, whereas sociability was not (both facets of extraversion). Studies examining sensation seeking have generally supported a relationship with crash involvement (Jonah, 1997).

5.4.1.1 Sensation seeking

Zuckerman (1994) defined sensation seeking as, “The need for varied, novel and complex sensations and experiences and the willingness to take physical and social risks for the sake of such experiences” (p. 27). Sensation seeking comprises four components: thrill and adventure seeking, experience seeking, disinhibition, and boredom susceptibility (Zuckerman, 1990, 1994, 2004; Jonah, 1997). Sensation seeking is generally measured through self-report forced choice questionnaires — for example, Zuckerman’s sensation seeking scale (SSS) form V (Zuckerman, 1994), or the Arnett Inventory (Arnett, 1994). As a relatively stable aspect of personality, sensation seeking manifests itself in varied and novel behaviors throughout a person’s lifetime, while sensation-seeking score is a partial predictor of risk-taking behaviors (Zuckerman & Neeb, 1980; Ball & Zuckerman, 1992). Zuckerman (1983) studied biological components of SS (sensation seeking), which he considered to be genetically determined. A genetic basis for sensation seeking has been suggested through a novelty gene associated with a dopamine receptor (Stuttaford, 1999). While not a direct measure of risk attitude, sensation seeking affects decision making in risky behaviors (DeBrabander et al., 1996). Bradley and Wildman (2002), and Heino et al. (1996) found that high SSS scoring individuals displayed more risk and reckless behaviors than did low SSS scorers.

Zuckerman (1983) reviewed evidence for neurological processes involved in personality, risk taking, and sensation seeking, while Zuckerman (1979) found that risk takers scored highly on extraversion and psychoticism. Of the association between arousal and risk-taking, Zuckerman (1983) found that fast alpha rhythms were often more pronounced in risk-seeking individuals. Thayer (1987) differentiated energetic arousal, which plays a role in information processing, and tense arousal, which is associated with threats. Evidence indicates that danger and risk situations are associated with physiological arousal and that people try to optimize their arousal level (Trimpop, 1994). The same risk-taking behavior can arise from different motivational states — for example, McMillan and Rachman (1988) characterized parachutists as either courageous or overconfident or fearless, based on different physiological responses to their first jump and in their behavior, which were attributed to different coping mechanisms and arousability. Arousal also depends upon the amount of skill required for a task (e.g., driving) and an individual’s experience on that task. However, arousal alone is not sufficient to account for risk-taking behavior (Trimpop, 1994). Risk may be seen as a threat or a challenge or not perceived at all. Reviewing the evidence, Trimpop (1994) showed consistent correlations between SS and risk-taking behavior.

In a review of 40 studies, Jonah (1997) found that a majority supported positive relationships between sensation seeking and risky driving, with correlations between 0.3 and 0.4.
Iversen and Rundmo (2002) concluded that risk-taking behavior was a major predictor of crash involvement, and that this behavior was associated with those who scored high on sensation seeking. This study contradicted earlier research suggesting that sensation seekers tended to drive fast, but also safely (Clement & Jonah, 1984; Burns & Wilde, 1995). Jonah (1997) found that drivers scoring high on the SSS rated the acceptability of risky driver behaviors as significantly higher and perceived lower risk than did drivers scoring low on the SSS on the same driver behaviors. Burns and Wilde (1995) found that high SSS drivers drove in a manner that was consistent with this aspect of their personality, and that SSS score provided a measure of prediction for road crash involvement. Arnett et al. (1997) also found that high SSS score drivers were involved in more road crashes than were sensation avoiders (low SSS score drivers). Furnham and Saipe (1993) found high sensation seeking to be the best predictor of risk-taking driver behaviors that led to road crashes and driving violations. Zuckerman and Neeb (1980) found a significant relationship between SSS and speeding for both males and females.

Matthews and Moran (1986) found that decision-making and risk-taking behaviors were more influential toward younger drivers' overrepresentation in road crashes, than were the age of the car, nighttime driving, or alcohol consumption. Other researchers have found no difference between SSS and driving when under the influence of alcohol (Jonah & Wilson, 1986; Mann et al., 1987; Vinglis et al., 1994). McMillen et al. (1989) found greater risk taking in driving by high-sensation seekers and that high-sensation seekers took more risks when they believed that they had consumed alcohol. Low-sensation seekers became more cautious when they believed that they had consumed alcohol. When considering both speeding and tailgating violations, Yu and Williford (1993) found a relationship with SSS for drivers who were corrective service clients, while Jonah (1997) and West and Hall (1997) linked sensation seeking and risk taking in traffic with social deviance.

There is less empirical evidence to suggest a relationship between sensation seeking and occupational injuries, although Lubner (1992) found that, compared with their nonincident involved peers, U.S. pilots involved in aviation incidents scored significantly higher on thrill and adventure seeking.

As noted above, there is an argument that sensation seeking (and therefore risk taking, violations, and crash involvement) is particularly associated with younger individuals, especially males. Begg and Langley (2001) found that as age increased, risk-taking behavior decreased, and studies comparing male and female drivers generally find a higher prevalence of risk-taking driving behaviors amongst males (Clement & Jonah, 1984; Groeger & Brown, 1989; Jonah, 1997; Donson et al., 1999; Begg & Langley, 2001; Jonah et al., 2001). However, Ulleberg (2002) cautioned against treating young drivers as a homogeneous group, for example, in road safety campaigns, noting that the same personality characteristics may underlie both male and female risk taking. From a survey of 2498 novice Norwegian drivers, Ulleberg identified six clusters on the basis of self-reported risky driving behavior, two of which were deemed to be high risk in traffic: over 80% of the first high-risk group were males, and were characterized by low altruism and anxiety, together with high sensation seeking, irresponsibility, and driving-related aggression; the second high-risk group comprised nearly 60% females, and reported high sensation seeking, aggression, anxiety, and driving anger. Ulleberg concluded that specific combinations of personality traits are related to young drivers' risk driving and crash involvement.

5.4.1.2 Other facets of extraversion
Other facets of extraversion, such as experiencing positive emotions, have been found to reduce the likelihood of injury involvement. Iverson and Erwin (1997) found that positive affectivity (PA) had a significant negative correlation with work injuries. They suggested
that the more socially adjusted aspects of extraversion, as reflected in PA, would mitigate against injury involvement, as high PA is associated with greater self-efficacy (George & Brief, 1992; Judge, 1993), which in turn is reflected in a higher degree of task engagement. They also suggested that high PA individuals will have more accurate and systematic decision-making skills, such as requesting information, recognizing situational contingencies, and using data (Staw & Barsade, 1993), which is reflected in more thoughtful and careful appraisal of situations, thereby reducing their injury risk.

5.4.1.3 Reversal theory
Application of reversal theory (Apter, 1982), a state approach to behavior, suggests quite different motivations for speeding than do trait approaches. Reversal theory distinguishes between extrinsic — a telic or goal-oriented state (e.g., getting to an important event on time) and intrinsic — a paratelic state, which relates to sensations associated with continuing behavior (as in enjoying a task for itself). This approach suggests bistability, or two optimal levels of arousal, between which an individual can switch, depending upon the situation. This contrasts with risk homeostasis theory (RHT), which implies only one target risk level at a given time (see Chapter 2, and Smith & Apter, 1975). The telic (reactive) state is split into subgoals and the individual seeks to terminate the activity as soon as possible. In the paratelic state the individual is proactive and seeks to continue the activity for as long as possible. The telic mode is dominant as it has to be satisfied first, while there are differences both between individuals and within individuals in different states. Paratelics tend to be sensation seekers, extravert, arousal reducers, and have high hope for success. While more flexible than most traditional approaches to personality, there are problems regarding state vs. trait aspects of reversal theory and also in testing it experimentally (Trimpop, 1994).

5.4.2 Neuroticism
Meta-analyses have suggested that emotional stability is associated with higher job proficiency across occupational groupings (Salgado, 2002). Conversely, one would expect that neuroticism would be associated with lower job performance. According to Eysenck (1970), individuals high in neuroticism (characterized by anxiety, hostility, depression, self-consciousness, and impulsiveness) will be more injury involved. Hansen (1989) suggested that the increased injury liability of neurotics is due to their distractibility — they tend to be preoccupied with their own anxieties and worries, and are therefore more easily distracted from the task in hand. Studies support a positive relationship between neuroticism and crashes for professional drivers (Pestonjee & Singh, 1980; Roy & Choudhary, 1985), motorists (Selzer et al., 1968; Mayer & Treat, 1977), and injuries in industrial settings (Hansen, 1989). Clarke and Robertson (2005), however, found support for a significant relationship between neuroticism and injuries in occupational settings, but not for vehicle crashes (nonoccupational).

The tendency to experience negative emotions (negative affectivity) has a significant positive relationship with occupational injuries (Iverson & Erwin, 1997). These authors suggested that not only are neurotics more distractible, but also that they prefer less direct coping strategies, such as emotion-focused coping (Parkes, 1990), thereby increasing their injury risk (see Chapter 7). Further explanation for mechanisms linking neuroticism with injuries may be related to neurotics’ response to stress. Neuroticism is the strongest single predictor of driver stress (Matthews et al., 1991), suggesting that neurotics may respond more negatively to environmental stressors. Acute reactions to stressors, including anxiety and fatigue, have the effect of decreasing cognitive and performance capacities, such as reaction times and judgment, increasing the probability of errors (Steffy et al., 1986). Offshore oil workers who were high in neuroticism reported significantly more work injuries
than did their low-neuroticism peers, as well as reporting greater dissatisfaction and lower mental health. They were also more likely to be heavy drinkers when onshore (Sutherland & Cooper, 1991). Whilst this may reflect neurotics’ tendency to experience greater stress symptoms, an alternative explanation is that neurotics have a negative world view, which leads them to negative perceptions of events, rather than actual experiences; thus, there is a tendency for neurotics to report more negative events, such as health complaints (Watson & Pennebaker, 1989; Feldman et al., 1999) and workplace abuse (Wislar et al., 2002) as well as injuries (Sutherland & Cooper, 1991). However, Clarke and Robertson (2005) argued that this tendency did not appear to account for the personality–injury association as in their meta-analysis, the significant relationship between neuroticism and injuries was found in relation to work injuries, in which most of the data referred to objectively verified injuries, rather than self-reports.

5.4.3 Conscientiousness

Meta-analyses consistently report a tendency for conscientiousness to correlate well across measures of job performance (Barrick & Mount, 1991; Tett et al., 1991), leading Barrick and Mount (1991) to suggest that this personality dimension could act as a general personality factor. However, it may not be desirable in all occupational fields, such as managerial performance (Robertson et al., 2000). There is evidence to suggest a role for conscientiousness in terms of safety performance, with empirical studies supporting significant negative correlations between conscientiousness and injuries (Arthur & Graziano, 1996; Cellar et al., 2001; Wallace & Vodanovich, 2003b), indicating that low scorers on conscientiousness are more likely to suffer workplace injury. Clarke and Robertson (2005) found that conscientiousness was a significant predictor in relation to vehicle crashes, but not for occupational injuries. One possible explanation is that because conscientiousness plays a more important role where volitional control is higher (Salgado, 2002), it may have greater influence over involvement in vehicle crashes, where individuals have more direct control over their actions (e.g., driving recklessly or too fast for the road conditions), compared with circumstances typical of work-related injuries. However, because Clarke and Robertson conducted their meta-analysis with accident involvement as the criterion, it is possible that conscientiousness would play a role in safety-related behaviors at work, such as participation in safety activities, which involve higher volitional control. Highly conscientious individuals may be more likely to engage in such behaviors, and be less likely to violate rules. Salgado (2002) found that low conscientiousness was the most significant predictor of deviant work behaviors (including rule breaking).

The definition of conscientiousness includes a number of different aspects, including competence, order, dutifulness, achievement striving, self-discipline, and deliberation. Goldberg (1990) described the conscientious person as organized, conforming, detail conscious, and dependable. There is evidence that several relevant personality traits, which relate to low scores on conscientiousness, are significantly associated with injury involvement. Low scores on self-discipline relate to carelessness and a lack of self-control (Suchman, 1970; Shaw & Sichel, 1971) and low scores on cautiousness to impulsivity (Mayer & Treat, 1977). A further aspect of conscientiousness, related to deliberation and order, is reflected in thoroughness in decision-making style; low thoroughness has been shown to correlate with crash risk (West et al., 1993). Low thoroughness is characterized by a lack of forward planning, absence of a logical or systematic approach to decision making, and inadequate cost–benefit analysis and contingency planning.

A low score on the dutifulness facet relates to a lack of respect for authority and social order: social maladjustment (Hansen, 1989); social rebellion and antagonism to authority (Shaw & Sichel, 1971); antisocial tendencies (Mayer & Treat, 1977); and, social deviance
Evidence from West et al. (1993) suggested that social deviance increased vehicle crash risk partly due to its association with increased driving speed. Two possible explanations are proposed: first, exceeding speed limits involves breaking the law and individuals with higher social deviance have less regard for authority; and second, social deviance may be caused by a stronger focus on immediate needs (such as making good progress) irrespective of possible future consequences for oneself or others (such as the adverse consequences of a crash). The latter explanation is reflected in optimizing violations (Reason et al., 1994), which serve nonfunctional goals, such as joy of speed or aggression and become part of the individual’s personal performance style. Those individuals who are higher in social deviance (low conscientiousness) would be more likely to engage in this type of rule-related behavior.

There is consistent evidence that violations are associated with increased crash risk in motorists (Parker et al., 1995) and truck drivers (Sullman et al., 2002), although little research has been conducted in workplace settings. Individuals who are low on conscientiousness exhibit behaviors characterized by a focus on satisfying immediate needs, regardless of future consequences for self or others (West et al., 1993), a lack of goal setting and failure to follow rules and regulations (Arthur & Doverspike, 2001), and inadequate reflection relating to on-task processes (Wallace & Vodanovich, 2003b). Furthermore, Wallace and Vodanovich (2003b) suggested that individuals who are low on conscientiousness are more vulnerable to cognitive failures, which in turn are predictive of workplace injuries (see Section 5.6).

Much of the research on personality dimensions in relation to workplace injuries or vehicle crashes has been conducted on the assumption of linear relationships; thus, for example, the more conscientious an individual, the less likely he or she is to be injured. However, some researchers have suggested that extremes of personality traits are related to crashes and injuries. Reason et al. (1998) suggested, “mispliances are likely to be associated with the personal characteristics of rigid compliance (‘rules must be obeyed at all times’)” (p. 300). This suggests that whilst high conscientiousness would normally be associated with lower injury risk, extreme conscientiousness could have the opposite effect, as mispliances involve obeying rules, even where the procedure was not appropriate for the situation (incorrect action) (see Chapter 4). The extent to which high conscientiousness is desirable will also depend on the requirements of the job: more highly routinized and formalized work will require reliable performance and safety compliance, and therefore, high conscientiousness. However, this personality characteristic may have lower importance in less formalized work.

### 5.4.4 Agreeableness

People who are high on agreeableness are pleasant, tolerant, tactful, helpful, not defensive, and generally easy to get along with (Hough, 1992). Some empirical evidence supports a negative relationship between agreeableness and injury involvement (Cellar et al., 2001) — that is, more dominant, aggressive, and egocentric individuals (low scorers on agreeableness) are more likely to be injured. However, others have failed to support this association (Arthur & Graziano, 1996). Clarke and Robertson (2005) found that low agreeableness was associated with incident involvement, being a valid and generalizable predictor of both occupational injuries and vehicle crashes.

Agreeableness includes elements of trust, compliance, and altruism that are reflected in studies examining personality and injuries. Davids and Mahoney (1957) found a significant negative relationship between trust and injury involvement in workers at a U.S. process engineering plant. Studies measuring low altruism, egocentricity (Davids & Mahoney, 1957; Conger et al., 1959; Shaw, 1965), and selfishness (Shaw & Sichel, 1971) have all supported
a significant positive relationship with injury experience. The opposite pole of compliance encompasses belligerence, hostility, and aggression, all of which have been examined in relation to injury involvement. High aggression has been associated with greater injury involvement in railway workers (Sah, 1989), U.S. airmen (Conger et al., 1959), and Indian bus drivers (Roy & Choudary, 1985). Evidence also suggests that high levels of aggression and hostility are associated with road vehicle crashes (Suchman, 1970; Hemenway & Solnick, 1993; Norris et al., 2000), although Vavrik (1997) found no significant relationship. A review of the literature concluded that hostile and aggressive tendencies are associated with greater injury liability (Beirness, 1993). The link between driver anger and subsequent near incidents on the road (Underwood et al., 1999) suggested that drivers who become angered, and respond aggressively, are more likely to crash. However, studies have generally found that ordinary violations (e.g., speeding) are significantly predictive of crash involvement (Parker et al., 1995; Meadows et al., 1998) rather than aggressive violations (e.g., expressing hostility to another road user) (Sullman et al., 2002).

Previous meta-analyses predicting job performance demonstrated mixed findings for agreeableness, with Barrick and Mount (1991) finding little effect, but Tett et al. (1991) finding a positive relationship (rho = 0.22). However, agreeableness is most salient in situations that involve interaction or cooperation with others (Barrick & Mount, 1991). The common element, in both occupational and nonoccupational settings, may relate to the decreased capacity of low scorers on agreeableness to manage interpersonal relations (Clarke & Robertson, 2005). Mount et al. (1998) found that agreeableness was related to job performance in occupations involving interpersonal relations, particularly in team-based working. Individuals who are low in agreeableness may be less able to cooperate with others effectively and be more liable to respond aggressively to situations, thus increasing their injury liability; whilst on the road, individuals low in agreeableness may be more prone to interpersonal violations (aggressive behaviors toward another road user) (Mesken et al., 2002). Findings from Hofmann and Stetzer (1996), examining group processes and work injuries, suggested that establishing group norms for safety-related behaviors, such as approaching team members engaged in unsafe acts, would have a significant impact on injury involvement. High scorers on agreeableness, who perform more effectively in group settings, may be more amenable to developing such group norms and more responsive in applying group norms to their own behavior. This suggests that teams with a higher proportion of highly agreeable individuals would be more effective in terms of safety-related outcomes. In relation to vehicle crashes, Mesken et al. (2002) suggested that interpersonal violations on the road are associated with higher negative affect and emotional arousal, which in turn influence perception and information processing (Deffenbacher et al., 1994), thereby increasing crash risk.

5.4.5 Openness

Openness is perhaps the least studied of the big five personality dimensions in terms of job performance. Likewise, compared with the other personality dimensions, fewer studies focus on openness and injury involvement. Arthur and Graziano (1996) found little evidence of a relationship between openness and self-reported vehicle crashes; however, other studies have examined some facets of openness. High-openness scorers are imaginative, unconventional, curious, broadminded, and cultured. Suhr (1961) found a negative relationship between imagination and injuries, while a positive relationship was found by Lardent (1991). Positive relationships have been supported between artistic, literary, and aesthetic interests and injuries (Parker, 1953; Conger et al., 1957). Meta-analyses (Barrick & Mount, 1991; Salgado, 1997) have supported a relationship between openness and training proficiency, indicating that high openness is associated with a positive disposition.
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Toward learning. Thus, high openness would be desirable for developing a well-trained workforce. However, particularly in routinized working environments, where safety compliance may be critical, more imaginative, curious, and unconventional individuals could be more liable to rule violations, experimentation, and improvization; whilst low scorers on openness would have an enhanced ability to focus on the task in hand and might therefore be less likely to have injuries. However, there is little evidence to support a substantive relationship between openness and injury involvement either one way or the other (Clarke & Robertson, 2005).

5.5 Risk propensity

A widely held view is that injuries happen because individuals fail to assess the danger inherent in a situation accurately or else they may correctly perceive the danger, but make a conscious decision to take that risk. Evidence from traffic studies suggests that violations, incidents, and crashes on the roads are strongly related to risk-taking behavior (Jonah, 1986; Iversen & Rundmo, 2002). However, several authors who have analyzed underlying causes of industrial injuries have emphasized the lack of conscious risk taking in behavior that leads to incidents (Reason, 1990). Wagenaar (1992) argued that much everyday behavior is conducted without conscious evaluation of the risk involved — much of our behavior is automatic, habitual, and shaped by past experience. Injuries are not caused by misperceptions of risk or conscious risk taking because behavior is based on habit, particularly in routine situations (see Chapter 6 for further discussion). For example, in an analysis of accidents at sea, less than 1% were found to have been caused by an individual consciously accepting a risky course of action (Wagenaar & Groeneweg, 1987). This may suggest that different personality traits may underlie safety-related behaviors in different contexts (Lajunen, 2001; Clarke & Robertson, 2005). The link between risk taking and vehicle crashes is strengthened by the consistent association of the personality trait of extraversion, which includes sensation seeking, with crash involvement. Research suggests that deliberate violations, especially speeding, are associated with increased crash risk, and that high-sensation seekers are more likely to engage in such violations. Although the propensity to take risks is most associated with vehicle crashes, the tendency toward errors and lapses has also been associated with crash involvement, particularly among the elderly (Parker et al., 2000). Individual differences in error-proneness are discussed further in Section 5.6.

Although a strong link is supported between risk taking and vehicle crashes, there is much less support for a similar relationship in occupational environments. However, there is some evidence that workplace risk cognition can influence injury liability. Fleming et al. (1998) found that perceptions of higher risk (feeling less safe) were significantly related to job situation (felt less in control), working environment (felt more harsh), satisfaction, with safety (felt less satisfied), and job satisfaction (felt less satisfied) explaining 22% of variance. However, whilst risk perceptions were related to injuries, the contribution of risk perception, safety attitudes, and safety satisfaction, accounted for only 3% of the variance. Rundmo (1995) found that risk perceptions, safety satisfaction and job stress were all significantly predictive of injuries/near-hits (explaining 23% of the variance). Sutherland and Cooper (1991) suggested that perceptions of safety could act as a stressor in hazardous working environments and also that experiencing an injury leads workers to perceive the environment to be more stressful. Other evidence supports this view. Morrow and Crum (1998) found that perceived dangerousness was a significant predictor of job stress (controlling for objective risk factors, including prior injury and tenure) in U.S. railroad workers. Previously-injured offshore workers have been found to feel less safe and to
experience more job stress (Rundmo, 1995). However, in hazardous work environments, it has been suggested that continued emphasis on the need for safety could be a greater source of strain than the hazards themselves (Cooper et al., 2001). Evidence suggests that intrinsic job hazards in high-risk jobs, such as police work, cause less psychological distress than do stressors such as organizational climate and structure (Hartet et al., 1995), a finding echoed by Glendon and Coles (2001) in respect of ambulance staff. McClain (1995) found that whilst lower perceived safety risk was positively related to satisfaction with workplace conditions, it was unrelated to job stress amongst firefighters and emergency medical technicians. However, perceived risk was a significant predictor of greater distraction from task accomplishment, indicating that perceptions of risk may act as distractions for workers, increasing their accident vulnerability. For more detailed discussion of the role of stress in injury causation, see Chapter 7.

Wagenaar (1992) suggested that whilst operators run risks, it is those placed higher in organizational hierarchies (i.e., managers) who consciously take risks. However, even at this level, the literature concerning managers’ risky decision making suggests that habitual behavior is also a significant factor. Both inertia (habitual response to risk) and outcome history are significantly related to risk propensity (Sitkin & Weingart, 1995; Pablo, 1997). More experienced decision makers may focus on their past ability to cope with obstacles, raising their level of confidence, and increasing the likelihood of risky behavior. However, less experienced individuals may also have raised levels of confidence because of their lack of knowledge of the possible consequences of their actions (also leading to riskier behavior). Evidence also suggests that organizational factors (such as, industry sector and degree of governmental control) have a direct effect on risk propensity (Williams & Narendran, 1999). In a large-scale review, Lawton and Parker (1998) found that no cohesive model had been established for a risk personality, and that the notion was of limited use for organizations. An organization’s culture will influence managerial decision making, dependent on the cultural value attached to risk seeking/uncertainty or risk avoidance/certainty. The risk climate within which managers operate provides a frame of reference for behavior and indicates the acceptability of risky behavior. The role of managerial personnel in injury causation is further discussed in Chapter 9.

5.6 Individual differences in error liability

The tendency toward errors and lapses has been associated with vehicle crash involvement (Larson & Merritt, 1991; Parker et al., 2000), although fewer studies have been conducted in relation to work injuries (Wallace & Vodanovich, 2003a, 2003b). This leads to the question: could there be an error-prone personality?

Broadbent et al. (1982), using their Cognitive Failures Questionnaire (CFQ), reported evidence indicating that liability for absentminded errors (e.g., opening the wrong door) is a feature of the makeup of some individuals. Where it exists, it is likely to be associated with, for example, memory lapses (e.g., forgetting where you left something) and lack of attention (e.g., not noticing something). Wallace and Vodanovich (2003a) investigated the relationship between work injuries and vehicle crashes and the propensity to commit cognitively based mistakes in 240 electrical workers. They found that the blunders factor of the CFQ (this factor relates to physical blunders, such as accidentally bumping into someone) significantly predicted both work injuries and vehicle crashes. Reason and Mycielska (1982) reported studies indicating a link between error proneness and the obsessionality personality trait (as measured by a version of the Middlesex Hospital Questionnaire, an instrument developed for primary use in clinical settings to measure various personality traits), which could be related to the conscientiousness dimension of the big five. Thus, the more obsessive
an individual, the lower is their propensity to make errors. Wallace and Vodanovich (2003b) investigated the link with conscientiousness. They found that cognitive failure moderated the relationship between conscientiousness and both unsafe behavior and injuries. Further reinforcing the results of Reason and Mycielska (1982), cognitive failure was found to be predictive of unsafe behavior, particularly for low scorers on conscientiousness.

Broadbent et al. (1982) also noted that general vulnerability to stress was related to error-proneness and it is known that high levels of stress can increase the likelihood of human error (e.g., Marshall, 1978). That there is an association between individual proneness to cognitive failures and increased vulnerability to stress is widely accepted (Broadbent et al., 1986; Reason, 1988). However, Reason (1990) argued that it is not so much that stress induces a high cognitive failure rate, but rather that certain cognitive styles can lead to both absent-mindedness and inappropriate matching of coping strategies to stressful situations. Reason and Mycielska (1982) considered that this is related to the amount of attentional capacity that people have available to deal with stress after other matters have been dealt with. There are also individual differences in the extent to which response to stress influences injury involvement (see Chapter 7).

Thus, there is strong evidence for individual differences in error proneness, which could be a new factor or dimension associated with one or more existing personality traits. First, it is known that stable individual differences influence minor cognitive failures. Second, a high incidence of slips and lapses is associated with increased vulnerability to stress. It seems that the same general control factor that determines error liability is also involved in coping with adverse effects of stress (see Chapter 7). Reason and Mycielska (1982) considered that coping strategies that are based upon increasing our capacity to pay attention through focusing upon the relaxation response (e.g., meditation), could reduce errors as well as alleviate stress.

5.7 Personality at work

Personality has been used as a variable in research in occupational settings for some time. For example, Anderson’s (1929) survey of staff at Macy’s department store in New York found that 20% of employees fell into the problem category, described as, “can’t learn, suffer chronic ill-health, in constant trouble with fellow employees and can’t adjust satisfactorily to their work.” Culpin and Smith (1930) surveyed over 1000 British workers and found 20 to 30% suffering some level of neurosis (around one in five maladjusted people in a heterogeneous population is typical). U.S. nuclear power industry officials listed over 150 cases of distracting behavior in nuclear power plant operations; argumentative hostility and impulsive action were considered to be particularly risky (Cook, 2004). Psychologists advised testing and periodic retesting (Dunnette et al., 1981). Other studies have found that extraverts tend to leave jobs sooner (Cooper & Payne, 1967), are less satisfied than introverts are with clerical jobs (Sterns et al., 1983), and that stable extravers were generally better in flying training (Bartram & Dale, 1982). Matthews et al. (1992) found that extraverts were better at mail sorting. Hough et al. (1990) found that personality traits similar to the big five could be used to predict some job-related criteria; for example, extraversion predicted effort and leadership in military personnel, while dependability (conscientiousness) predicted personal discipline.

5.7.1 Using personality tests in selection

Testing is basically of two types: aptitude (e.g., intelligence or various types of ability, spatial, speed, accuracy, and programming ability) and personality (e.g., using 16PF and big five). Dorcus and Jones (1950) noted that, in the United States, use of psychological
testing grew rapidly between 1910 and 1948, while in the United Kingdom and the rest of Europe it remained at a relatively low level. A large number of personality measures is available (Buros, 1970; Conoley & Kramer, 1989), many of them quite dated. During the 1980s, personality testing increased in U.K. organizations' selection procedures (Robertson & Smith, 1989), leading to continued growth in the 1990s (Robertson & Smith, 2001). To some extent this reflects a greater confidence in personality as a predictor of job performance due to recent meta-analytic studies that have provided evidence of at least a moderate level of criterion-related validity for personality (Ones et al., 1993; Frei & McDaniel, 1997; Salgado, 1998; Hermelin & Robertson, 2001). In a meta-analytic review of the predictive validity of personnel selection methods in relation to job performance, Hermelin and Robertson (2001) found that personality tests measuring the big five fell into the lowest category of validity (where the mean corrected validity ranged from 0 to 0.25). Amongst these, they reported that conscientiousness showed the highest mean validity, followed by neuroticism, extraversion, agreeableness, and openness.

Attempts have been made to develop personality tests that have a more specific occupational orientation. A prime example is the Occupational Personality Questionnaire (OPQ) (Saville & Holdsworth, 1984, 1985). The OPQ was developed to measure personality factors deemed to be particularly relevant to occupational environments. The OPQ has three main domains: relationships with people, thinking style, and feelings and emotions, as well as traits and descriptions within each domain. Matthews et al. (1990d) and Stanton et al. (1991) factor analyzed the OPQ and found a factor structure that corresponded with the big five. Robertson and Kinder (1993) found that OPQ personality variables were significantly associated with job competencies, such as creativity, analysis, and judgment. However, there is continuing debate about the appropriate level of analysis for personality measurement. Ones and Visweveran (1996) argued that broad measures using the big five provide the most appropriate level of analysis, particularly when predicting overall job performance. However, other research has demonstrated that where prediction concerns specific occupational areas, a narrower approach provides better validity (Robertson et al., 2000). Clarke and Robertson (2005) found relatively small validities for the big five personality dimensions in relation to injury involvement, but concluded that exploring the predictive validity of lower level facets would yield more convincing levels of validity. For example, there is evidence that sensation seeking is more strongly related to injuries, than is the broader extraversion dimension.

Numerous difficulties are associated with developing personality tests to predict job performance. One problem is that many jobs involve a wide variety of activities (e.g., the job of a safety and risk professional) and thus it would be difficult to find a single test that could validly predict for all aspects of such jobs. As Deary and Matthews (1993) pointed out, in many jobs, where a variety of types of processing (e.g., mental and physical activity) are required, stress and motivation (and other factors) vary over time so that (personality) trait effects are swamped by overall performance measures (and external demands). Hesketh and Robertson (1993) explained the necessity of examining the relative contributions of personality and situation in job performance as a basis for measurement. Thus, personality tests may most appropriately be used to predict relatively homogeneous aspects of job performance or those aspects that are critical, for example to safety systems. A recent development in this area has focused on developing instruments that reflect the personality requirements specific to a job (Raymark et al., 1997; Hogan & Rybicki, 1998; Westoby & Smith, 2000). A more accurate specification of the personality requirements of a job means that these become the focus of the instrument, with less relevant dimensions eliminated — the average validity of the remaining dimensions is thereby improved (Hermelin & Robertson, 2001; Robertson & Smith, 2001). For example, subject-matter experts were involved in the development of a 60-item questionnaire that identified those of the 16PF
Chapter five: Personality and risk liability

Summary Text 5.7 Selection Techniques to Complement the Use of Personality Tests

- Interviews — should be structured and interviewers properly trained
- Biographical data (biodata) — to indicate relevant aspects of experience, qualifications, and background
- Ability tests — to assess relevant cognitive or behavioral components of job performance
- Work sample/simulation tests — to replicate the type of work environment to be encountered for assessing a sample of performance
- Assessment centers — to collect data from a range of different tests and exercises that focus upon job (particularly managerial) performance

scales that were likely to be predictive of performance in a specific job (Westoby & Smith, 2000).

Although there has been criticism of the validity of personality tests in job selection (Blinkhorn & Johnson, 1990) there has been strong support for personality testing (Day & Silverman, 1989; Gellatly et al., 1991; Tett et al., 1991). Jackson and Rothstein (1993) concluded that personality testing can be a useful component of personnel selection if the following criteria listed here were adhered to:

- Well constructed and validated personality measures are used
- Choice of personality measure is guided by job analysis and prediction
- Appropriate statistical analyses are used to validate the measure
- Economic benefits are evaluated in respect of improving job performance

In addition, personality tests should be used in conjunction with one or more of other selection techniques, for example, those listed in Summary Text 5.7. Research has shown that combining multiple predictors that have low intercorrelations can improve overall validity in predicting job performance (Ones et al., 1993; Schmidt & Hunter, 1998). Another means of combining selection methods is to explore interactive relationships between different predictors, such as cognitive ability and personality. Although there is currently little research in this area, Wallace and Vodanovich (2003b) demonstrated a significant interaction between conscientiousness and cognitive ability in relation to safety performance.

When considering personnel selection in a strategic context, such as one provided by human resource management, the contribution of personnel selection to the organization’s corporate objectives needs to be considered as an investment in human resources. Cook (2004) argued for a systematic approach to selection as a means of improving productivity, and it is increasingly recognized that poor selection decisions can be very costly for an organization. One principle of human resource planning is to use selection procedures systematically. Part of this process is to use job analysis, often done by observing those doing the job and by interviewing present incumbents. The job description drawn up should show the following features listed:

- Responsibilities involved in the job
- Skills and knowledge required
• Authority level and position in organization
• How the job is to be performed
• Personal factors required — for example, age range, qualifications, experience, abilities, and personality factors (required, desirable, and undesired)

From a detailed job analysis, including safety and risk aspects of the job, an appropriate personality measure may be a useful component of the selection process.

5.8 Conclusions

From evidence reviewed in this chapter, personality models that have been developed to date have still to realize their full potential in helping to manage individual risk in workplaces. A major problem with an approach through accident proneness is that injuries are caused by many factors and trying to isolate one, which itself is a collection of different components, is unlikely to be worth the effort involved. However, it is useful to know where to look for solutions to health, safety, and risk problems. For example, for any given type of work, if personality does not appear to be a fruitful area because of the uncertainty of evidence and difficulty of relating traits to specific types of behavior, then attention might be better focused upon design and ergonomic issues. However, to ignore personality factors because of the problems of measurement and its ambiguous relation with behavior would be a mistake in the long term. This is first of all because personality factors have been shown in many studies to be related to aspects of job performance that are relevant to safety and risk, and second because personality testing is extensively used in the selection process, which is a critical component of managing human resources strategically.

The personality profile of workers and managers is just one component of a complex of factors that together are important in managing risk and safety features of jobs and tasks. However, progress on specific ways in which personality factors influence occupational health, safety, and risk has not been spectacular. Nevertheless, there have been a number of recent advances, particularly in the use of personality testing in personnel selection. Even in this area, further research is needed to inform these developments in relation to safety performance, specifically research on interactions between personality and other selection criteria, such as cognitive ability. Personality is conceived of, and usually defined as, a relatively enduring set of individual characteristics. Thus, there is no such topic area within psychology as personality change, unlike, for example, attitude change. However, even those personality theorists who consider that a large percentage of the variance in personality is inherited (e.g., Eysenck) believe that behavior that is attributable to personality can be modified and shaped by external influences, a view that would be shared, albeit for different reasons, by personality theorists of all persuasions. Therefore, when seeking to modify behavior in the context of managing safety and risk, it would not be correct to think of an individual’s personality as immutable.

By using various personality measures (e.g., variants of the big five) we can acquire information that can be used to counsel individuals, giving feedback on their strengths and weaknesses in order to encourage change from within. Thus, where personality is likely to be important in the performance of a task or job, then it may be part of the role of the safety and risk scientist practitioner to acquire expertise to assess the personalities of relevant personnel and to act accordingly. In only a small number of cases is it likely to be worth trying to use personality tests to select out candidates for jobs involving specific safety or risk components. For example, in some jobs where decision making on risk could have critical consequences, particularly in some senior managerial jobs, it may be prudent to screen candidates so as to exclude those with certain combinations of personality traits, for
example, a combination of high levels of extraversion, neuroticism, tough mindedness, and impulsiveness (see Chapter 9). However, a more proactive use of personality tests would be as a basis for assessing training needs for particular types of job, especially where the job incorporates safety critical functions.

In general, the type of job (e.g., managerial, supervisory, or operational) and its safety requirements and responsibilities should be looked at systematically, for example, using job analysis designed to identify the range of personality requirements of a job. If personality tests are to be used as a selection device, then systematic job appraisal can be used to develop appropriate tests, particularly for safety critical jobs.
chapter six

Attitudes, values, and risk behaviors

This chapter addresses a topic that is generally acknowledged to be central to workplace health and safety — attitudes and their link with behavior. After evaluating the nature of attitudes, including their components, dimensions, and measurement, attention turns to attitudes toward safety and risk, and theories about the link between attitudes and behavior. Attitude and behavior change is next discussed incorporating a number of case examples of attitude and behavior change in respect of safety. The final substantive topic is the concept of safety climate.

6.1 Introduction

This chapter seeks to answer questions relating to the extent to which attitudes toward safety and risk issues are critical to safety-related behavior, including the concept of safety climate. Objectives of this chapter are as follows:

- Explain what attitudes are and the functions they serve
- Outline major approaches to attitudes and their measurement
- Discuss attitudes toward safety and risk and the concept of safety climate
- Consider the relationship between attitudes and behavior
- Demonstrate the relevance of attitudes to safety and risk management

After reviewing the relevance of attitudes to some safety and risk issues, various aspects of attitudes are introduced, the important ones being considered in greater detail later in the chapter. Different attitude components are considered, feeling, thinking, and tendency to act, as well as a number of different attitude dimensions. We next turn to consider attitude measurement, using different types of scale, each of which is explained with safety examples. The literature on attitudes toward risk and safety is reviewed and the relationship between safety attitudes and safety climate is considered.

A number of models linking attitudes and behavior is outlined, highlighting inadequacies of oversimplistic models of attitude–behavior links. It is explained that it is necessary to know about very specific factors in attitude–behavior links before attitudes can be used as valid predictors of behavior. Also discussed are approaches that consider the influence of behavior upon attitudes, attitude–behavior consistency, and other factors that can affect both attitudes and behavior. More complex theories of attitude–behavior links are
next explored, including more detailed consideration of a range of factors that can influence behavior. These include: beliefs about how others view the behavior in question, beliefs about consequences of the behavior, attitudes toward the behavior, intentions, perceived risk of outcomes, and degree of control that the individual believes that he or she has over the behavior. The topic of attitude change is next addressed and is considered under the headings: audience, persuader, personality factors, presentation of issues, and persistence of change. Finally, specific studies on attitude and behavior change in health and safety, including a number of case studies, are described before the chapter conclusion. Relevant examples and illustrations in respect of health, safety, and risk are provided throughout.

6.2 Understanding attitudes

What is the relevance of attitudes to safety and risk scientist practitioners? One answer is that increasingly, safety and risk scientist practitioners are becoming aware that people’s attitudes and behavior toward risk and hazards sometimes need to be changed — and not just those of workers. Managers and employers may also require attitude and behavior change if there is to be a step change in making occupational health and safety (OHS) improvements. To change attitudes and behavior requires certain knowledge and skills. Safety and risk professionals know that they require skills that are as much to do with communicating, influencing, and negotiating with others, as with technical and legal knowledge and expertise in health and safety. They know that having technical expertise is of limited use if that expertise cannot be brought to bear through interacting with other people, both in the workplace and outside. This involves attempts to influence significant others (e.g., colleagues, managers, and workers) and this, in turn, can involve attitude change. Thus, like many other groups, safety and risk scientist practitioners seek to win hearts and minds in order to be able to carry out their tasks and functions effectively. Therefore they need some understanding of the nature of attitudes and attitude change and how these concepts relate to, and in some cases do not relate to, behavior. It is necessary to appreciate something of the complexity of the relationship between attitudes and behavior and also to be equipped with adequate models of this relationship that are of practical use.

Attitude is an example of a psychological concept that was long ago incorporated into everyday parlance, as for example, we might comment that someone has an attitude problem (perhaps meaning that we don’t agree with their point of view!) or that we need to change attitudes in order to improve health and safety (perhaps meaning that we don’t know what is wrong or what else to do and so this must be the solution!). Thus, attitudes are often ascribed the status of a cognitive (i.e., mental) force with the potential for either good or evil. Sometimes this force remains within an individual’s mind, while at other times it is represented as observable behavior. In other words, attitudes have the potential for influencing behavior on the assumption that some form of thought process always precedes action. In this scenario, the task is to discover what attitudes individuals (and groups, e.g., of managers or workers) hold and then to seek to change them in accordance with the agenda of another group (e.g., safety professionals) in order to improve their behavior. This is the simple and original theory behind attitudes and it is one still held by many people implicitly if not explicitly, namely, that if you can change people’s attitudes then you can influence the behavior that corresponds with those attitudes. Thus, much time and effort has been devoted to attempts to measure attitudes and to develop theories that will explain how attitudes may be changed and how they can account for behavior.
As we shall see in the course of this chapter, life is rarely as straightforward as would be suggested by this approach to attitudes. However, there are obviously links between attitudes and behavior and much work has been done in seeking to establish the nature of such links. This chapter explains some of the main attempts that have been made to elucidate attitude–behavior links and reviews their relevance to psychological components of safety and risk management. Attitudes are one type of individual factor (along with perception and personality, dealt with respectively in Chapter 3 and Chapter 5) that can influence behavior via motivation. Thus, some understanding of how attitudes exist and can be changed is important in appraising how such influences may operate.

6.3 The nature of attitudes

6.3.1 Definition

An attitude can be defined as a learned tendency to act in a consistent way toward a particular object or situation. This definition follows the approach to attitudes of a well-known pair of authors in this field, Fishbein and Ajzen (1975). The definition indicates that attitudes can be described as having the following features:

- Learned through social interactions and other influences (i.e., are not innate); an example of how such learning might occur in the health and safety field is given in Summary Text 6.1.
- A tendency to act — although there is no certainty that a person with a given attitude will actually act in any particular way; this behavioral component is explored at various places in this chapter.
- Characterized by a degree of consistency — we tend to have clusters of attitudes that are generally mutually consistent.
- Specific to a particular object or situation — that is, they should not be thought of as being generalizable to other objects or situations.

Thus, attitudes in the safety field need to be seen as specific to particular aspects of health and safety at work or elsewhere. Virtually everyone would say that they are in favor of high standards of workplace health and safety (i.e., people generally have a positive attitude toward health and safety), but this is not to say anything useful. For example, when piloting an attitudinal questionnaire on safety, Williamson et al. (1997) found that a large number of attitude items were so positively skewed that they had to be removed from the final questionnaire — illustrating both response set and a ceiling effect. Thus, we need to specify what particular aspects of health and safety people hold attitudes about, for example, following safe procedures, and then ensure that measurement instruments are designed with care. For example, an item such as “I always follow safety procedures” is likely to be widely endorsed and to be subject to the response bias of social desirability — in which respondents tend to reply in the way that they perceive will be acceptable to others. However, even knowing that a great majority of managers and workers hold positive attitudes toward following safe procedures does not mean that we can necessarily predict their behavior in situations that require them to do so. Why this might be so is dealt with in the course of this chapter when we consider various models of the attitude–behavior link.

The consistency aspect of our attitude definition affirms that the best predictor of future events is what happened in similar circumstances in the past. Thus, the best guide to a person’s current attitude to a situation (e.g., as measured on an attitude scale, see Section 6.3.4) is his or her past attitude (as measured on the same scale). Clearly, this has implications
Summary Text 6.1 Attitudes in the Construction Industry: An Illustration

Leather and Butler (1983) found that attitudes to safety in the construction industry differed depending upon whether a worker had ever personally experienced an accident injury. Compared with nonvictims, injury victims considered that construction work was inherently dangerous and that too much familiarity with the job (and reduced danger awareness) was a significant cause of injuries. They also thought that tiredness or fatigue contributed to injury causation and felt that their employers could do more to promote and safeguard their safety. In contrast, nonvictims — unable to rely upon firsthand experience of injuries — tended to stress the importance of their own behavior in controlling hazards at work in avoiding injuries. They felt positive about the power of their own decisions and behavior on safety matters — after all, their commonsense experience told them that these were reliable. These workers considered individual carelessness to be an important cause of injuries, took a positive view of their employer’s concern for safety, and were satisfied with the role of the safety officer at their place of work.

Thus, each group’s cluster of attitudes appeared to be related to their particular experiences — which influenced the affective or feeling component of their constellation of attitudes toward workplace safety. Attitudes expressed by the noninjury group may be seen to be subject to the fundamental attributional bias discussed in Chapter 3, whereby others’ injuries are attributed to carelessness. In contrast, injury victims’ attitudes were more likely to be subject to the availability bias as they would recall the circumstances of injuries that were within their personal experiences and the factors associated with them.

6.3.2 Attitude components

The three components that attitudes are commonly endowed with (Rosenberg & Hovland, 1960) are described in the following sections.

6.3.2.1 Affective

This means being concerned with feelings and emotions. For example, someone who has witnessed a traumatic injury is likely to feel more strongly about safety than a person who...
### Table 6.1  Psychological Variables and Influences

<table>
<thead>
<tr>
<th>Nature of variables</th>
<th>Examples of psychological variables</th>
<th>Examples of external influences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep-seated</td>
<td>Values, beliefs</td>
<td>Socialization, culture, learning, experience, group norms</td>
</tr>
<tr>
<td>Intervening</td>
<td>Personality, attitudes, perceptions, cognitions, emotions</td>
<td>Pressures, conflicts, rewards</td>
</tr>
<tr>
<td>Proximate</td>
<td>Motivation, intention, moods, attributions, views, opinions</td>
<td>Training, incentives, triggers, media information, discussions</td>
</tr>
<tr>
<td>Observable</td>
<td>Behavior</td>
<td>Environment, social norms, laws, conventions</td>
</tr>
</tbody>
</table>

### Summary Text 6.2  A Powerful Memory as a Safety Influencer

One of the authors remembers vividly an occasion as a child of about four years old, out walking with his father. “A few metres from where we were walking, a child about my own age fell face down from the passenger door of a moving car (this was before the days of seat belts, let alone legislation on such matters). The child’s (presumed) father stopped the car, gathered up the child — whose face I remember as being unrecognizable through the mass of blood — to ask my father directions to the nearest hospital. Such an experience — I could take you to the exact place where that event happened well over 50 years ago! — may have something to do with my own obsession with ensuring that my own children (and others who travel with me in a car) always had to wear seat belts on all car journeys (even before there was legislation on this). While I am not continually conscious of the event described above, I acknowledge the impact that it probably had on my subsequent behavior (early memories for, often violent, impact events can be very powerful in influencing our later behavior)”. The feeling (affective) component of an attitude can thus be very potent (see also Summary Text 6.13).

has not learned through such an experience. This is because of the powerful impact of the memory of how they felt when witnessing the event. For a personal illustration, see Summary Text 6.2. However, emphasizing the affective dimension is rarely a practical way of teaching people about safety.

#### 6.3.2.2  Cognitive

This is essentially concerned with the thinking aspect of an attitude; for example, having an attitude as to whether something is dangerous. This component can be influenced by a potentially wide variety of factors — for example, reading an article or seeing a powerful TV documentary on a risk-related topic or an anecdote related by a friend. This is where our risk cognition or risk perception apparatus comes into play (see Chapter 2). In its simplest form, we either consider that a particular event is or is not dangerous — for example, scary fairground rides, bungee jumping, or working at heights. Subsequently, we develop an implicit rank order of different risks (Slovic et al., 1979) as part of our risk cognition that
we may refer to when considering whether the perceived benefits of an activity more than compensate for the perceived risk involved.

6.3.2.3 Behavioral intention

This relates to the tendency to act component described above; this is the aspect by which the utility of the concept of attitude stands or falls. If attitudes can predict behavior then this behavioral intention component has utility value. Behavioral intention is an important component in some models of attitude-behavior links and relates to specific items, such as intending to acquire further training if you consider that a job or task you are doing is dangerous or intending to follow safety procedures more closely next time or intending not to perform the action again. Behavioral intention can involve imagining oneself engaging in the behavior that relates to that attitude.

While these three attitudinal components can be separately identified, the relationship between them may be problematic, as demonstrated by the experiments described in Summary Text 6.3.

Summary Text 6.3 Relationship between Attitude Components

Kothandapani (1971) studied the interrelationship of the three components of attitudes. However, Breckler (1984) considered that this interrelationship was only of modest proportions. Participants in an experiment were presented with a live snake and their reactions were recorded using verbal measures of the three attitude components. These were compared with their heart rate (affective component) and coping behavior (behavioral component — e.g., avoiding the snake).

In another study, participants were put through the same procedure but on this occasion they were merely asked to imagine that a live snake was present. Relying purely on verbal measures, interrelationships between affective, cognitive, and behavioral components of attitudes toward snakes were found to be higher than in the first study.

The findings can be explained in the following way. When you imagine a live snake in your presence, believed to be harmless (cognitive component), on the basis of verbal statements only, it might be presumed that you would not be afraid of it (fear being the relevant affective component in this case) and that you would be prepared to handle it (behavioral component). However, when actually confronted with a live snake, even a benign one, different reactions may well be seen, for example, heart rate increases, indicating increased arousal, probably fear or apprehension in this case and avoidance of the snake rather than handling it. Thus, it may be concluded that merely asking people to imagine what their reactions would be in a situation involving threat is not a valid predictor of their actual behavior or of their feelings in respect of the threat. Thus, the power of the actual situation in governing behavior (and attitudes) is paramount — a point that has been highlighted in a number of controversial psychological experiments in which ordinary people have been persuaded to deliver powerful electric shocks to others (Milgram, 1965) or have behaved brutally when in the role of guard toward fellow citizens playing the role of prisoner (Zimbardo, 1973). Given the powerful influence of a range of situations (e.g., war, opportunities to make money, or to exert power over others) it is clear that attitudes are only one source of influence upon behavior, and perhaps a very weak one.
6.3.3 Attitude dimensions

The main characteristics of attitudes, sometimes referred to as attitude dimensions, are as follows:

- **Valence** — the way in which the object of an attitude is evaluated, the degree of positive or negative feeling; this is what attitude scales are often designed to measure (see Section 6.3.4).
- **Multiplexity** — the degree to which an attitude is differentiated from other attitudes, for example, the extent to which attitudes about safety are differentiated from attitudes about health.
- **Breadth** — the number of attributes characterizing the object of the attitude, from very broad (e.g., workplace health and safety) to very narrow (e.g., a particular safety procedure).
- **Intensity** — the strength of feeling about an object (e.g., an injury that has been witnessed).
- **Stability** — how resistant to change (see Section 6.7.3.3).
- **Centrality** — how much the attitude is part of an individual’s self-concept or the extent to which a person feels that it reflects their identity (e.g., a safety and risk scientist practitioner feeling that holding safe attitudes is part of their self-concept).
- **Salience** — the degree to which an attitude occupies a person’s awareness from total preoccupation to complete absence (e.g., a safety and health practitioner might be considering safety issues all the time while at work, while most other people would not be).
- **Interrelatedness** — how related the attitude is to other attitudes (e.g., to form a consistent cluster of attitudes toward safety issues).
- **Behavioral expression** — the degree to which an attitude is acted upon (see Section 6.5 on attitude–behavior links).
- **Verifiability** — the extent to which an attitude can be checked against evidence (e.g., attitudes toward following safety procedures being verified by observing compliant behavior).

6.3.4 Attitude measurement

There are two main reasons for attempting to measure attitudes. First, we want to know not only whether a person has a positive or negative view of a particular issue or event, but also the strength of that feeling. Second, if we are seeking to change attitudes through some intervention (e.g., a safety campaign) then some objective measure is required to gauge attitudes before and after the intervention. A number of techniques for measuring attitudes have been devised and these can be divided into direct and indirect measures. An example of an indirect technique is to observe unobtrusively the behavior of a person — for example, by observing and recording their compliance with safety procedures in completing a particular task sequence. A measure of their attitude toward safety procedures may be taken as the amount of time that they follow them. The assumption here is that behavior is consistent with the attitude, although as indicated earlier, behavior may not always be a good guide to attitude. Better known measures of attitudes are direct measures, usually called attitude scales, which have been developed over many occasions of use and which are considered to be reasonably reliable (being a consistent measure on successive occasions of use) and valid (actually measuring attitude as opposed to something else). The most common types of attitude scale are described in the following sections.
6.3.4.1 Likert
This is the best-known type of attitude scale, the development and nature of which is described in Summary Text 6.4. It is designed to measure attitude intensity. Likert scales are relatively easy to construct and administer, but to be used as a valid measure of attitudes, require attention to scale item development so that items represent the best available measure of the attitude.

Summary Text 6.4 Developing a Likert Scale to Measure Attitudes toward Workplace Safety

Statements for inclusion in a Likert scale may be selected from previous similar studies or derived from experts and those knowledgeable about the study topics — for example, through interviews or focus groups. A reasonable number of items is required to represent the expected range of attitudes on the issue in question — for example, a minimum of 30 may be required for a scale for measuring attitudes to workplace safety. Sometimes both favorable and unfavorable items on the topic are included to avoid response set. However, one disadvantage is that negatively worded questions are more difficult to answer and can lead to data distortions and possible coding and transcription problems. The items listed below were included in a study of union and management attitudes to safety (Price & Lueder, 1980):

- Management plays a crucial role in providing a safe and healthy workplace
- No monetary value can be placed on human life
- Unions play a crucial role in providing a safe and healthy workplace
- There are times when production is at least as important as safety
- The benefits of safety outweigh its costs

Respondents indicate their degree of agreement or disagreement with each statement, usually on a 5-point scale such as: strongly agree; agree; neither agree nor disagree; disagree; strongly disagree. Larger or smaller numbers of categories may be used — for example, a 7-point scale for greater discrimination or a 4-point scale so that respondents cannot opt to be neutral about any item.

In developing a Likert scale, each respondent’s scores are totaled and the scores for all respondents on each item are then correlated with the total score — a procedure known as item analysis. The final scale should comprise those items correlating most highly with the total score — that is, those that measure most effectively what the whole scale is intended to measure — known as construct validity. Scales can be further refined through statistical techniques such as factor analysis, both exploratory and confirmatory, on sufficiently large samples, to produce robust and reliable scales that can be applied on subsequent occasions. Software is available for developing questionnaires for electronic (e.g., Internet) delivery and for transfer of data directly to files for computer analysis, which practically eliminates the possibility of transcription errors.

For a detailed description of the development of a safety climate tool, see Davies et al. (2001).
Chapter six: Attitudes, values, and risk behaviors

To indicate your views on the film you have just seen, please circle the number that is closest to your view for each of the pairs of adjectives listed below. There are no right or wrong views, just views. Go through the list fairly quickly trusting your first impressions. Please ensure that you circle one number on each line.

The film that I have just seen was in my view...

<table>
<thead>
<tr>
<th>Good</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credible</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Strong</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Sensational</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td>Fast</td>
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<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Figure 6.1 Sample items from a semantic differential (Osgood) scale measuring attitudes toward a safety film.

### 6.3.4.2 Semantic differential

Sometimes known as the Osgood scale after its originator, this type of scale can provide an indication of the strength of an attitude as well as information about its significance to the individual. Scales of this type have nine response points, which are anchored by a pair of polar opposite key words designed to measure aspects of three dimensions of an attitude toward some topic — evaluative, potency, and activity. For example, respondents may be asked to rate their attitudes toward a safety film using the bipolar adjectives shown in Figure 6.1.

### 6.3.4.3 Visual analogue

This type of scale comprises a set of attitude or behavior statements, obtained in similar fashion to those derived for other types of scales, which describe various examples of the attitude or behavior being explored, for example, road safety. Respondents are required to express their attitude to each illustration of the attitude or behavior by indicating on a single line of fixed length (usually 100 mm) their view of the attitude item in respect of whether it represents more or less safe or unsafe behavior. The total score on a number of items, perhaps 20 or more, represents that individual’s rating on the scale. An example item is shown in Figure 6.2.

There are other types of attitude scales and those described above require more detailed reading before use can be considered. Consulting a text on attitudes and attitude measurement (Oppenheim, 1992) is recommended.

### 6.4 Attitudes toward safety and risk

Researchers have focused upon measuring workers’ attitudes in relation to workplace safety and risk. Cox and Cox (1991) investigated attitudes toward a number of safety-related objects and activities, including safety software, people, and risk (but excluding safety hardware or specific hazards). They found that workers’ attitudes tended to cluster around
Please mark the scale below at the point that most closely represents your own view of the activity described. For example, if you felt that “overtaking a vehicle on the inside lane of a dual carriageway if there is a vehicle in the outside lane” is generally a rather unsafe manoeuvre, then you might mark the scale as indicated below.

Overtaking a vehicle on the inside lane of a dual carriageway if another vehicle is occupying the outside lane is generally...

Very safe / Not at all safe

Figure 6.2 Example of a visual analogue scale item measuring attitudes toward driving safety.

the following five dimensions:

1. Personal skepticism (unconstructive belief)
2. Individual responsibility (constructive belief)
3. Safety of the work environment (evaluation)
4. Effectiveness of safety arrangements (evaluation)
5. Personal immunity (unconstructive belief)

Safety attitudes were either related to unconstructive/constructive beliefs or to evaluations of the workplace. Personal beliefs about risk and safety included: immunity (e.g., injuries only happen to other people) and skepticism (e.g., if I worried about safety I would not get my job done). People’s attitudes toward injuries will be influenced by previous experience, perceived likelihood of injury, and knowledge of the ways in which injuries occur (Donald & Canter, 1994), as well as individual dispositions, such as the personality variable safety locus of control (Jones & Wuebker, 1985), which reflects the extent to which an individual believes that they have control over external events in the safety domain. Individual responsibility, described as a constructive belief by Cox and Cox (1991), included items such as, “Safety equipment should always be worn”. Safety attitudes derive from the extent to which processes or events are perceived as hazardous (see Chapter 2, on risk perception) — thus, evaluations of the working environment will shape attitudes. Cox and Cox (1991) noted two dimensions of evaluation: satisfaction with safety measures (e.g., procedures, rules and regulations, evacuation drills) and the work environment/job conditions.

Given that attitude development depends on social context (see Section 6.6), assessment of people’s safety attitudes should focus not only on individual values and beliefs, but also on their perceptions of others and upon others’ attitudes, such as those of coworkers, supervisors, and managers. Williamson et al. (1997) reviewed the literature on safety attitudes and identified the following eight aspects:

1. Safety awareness — attitudes to hazards and risks, and the possibility of personal work injury
2. Safety responsibility — attitudes about whose role it is to ensure workplace safety
3. Safety priority — beliefs about the importance of workplace safety
4. Management safety commitment — perceptions of management commitment to safety
5. Safety control — attitudes to injury controllability
6. Safety motivation — attitudes and perceptions relating to influences that motivate safe and unsafe behavior
7. Safety activity — perceptions of the individual’s own safe behavior
8. Safety evaluation — perceptions of safety in the individual’s own workplace
The main reason why workers' attitudes toward safety are important is that attitude measures have been shown to be significantly correlated with self-reported injuries, such that individuals who hold more positive attitudes are more likely to remain injury free (Donald & Canter, 1994). The association between safety attitudes and injuries is assumed to exist because attitudes act as a precursor to behavior, thus more negative safety attitudes lead to a higher frequency of unsafe acts, and therefore increase injury likelihood. However, safety attitudes may be an important antecedent of safety performance through other pathways; for example, Schroder (1970) argued that the more mature the safety attitudes of workers, the more likely they are to search for safer environments (hence unsafe behavior would decrease). In order to develop a better understanding of how safety-related attitudes might influence injury likelihood, the attitude–behavior relationship is considered in more detail under the heading below.

6.5 Attitudes and behavior: some theoretical perspectives

Everyone has theories about such everyday things as attitudes and behavior. For the most part, our commonsense theories are not in our conscious minds and therefore generally remain unarticulated. However, it is useful to identify the theory, or more appropriately model, that you use to explain attitudes and behavior because this makes explicit the assumptions you make about other people's attitudes and why you think they behave as they do. Typically, everyday models we use take one of the forms described in the following sections.

6.5.1 Attitudes influence behavior

If we know a person's attitude to something (e.g., following safety procedures) then we can predict their behavior toward it, which can be expressed diagrammatically as in Figure 6.3. However, merely expressing positive attitudes about following safety procedures is not sufficient to change people's behavior with respect to actual compliance, although it is one component of desired behavior change. Evidence suggests that we should be cautious of any simplistic "attitudes influence behavior" type of model as a complete explanation of the attitude–behavior link. An example of this model type is described in Summary Text 6.5 — see also discussion on attitude change (Section 6.7).

6.5.2 Behavior influences attitudes

If we wish to change people's attitude toward something (e.g., following safety procedures) then we might achieve this by obliging them to behave in a particular way, for example, by passing legislation or making a rule and enforcing it — see Figure 6.4. This type of model about the nature of the attitude–behavior link can provide the basis for certain types of legislation, in health and safety and in other fields. According to cognitive consistency theory (see Summary Text 6.6), if we are obliged (e.g., by law) to behave in a

\[\text{Influences/predicts}\]

\[\begin{align*}
\text{Attitude} & \quad \text{(e.g., "observing this safety procedure makes sense")} \\
\text{Behavior} & \quad \text{(person is seen to observe the safety procedure)}
\end{align*}\]

\[\text{Figure 6.3 A simple model of the attitude–behavior link.}\]
Summary Text 6.5 Example of a Theory Maintaining that Attitudes Influence Behavior

Fazio (1986) maintained that an attitude influenced behavior by selectively activating various thought processes held in the person’s memory. This produces selective perception of the object related to the attitude in question. For example, if you hold a positive attitude toward injury prevention, this could mean that you are more likely to think consciously about positive precautionary measures. Any focus on these measures (e.g., via a safety campaign) will then shape your selective perceptions of what precautionary measures exist to prevent injuries. These processes can then influence a decision to act in the context of injury prevention. According to Fazio, an attitude is anchored in previous positive and negative experiences but it selectively influences the memory of these influences, rather than being influenced by them when deciding on a course of action. Therefore, individuals with different attitudes when confronted by a particular scene or events are likely to see different aspects of the situation as salient or important.

![Figure 6.4](image_url) An alternative model of the attitude–behavior link.

certain way, then whatever our initial attitude toward the topic of the legislation (e.g., seat belt wearing), in order to remain consistent we change or attitude so as to correspond with the newly required behavior. An alternative interpretation (Bem, 1967) is that we frequently determine what our attitudes are by observing our own behavior (self-perception). For example, if people repeatedly take various safety precautions at work (safe behavior or habit) they might conclude that they possess positive safety attitudes. Self-perception theory maintains that a person forms attitudes through observing his or her own behavior. Chapter 3 provides an example of how behavior modification can lead to attitude change.

6.5.3 Attitudes and behavior are mutually reinforcing

If we change either one then this is likely to lead to a change in the other. This relationship is represented by Figure 6.5 (amalgamating Figure 6.3 and Figure 6.4), which shows that attitudes influence behavior and behavior influences attitudes. This approach reflects one obvious conclusion from the dual premises represented in the two unidirectional models already described. This model thereby represents an advance on the previous two and is characterized by the notion of attitude–behavior consistency. The notion of consistency, congruity, or balance underlies such theories as those of Festinger (1957) on cognitive dissonance, the basic premise being that people strive to make their attitudes and behavior consistent (see Summary Text 3.8). Summary Text 6.6 illustrates a case of the attitude–behavior link from a cognitive consistency perspective.
Summary Text 6.6 Cognitive Dissonance: A Health Example

An example of behavioral change can be drawn from the spouse of one of the authors, who stopped smoking (reducing a 20-year habit of 40 cigarettes per day to zero) following a serious bout of pneumonia. The shock of experiencing such a life-threatening episode was sufficient to change the behavior, but a more negative attitude toward smoking has been much slower to follow (spouse still believes that smoking reduces stress, is enjoyable, etc., despite it being harmful).

Figure 6.5 A mutual influence model of the attitude–behavior link.

Figure 6.6 A third factor consistently influences both attitude and behavior.

6.5.4 Attitudes and behavior are likely to be mutually consistent, but independent

If we want to change either attitudes or behavior, it is necessary to address both independently — that is, to consistently and deliberately influence attitudes on the one hand and behavior on the other. The fourth type of model is based upon the premise that while there may be consistency between attitudes and behavior, this is not necessarily a basis for judging one to be a prime causal agent in respect of the other. Thus, while the importance of cognitive consistency is implicitly acknowledged, the possibility of additional factors that could influence both attitudes and behavior is considered. Figure 6.6 illustrates this type of model of the nature of the attitude–behavior link.

Figure 6.6 shows that an underlying factor, for example, a safety campaign, might be designed to address relevant attitudes and behavior of a section of the workforce. A simple
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Provide safety information plus safety awareness campaign (see e.g., Summary Text 6.14) 

To influence cognitions and produce

Attitude change

Mutually supportive

Continue to monitor

Training/instruction plus feedback to reinforce behavior (see e.g., Summary Text 6.15) 

To influence behavior and produce

Behavior change

Figure 6.7 Example of health and safety intervention strategy.

Example might be that incentives, perhaps in the form of bonuses, are given for achieving a certain safety index score. This might be a combination of a safety audit score at a specified level, a given housekeeping level as revealed by successive workplace inspections, and an injury rate target achieved. To reinforce this attempt to influence behavior, a reminder system is used, for example, a combination of posters showing an appropriate message, toolbox talks with supervisors, and personally addressed letters. Such a campaign would be a variant on the marketing approach to influencing consumer behavior whereby advertising messages designed to influence attitudes toward a product (but not necessarily to make people buy it) are reinforced by promotional activity, such as offers of free flights or price reductions when the consumer enters the store to buy. This approach to health and safety may be represented in a general strategic model, as shown in Figure 6.7. It shows that in order to effect change in workplace behavior in respect of health and safety, it is necessary to address both cognitions (e.g., attitudes, perceptions, motivation) and behavior directly in order to make progress. This approach to the attitude–behavior link tends toward more sophisticated models, such as the theory of planned behavior (TPB) and the health belief model (HBM) described under the next heading.

What would be valuable would be to specify the conditions under which attitudes are likely to influence behavior. In a review of over 100 studies of attitude–behavior links, Ajzen and Fishbein (1977) considered that four particularly important factors were involved in this relationship: action, target, situation, and time frame. An illustration of the health and safety implications of this review is provided in Summary Text 6.7. The main conclusion to emerge from Ajzen and Fishbein’s (1977) study is that it is possible to predict behavior if attitudes are known, providing that the attitudes are highly specific in respect of that behavior. By the same token, if we are seeking to change behavior by the route of attitude change, then we must address those attitudes that are directly and specifically related to that behavior.

6.6 More complex approaches to attitude–behavior links

6.6.1 The theory of planned behavior (TPB)

The importance of motivational factors in the attitude–behavior link have been elaborated within social psychology in the theory of reasoned action (TRA) and in a later adaptation of this theory, the theory of planned behavior (TPB) (Fishbein & Ajzen, 1975; Ajzen, 1985,
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Summary Text 6.7 Important Factors in the Attitude–Behavior Relationship

- Action. The closer the correspondence is between the activity that is the object of the attitude and the behavior, the greater is the likelihood that the behavior will be influenced by the attitude. For example, in seeking to predict or to influence behavior with respect to wearing hearing protection in noisy environments attitudes toward this specific activity should be addressed.

- Target. The closer the target behavior is under scrutiny to the attitude that is being addressed the greater is the likelihood of attitude change. For example, if it is sought to predict or to influence behavior in respect of following safety procedures, then it is attitudes toward following safety procedures that should be addressed. Seeking to change specific behavior by reference to general attitudes — for example, to health and safety — is unlikely to be effective. Thus, campaigns that focus upon the particular attitude–behavior link (e.g., in respect of certain safety rules, such as wearing protective headgear) are more likely to be successful than those seeking to effect behavior change through generalized attempts to change attitudes.

- Situation. The context within which attitudes and behavior are linked should be as near identical as possible. Thus, attitudes about following safety procedures will not necessarily transfer between situations. This means that if we are seeking to influence behavior in a particular context — such as a given part of the workplace, then it is attitudes toward following safety procedures in this part of the workplace that need to be considered.

- Time frame. For influence to occur it is important that the link between the behavior and the associated attitude is as temporally close as possible. Thus, a past attitude is less likely to influence a given behavior than a currently held attitude. For example, a once-held negative attitude toward following safety procedures will probably be less influential than a positive one that is held at present.


1988). The TPB model (shown in diagrammatic form in Figure 6.8, incorporating a safety example) argued that behavior could be predicted if we know the following four features:

1. The individual’s attitude to the particular behavior
2. The individual’s intention to perform that behavior
3. What he or she believes are the consequences of performing that behavior
4. Social norms (socially acceptable behavior) that govern the behavior

The theory of planned behavior (Ajzen, 1991) extends the TRA model by adding an individual control component that is influenced by the person’s evaluation of factors likely to inhibit or facilitate their performance of the behavior. Behavior is predicted by behavioral intention, which in turn is determined by a combination of three factors: attitude to
Beliefs about how others view the behavior (e.g., how do other workers view following safe procedures) — affects my motivation to comply

Evaluation of beliefs about consequences of the behavior (e.g., what others will think of me for following safe procedures, how the behavior will protect me from harm) outcome evaluations

Perceived degree of personal control over the behavior ("can I exert control in these particular circumstances?" — see e.g., Figure 3.1)

Subjective norm (my perception of the general standard for following safe procedures in this workplace)

Attitude toward the behavior (either positive, neutral, or negative toward me following safe procedures)

Behavioral intention (to follow safe procedure)

Behavior (follow safe procedure)

**Figure 6.8** Theory of planned behavior. (After Fishbein & Ajzen, 1975; Ajzen, 1985, 1988.)

behavior (the individual’s attitude toward performing the behavior), subjective norm (the individual’s perception of the normative pressure to perform the behavior), and perceived behavioral control (the individual’s perception of the degree to which performing the behavior is under his or her volitional control). An individual’s attitudes are determined by two factors — the individual’s beliefs about the consequences of the behavior (both positive and negative) (behavioral beliefs), and the individual’s evaluations of those outcomes (outcome evaluations). The influence of subjective norms is determined by the individual’s perceptions of the extent to which significant others think he or she should engage in the behavior (normative beliefs) and his or her motivation to comply.

The TPB model has been expanded (Manstead & Parker, 1995) and tested extensively in relation to driver behavior. For example, Parker et al. (1992b) demonstrated the TPB model’s ability to predict driving violations in a sample of 881 motorists. Interestingly, the influence of the social context, in the form of subjective norms, was more powerful in predicting behavioral intentions than an individual’s own attitude to their behavior. In the case of behaviors that are antisocial or attract social disapproval, it has been suggested that personal norms are also influential. Parker et al. (1995) examined the impact of adding the variables anticipated regret and moral norm to the prediction of motoring violations (including cutting across traffic to leave a motorway and overtaking on the inside). The study illustrated that adding these variables significantly improved the model’s ability to account for the behaviors.

The theory of planned behavior is a general theory of the relationship between attitude and behavior, and so it may be difficult to encompass all instances where the attitude–behavior link breaks down. A more specific approach in relation to predicting health behaviors, the health belief model, is considered below. In its original form, the TPB model is also a cognitive theory. In reality, actions are not always rational because
they are subject to emotional factors as well as to rational appraisal; this has been acknowledged in extensions of the model, which have included the influence of affect, such as anticipated regret (Parker et al., 1995) and affective beliefs (Parker et al., 1998). In the latter study, the role of affect in the commission of aggressive driving behavior was examined in two scenarios, one in which the respondent is described as retaliating to aggressive behavior on the road (deliberately slowing down a following vehicle that is tailgating and flashing its headlights) and the second, where the respondent is described as initiating a road rage incident (giving chase to a car that has cut in front of you, forcing you to brake sharply, and gesticulating/verbally abusing the driver). In both cases, consideration of affective beliefs predicted behavioral intentions over and above the elements of the TPB model. Overall, beliefs and attitudes toward retaliatory aggressive driving accounted for 30% of the variation in committing aggressive violations. Those who reported relatively high levels of retaliatory road rage had more positive attitudes toward aggressive driving, perceived more social support for aggressive driving, experienced greater feelings of positive affect, and less control in terms of being able to refrain from retaliating behavior.

Although affect accounted for a small but significant proportion of the variance, the key psychological variable was perceived behavioral control. The TPB model, including affective beliefs, was most significant in predicting aggressive violations in relation to beliefs and attitudes toward initiating road rage, where 40% of the variation was predicted. This may reflect the more considered nature of initiating an aggressive act (i.e., more deliberately planned) compared with being provoked to respond to aggressive behavior from others.

Rothengatter’s (2002) criticisms of the way in which the TPB model has been applied, particularly in respect to driver behavior in the field of traffic and transport psychology, are as follows:

- TPB model has been used primarily to predict self-reported behavior or stated behavioral preferences, rather than actual behavior; this may lead to lower correlations between attitudes and behavior than those generally cited in the literature.
- Much application of the TPB model has been in isolation from environmental factors, on the assumption that the influence of environmental changes on behavior will be mediated by attitude change (or a change to one of the other model components). Yet there is evidence to suggest that drivers adapt their behavior to different environmental conditions, with little impact on their attitudes. For example, Åberg et al. (1997) demonstrated that drivers’ attitudes toward speeding hardly differentiated between different road types, suggesting that behavioral adaptation is a direct result of environmental change and is not mediated by attitude change.
- The model determines that attitude change should precede behavioral change, but this has not been confirmed in applied settings, such as traffic.
- Factors such as habitual behavior, which are not accounted for in the theory, have proven more powerful than attitudes in predicting behavior (Verplanken et al., 1994).

After analyzing numerous studies of the TPB, Armitage and Conner (2001) were complimentary about the TPB, though they found that subjective norm was not as influential as the other variables. This could mean that people were not prepared to accept that social norms influenced them in a significant way, which is likely to be prevalent in individualistic societies, such as the United States. After analyzing some studies, Bohner and Wanke (2002) concluded that the TPB is superior to the TRA in predicting behavioral intentions
(and behavior) when the behavior under study is difficult to perform, while other studies indicate that this is not true for behaviors that can be performed easily.

Thus, whilst the TPB model has had limited success in accounting for behavior, for example, in the domain of traffic psychology, there has been little application in more general health and safety areas. In terms of safe and unsafe behaviors at work, studies have focused upon safety attitudes, most often within the context of safety climate (see Section 6.8), but rarely within a reasoned action framework. Although perceived behavioral control has emerged as a particularly influential factor in determining driver behavior, in a work context, where individuals often work in team settings, other factors are likely to be more influential, including others’ behavior (subjective norms). Workers may be more likely to follow safe procedures in response to pressure from social norms — for example, colleagues expecting them to behave safely rather than because they have a positive attitude to following procedures or because they harbor an intention to follow them. A consideration of attitudes operating at different levels is taken up in Section 6.7.2. Other factors that might promote continued compliance with safety procedures include a desire to obey (safety) rules and developing a particular safety habit.

The roles of previous behavior, frequency of the behavior, and habituation have been the subject of debate. There is evidence to suggest that models such as TPB are less powerful in predicting high-frequency behaviors that demonstrate habituation responses. For example, Knapper et al. (1976) investigated attitudes toward car safety belts, the results indicating an overwhelming tendency for respondents to express positive attitudes toward the use of seat belts and confidence in their effectiveness; yet these attitudes existed irrespective of whether respondents claimed to use seat belts. A significant finding was that the main factor responsible for claims by respondents that they were using seat belts was not simply a matter of having a positive or negative attitude, but was predominantly governed by the habit of using a seat belt, a finding confirmed in a qualitative study of young drivers by Glendon (2005). Similarly, Verplanken et al. (1994) when examining choice of travel mode (car vs. train) found that the attitude–behavior link was weak when habitual behavior was strong, and conversely, that attitude was only a good predictor of behavior when habit was weak, suggesting that habit strength moderated the attitude–behavior relationship. Another example, which may well extend to compliance with safety rules and regulations, is drivers’ compliance with speed limits. Åberg et al. (1997) found that more than 50% of drivers in their study exceeded the speed limit and a majority of them overestimated the speed of other drivers. Perceptions of other drivers’ speeding, as well as attitudes toward speeding, were significant predictors of exceeding the speed limit. In their study of 598 drivers, Elliot et al. (2003) illustrated the moderating effects of habitual behavior by finding that prior behavior moderated the perceived control–intention and perceived control–subsequent behavior relationships.

6.6.2 The health belief model (HBM)

The HBM (Becker, 1974; Becker & Rosenstock, 1987) is a widely used model for behavior change, and has been used as the basis of many campaigns seeking to change people’s behavior to a healthier way of living. Janz and Becker (1984) reviewed some of these studies, while Harrison et al. (1992) reported on the success of the HBM in predicting health behaviors and outcomes. Summary Text 6.8 outlines the essential points of the HBM, while Figure 6.9 shows this approach to the (health) attitude–behavior link in diagrammatic form. Costs and benefits in the HBM are analogous with the element of perceived control in TPB, which is influenced by the person’s evaluation of factors likely to inhibit or facilitate their performance of the behavior, and are also reminiscent of the costs and benefits components of (risk homeostasis theory) RHT, described in Chapter 2.
Summary Text 6.8 The Health Belief Model

The HBM offers insight into aspects of human perception and experience that need to be addressed if behavior is to be changed in the direction of greater health and safety, specifically the likelihood that an individual will take some form of preventive behavior to improve their health or safety (e.g., wear a hard hat to protect their personal safety or reduce/stop smoking to improve their health). Two main factors influence such behavior; first the individual considers the perceived benefits and disadvantages of taking the action and second the person has a view of the threat that is posed.

An example of taking preventive action to preserve safety might be following safety procedures at work. In taking the decision to comply or not to comply, the individual assesses the perceived benefits (e.g., praise from supervisor for working safely and reduced likelihood of being injured) and weighs these against the barriers (e.g., task taking longer to complete and ridicule or disapproval from coworkers). Benefits and barriers perceived by the individual will be based upon personal experience, education, and other factors.

The individual also assesses the threat to their health or safety and in so doing considers their own personal susceptibility to the disease or condition against which they might protect themselves and their perceived severity of the condition should they succumb. This assessment is also influenced by their experience, background, and other factors. The perceived threat of the condition will also be influenced by cues to action, for example, posters, articles in newspapers, reminders from work colleagues, or again, past experience.

In applying the HBM to any health or safety campaign or attempt to change behavior so that it reduces the risk to the individual, the factors described below need to be addressed if the campaign is to stand any chance of success:

- Ensure that the perceived benefits of taking the action are greater than the perceived barriers — for example, highlight positive aspects and attend to any disadvantages, for example by intervening at a group level, so that coworkers support each other in adopting changed work practices.
- Emphasize that the target audience is susceptible (and demonstrate this whenever possible) and also the severity of the long-term condition — not forgetting to explain how the condition can be avoided.
- Provide appropriate cues for action, for example, posters at strategic points, supervisors giving reminders, and reinforcing workers when safety procedures are followed. This also serves to demonstrate that individuals have control over the situation and that they can take responsibility for their health and safety.

6.6.3 Protection motivation theory

A related model, protection motivation theory (Beck, 1984; van der Velde & van der Plight, 1991) considered that health behaviors were affected by the following factors:

- Perceived severity of outcomes
- Probability of outcomes
Perceived individual susceptibility to disease plus perceived severity of outcomes (e.g., heart disease, stroke — see e.g., Figure 3.1)

Cues to action — for example, media information, advice from friends or relatives, reminders, medical checkups, feedback from blood tests, consultations with doctor

Perceived risk — for example, of self getting heart disease, stroke, other outcome

Perceived benefits of taking preventive action — for example, improved health, greater longevity, better quality of life for self and family MINUS perceived barriers — for example, enjoyment of current diet and lifestyle, trouble making changes to dietary and exercise habits

Likelihood of taking relevant health-related actions — for example, changing diet, taking more exercise

Other variables — for example, age, sex, social background, education

Figure 6.9 Health belief model with illustrative health example. (After Becker, 1974.)

- Efficacy of behavior
- Expectation that the individual will be able to carry out the behavior

The first two of these factors relate to the individual’s perceived risk, while the third and fourth factors relate to the likely effectiveness of any individual intervention (akin to perceived control). Protection motivation theory introduced the important notion that attitudes and perceptions are linked to behavior through motivational processes. The four components combine through the notion of protective motivation, which arouses, sustains, and directs activity to protect the individual from danger. This theory is described in Figure 6.10, together with safety-related examples. Floyd et al. (2000) reviewed research on protection motivation theory.

6.6.4 Overview of complex models describing attitude–behavior links

The complex models described above are examples of social cognition models and all emphasize the rationality of human behavior. They are useful in respect of identifying key variables that link attitudes and behavior in the health and safety (and other) fields in a coherent and structured way. They have been tested and found to have some validity when used as a basis for interventions (Sheppard et al., 1988; Six & Schmidt, 1992; Parker et al., 1995). This is because they help to identify relevant factors that need to be addressed, for example, in safety or health campaigns. However, such models tend to ignore nonrational and emotive aspects of human functioning and also behavior that is governed more by
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Perceived severity of outcomes (e.g., reduced hearing ability) X Probability of outcomes (may be difficult to assess, perhaps considered to be "possible")

Perceived risk

Plus

Perceived efficacy of behavior (e.g., need for involvement in selection, training for use, and confidence in PPE effectiveness and maintenance) X Expectation that person will be able to engage in the behavior (individual must be aware of their responsibility for action)

Equals

Effectiveness of individual intervention — that is, person’s perceived control over the situation

Gives rise to

Protective motivation — work environment arouses, sustains, and directs (i.e., motivates) PPE use

And results in

Behavior — person uses PPE to protect themself from danger, in this case hearing loss

Figure 6.10 Protection motivation theory. (After Beck, 1984; van der Velde & van der Plight, 1991.)

habit than by reason. For example, health-related behaviors, such as smoking, alcohol consumption, exercise, and diet, are frequently at odds with attitudes. Thus, in spite of the assumption of cognitive dissonance, people may continue to engage in behavior that they know is damaging to their health. One factor is that for some smokers, their behavior is physically determined (i.e., nicotine addiction) and thus beyond the reach of influence through persuasion, as well as being functional in countering stressful conditions (Eiser & van der Plight, 1988). In addition, while smokers tend to emphasize short-term benefits of smoking, nonsmokers tend to focus upon long-term consequences of smoking (Eiser & van der Plight, 1982) — an example of the time frame component of the attitude–behavior link referred to by Ajzen and Fishbein (1977). External factors also tend to be ignored, such as the social skills required to carry out certain types of behavior (e.g., refusing cigarettes in social situations) and complex interactions between individuals in the settings in which the behavior occurs. Thus, the models assume that individuals are highly motivated to think about health-related behavior, whereas in reality there will be competing, and frequently conflicting, attitudes and behaviors to consider.

Thus, while these models can help to unravel some of the main factors influencing behavior, including attitudes, they do not yet include all relevant factors. Some authors (Connor, 1992; Schwarzer, 1992) have produced integrated reviews, from which it is possible
Summary Text 6.9 Main Factors Influencing Behavior in Respect of Health, Safety, and Risk

Behavior only
- What is the social context (e.g., norms) for the behavior?
- What are the person’s habits in respect of the behavior? (past behavior is a good guide to future behavior)

Attitude and behavior
- What is the nature of any social pressure in respect of the behavior?
- What factors are likely to inhibit or facilitate the behavior?

Attitude only
- What is the person’s attitude toward the behavior?

Attitude and perception
- What are the costs and benefits of taking a given set of actions?
- What do relevant others think about the behavior?

Perception only
- What are the various outcomes possible?
- How severe are the respective outcomes?
- How likely are various outcomes?
- How much control does the individual have?
- How effective is the individual’s behavior likely to be?
- What reminders are there?

Perception and motivation
- Are there differences between long-term vs. short-term benefits and costs?

Motivation only
- What is the person’s intention in respect of the behavior?
- How important is this behavior to the individual?
- What is the person’s motivation to comply with social pressure?
- What are the emotional reactions to the decision and subsequent behavior?

Behavior, attitude, perception, and motivation
- What are the individual’s personal characteristics (e.g., age, gender, background, and experience)?


to develop a list of the main factors, including those not in the models, which influence behavior in respect of health, safety, and risk. These factors fall under four overlapping headings: attitudes, perceptions, motivation, and behavior, and are outlined in Summary Text 6.9. The components in Summary Text 6.9 can be used as a checklist of items in all circumstances when a change in behavior is sought. It will be seen that not all influences upon behavior are attitudinal in nature and that perceptions and motivations as well as past behavior all play a part.
6.7 Attitude change

The review thus far has indicated that attitudes and behavior have a cyclical relationship; one follows the other in a continuing process. This section considers some of the main factors that affect attitude change. Aspects of this process have already been considered in the form of cognitive consistency theory — the notion that we seek to make our attitudes and behavior mutually supportive (see Summary Text 3.8). Attitudes can be changed and a number of processes are responsible for bringing about change. A new attitude may be adopted for an ulterior motive, such as a desire to make a favorable impression on a boss or a client or to develop a relationship with someone whom you value. These are examples of the instrumental function of attitudes (see Section 6.7.1). The new attitude may then be embraced as part of your cluster of attitudes toward that party. Membership of a group or organization, whereby a person is influenced by prevailing practices can also contribute to a change in attitudes; for example, when a worker joins an organization whose employees are committed to following sound and progressive safety practices (see also Chapter 8). To understand how to change attitudes, we first consider attitudes in terms of their functions and levels.

6.7.1 Attitude functions

Attitudes are generally considered to perform a number of functions (Katz, 1960). First, they have an instrumental function, serving certain ends and enabling us to obtain reinforcement for our desires and requirements. Thus, a positive attitude toward people and events is developed with the purpose of satisfying an individual’s needs, while negative attitudes are more liable to thwart those needs. Attitudes are also held to have an ego defensive function, whereby they permit expression of defense mechanisms by an individual. For example, people may use their attitudes as a means of protecting themselves from certain harsh realities, such as that they are working in a dangerous environment or are pursuing behavior that presents a risk to their health. Another function of attitudes is the value expressive function whereby attitudes permit people to express the concept that they have of themselves. Thus, attitudes are part of an individual’s self-concept, for example, considering themselves to be safe or normal or independent partly on the basis of the attitudes that they communicate to themselves and to others. Attitudes also serve a knowledge function, being a prime means by which people can order their environment and through which they are able to make sense of and react consistently and meaningfully to the world around them. Without some degree of stability in the way in which we perceive the world we would encounter many problems in our personal relationships and our interpretation of events. When a person finds that an attitude, or a set of attitudes, is no longer functional in dealing with the situation in which they find themselves, he or she could well question existing attitudes in the light of new information and, as a result, bring his or her attitudes more in line with reality. Circumstances under which attitude change is most likely are dealt with in Section 6.7.3.

6.7.2 Attitude levels

6.7.2.1 Compliance

In considering the social influences that impact upon individuals in respect of whether they will adopt particular attitudes and behavior, it is also useful to consider the levels at which attitudes and behavior are formed. Kelman (1958) developed a useful categorization. The first level of attitude/behavior is that of compliance. Here a person accepts influence from another party because they hope to achieve a favorable reaction from them, for example,
attaining certain rewards or avoiding punishments. In the safety field, an example would be a worker complying with certain safety rules either because he or she wished to please the supervisor or because the rules were strictly enforced and would evoke sanctions, including eventual dismissal, for noncompliance. However, the attitude–behavior link in this case is not strong because of the possibility that once the reasons for compliance are removed (e.g., a new supervisor arrives who is less readily pleased or the rules are less strictly enforced because of increased production pressure), complying behavior tends to lapse. In this example, the attitude–behavior link is weak because behavior results from external pressures rather than from internal beliefs.

6.7.2.2 Identification
The second level is identification, which occurs when an individual adopts behavior that is derived from another party because of their relationship with that party. A good example would be group norms, whereby a person follows safety procedures because others in the group do and the person values their relationship with other group members. The behavior in this case is likely to continue as long as the individual remains with that particular group. However, if they transfer to another job and become part of another group with different norms (e.g., for noncompliance), again the behavior could be susceptible to change in response to changing circumstances (i.e., they now value maintaining their relationship with the new group). Group relationships are considered in greater detail in Chapter 8. The attitude–behavior link in this case essentially depends upon external factors, in this case social relationships, for its continuation, and is liable to decay if these change.

6.7.2.3 Internalization
The third level at which attitudes may be expressed is that of internalization. In this case, a person adopts a particular behavior because of its functional value or because it accords with their existing belief system. At this level, the attitude–behavior link is at its strongest because, whatever external factors operate, an individual engages in the behavior because they believe that it is correct, irrespective of rules or what others choose to do. Thus, in our example a worker would comply with safety procedures because he or she knew it to be the right thing to do — it was consistent with his or her own internal belief system about safe behavior.

6.7.2.4 The importance of attitude strength
There are practical lessons to be drawn from this simple theory about levels of the relationship between attitudes and behavior and the influences upon them. The critical point about promoting a desired behavior is that the individual (whether worker or manager or whoever) must believe that it is correct, in other words should have internalized the attitude–behavior link. This link should be independent of any external factors. If the entire workforce has developed this belief system, the group norm for safety will apply throughout and will serve to reinforce individually held attitudes. Rules and sanctions can then reinforce still further the appropriateness of these attitudes and behaviors. For example, in working with electricity or with other high-potential energy sources, trained individuals take all necessary precautions because they know the danger and behave accordingly. Group norms as well as rules and procedures reinforce and guide these beliefs. Thus, there is a coherent and consistent system of company rules and regulations, individual attitudes, and group behavior. Organizations that can successfully achieve the mutual reinforcement and confluence of attitudes and behavior at these three levels will have taken a vital step along the road toward a positive safety culture (see Chapter 11). However, seeking to change
behavior by imposing rules and regulations, without changing attitudes, is much less likely to be successful (see the model in Figure 6.4).

6.7.3 Attitude change interventions

The mass media — press, radio, and television, is often held responsible for attitude change, particularly when recipients of media messages have opportunities to discuss the issues involved with people whose opinions they have confidence in and who find the message acceptable — see discussion on the social amplification of risk in Chapter 2. Campaigns may be mounted via the media that have a strong safety message, for example, the safe sex message presented by the U.K. Government in the late 1980s in relation to AIDS (don’t die of ignorance). Such campaigns may have some influence upon attitudes, which begin by being unformulated or are at odds with those implied by the campaign, but are more likely to be effective in reinforcing existing attitudes that are consonant with the message. Appealing to important motives and needs of the target group is likely to be the most effective way of promoting attitude change within this group. A comprehensive set of studies was carried out at Yale University during the 1950s and 1960s, findings from which have formed a generally accepted set of criteria for effecting attitude change, which are outlined in the following sections.

6.7.3.1 Audience

Audiences generally self-select; that is, they make decisions in respect of messages to which they choose to expose themselves. This is important for the communicator of any message to remember, regardless of the field (e.g., marketing, safety). Thus, to communicate a message aimed at changing attitudes, you need to address this to your audience on their home ground. It is also important to remember that members of an audience will have an existing network of interconnected attitudes and that it is helpful to know what these are, for example, by measuring them (see Section 6.3.4), in order to be able to identify those where change is desired and to measure whether any change has taken place. It is also necessary to accept that because there are individual differences, it is unlikely that you will be able to change the attitudes of every person in an audience at the first attempt. Important considerations also relate to the self-esteem and ego involvement of your audience. It is advisable to seek to promote attitude change through addressing needs and motives that are important to the audience's self-esteem and in which they are highly involved. For example, Millar and Millar (2000) found that messages emphasizing positive aspects of an attitude change (gain messages) led to increased intentions to perform safe-driving practices where the audience were highly involved, compared with those who were low in involvement.

6.7.3.2 Persuader

It is important that a persuader should have credibility in the eyes of the audience, for example, to be seen as an expert in the area and to be trustworthy. The communicator should be seen to derive little personal advantage from influencing others to change their attitudes. A communicator who is attractive to and liked by, the audience is more likely to be accepted and to be able to induce attitude change. They should exhibit characteristics that are similar to, or at least acceptable to, the audience and they should express views congruent with those of the audience. For example, in attempting to introduce a new safety rule, it could be pointed out that everyone favors a safer workplace and that the new rule is congruent with this broader attitude. The message should aim to have some immediate impact so that people remember it (salience requirement). It has been found that if you ask...
for extreme change in an attitude, then it is more likely that the audience will at least move some way in the direction of change.

6.7.3.3 Personality factors
A number of personality factors has been found to be associated with the likelihood of attitude change (personality is considered in more detail in Chapter 5). It has been suggested that there is a general trait of persuasibility, which is another way of saying that individuals differ in their liability to attitude change. It also seems that more intelligent (or open-minded, see Section 5.4.5) people are more open to attitude change, although individual cognitive needs and styles are also relevant. Some individuals are more defensive than others and highly self-defensive people may hold attitudes that are highly resistant to change. Group affiliations are important, because people discuss their views within their peer group before firming up their own attitudes on a topic (see Chapter 8).

6.7.3.4 Presentation of issues
It is usually better to present both sides of an argument rather than one side only. An audience tends to be wary of a message that presents one side only, unless this is one about which it already holds positive attitudes, such as workplace safety. There is no particular rule as to where the most important material in a message should be placed, although there could be both primacy (first material most likely to be remembered) and recency (last presented material also highly likely to be remembered) effects in any communication. The primacy effect is generally stronger. When the audience is intelligent and knowledgeable about the topic or where the topic is fairly straightforward, they can be left to draw their own conclusions, otherwise it may be helpful to spell out the main findings and issues for an audience. Whether the material should be presented in an emotional or factual way depends upon the nature of the message and the desired change. The most extreme form of emotional appeal for a safety message is usually a fear appeal or threat and this issue is taken up below.

6.7.3.5 Persistence of change
Persistence of any change is aided by active participation in message delivery. For example, participation through role play has been found to be particularly powerful in changing safety attitudes and behavior in respect of the use of personal protective equipment (PPE) (Pirani & Reynolds, 1976). Transmitters of messages also rely upon repetition to reinforce a change in attitude and this can be effective if the message is received several times by an audience. There is also the so-called sleeper effect whereby a message is received but the processing takes some time and any change may take time to show.

6.7.4 Other factors in attitude–behavior change

6.7.4.1 Information provision
The most common type of intervention for improving workplace safety is focused at an individual level. The most frequently used interventions, which target individual behavior, involve behavior modification techniques (discussed in Chapter 3) that seek to change behavior directly, without trying to influence attitudes. Another, less common, intervention targets individual attitudes, where techniques involve trying to change attitudes through information measures (e.g., mass media campaigns, leaflets, booklets, films, posters, and direct mail) or persuasion (e.g., through counseling or education based in classrooms or small groups). Whilst the use of attitude interventions has been well documented, there is very little evidence that attitude change, for example, in respect of safety, can be achieved through information or education measures alone. Numerous studies have demonstrated
that such interventions fail to result in changed behavior or have any effect on injuries (Fleischer, 1973; Robertson et al., 1974; Anderson, 1978; MacKay & Rothman, 1982; Saarela, 1989; Damoiseaux et al., 1991; Robertson, 1994; Delhomme et al., 1999; Lund & Aaro, 2004). For example, Delhomme et al. (1999) conducted a meta-analysis of six mass media campaigns aimed at changing driver behavior through attitude change; this showed no significant effect.

Some evidence of success has been recorded with highly motivated audiences — for example, mothers of newborns regarding the use of child restraints in cars (Geddis & Pettengell, 1982) and with repetition of the message through mass media campaigns (Koenig & Wu, 1994). Counseling or education in small group settings is more successful, particularly those conducted within a formal work setting, where the session includes group discussion, as well as one-way communication (Geller & Hahn, 1984; Dunton et al., 1990). Parker (2002) described the use of a video-based intervention with small groups in relation to driving behavior. The intervention focused on changing underlying beliefs, values, and attitudes that influenced the decision to speed (according to the TPB model discussed in Section 6.6) through discussion. The intervention was successful in achieving significant attitude change. It is possible that attitude change is supported by the development of new social norms through group discussion (Lund & Aaro, 2004).

Safety propaganda campaigns by themselves are likely to have limited success in changing attitudes, particularly where these are not backed up by other measures, such as training (see Chapter 10). Where such support does not exist, gradual reversion to previous behavior is likely (Hale, 1974). In reviewing a number of research findings, Sell (1977) set out the conditions necessary for a change in safety behavior as a result of using safety posters and other propaganda, as well as situations to avoid. Findings from this study are shown in Summary Text 6.10. Using informational and educational campaigns has shown some evidence of success, but the vehicle of change would appear to be behavioral, rather than attitudinal. For example, an education program aimed at reducing drink-driving amongst young drivers through peer education and role-play demonstrated a positive effect on behavior, but no effect on attitudes (McKnight & McPherson, 1986). However, it is more often the case that educational programs succeed in increasing knowledge, but have little effect on behavior (Mann et al., 1986). The effect of combining informational techniques with feedback or rewards for desired behavior is a preferred technique (discussed in Chapter 3). Five case studies on successful attitude and behavior change in workplace and driving settings are described in Summary Text 6.11 to Summary Text 6.15. These illustrate some of the principles outlined in this chapter and indicate that quite dramatic changes are possible in respect of safe attitudes and behavior.

6.7.4.2 Fear

The issue of whether fear arousal should be used in seeking to change attitudes and behavior has been the subject of much research (for reviews see Hale & Glendon, 1987; Witte & Allen, 2000). Fear appeals can be effective; for example, at the height of the AIDS epidemic in the late 1980s, Hill (1988) found that compared with nonfear appeals, fear appeals in condom advertisements were more successful in changing attitudes. However, Hill’s study also showed that the moderate-fear condition was more effective than the high-fear condition in producing positive attitude change. In general, findings indicated that high levels of fear arousal were counterproductive in changing attitudes and behavior because the audience erects defensive barriers and tends to reject the information, for example, on the grounds that they could be seriously hurt or suffer ill health, which represents a threat to be avoided. Moderately arousing messages on the other hand may be more effective. However, more importantly, an audience needs to perceive that they have control over the
Summary Text 6.10 Safety Posters and Other Propaganda

To be really effective they should follow the following guidelines:

- Be specific to a particular task or situation
- Reinforce a training program
- Give a positive instruction
- Be located close to where the desired action is to take place
- Build on existing knowledge and attitudes
- Emphasize nonsafety aspects
- Be concerned with topics over which the audience has some control

To be really effective they should avoid the following features:

- Involve horror — this can bring defense mechanisms into play
- Be negative, as this does not indicate the correct way of doing something
- Be general exhortations, as people then think the message applies only to others
- Have a different impact upon different groups — for example, a positive effect on those already acting safely but a negative effect on those who are not acting safely


threat (high efficacy), whether this is available from the environment (e.g., via some protective barrier) or from their personal resources (e.g., in the form of skill or ability). Witte and Allen (2000) found that the greatest level of behavior change resulted from strong fear appeals combined with high-efficacy messages, whilst the greatest degree of defensive avoidance and reactance was found for strong fear appeals with low-efficacy messages. Thus, in general, considerable caution needs to be exercised in using fear in propaganda messages.

6.7.4.3 Sanctions
Sanctions associated with legislation have been successful in inducing behavior change. There is evidence that combining informational or educational techniques with legislation is much more effective than either used in isolation. For example, Dannenberg et al. (1993) found that while educational measures alone failed to increase bicycle helmet use, when legislation enforcing helmet wearing was introduced alongside the educational campaign, a positive change in helmet wearing was observed. The information campaign helped the legislation to gain acceptance from its target population, resulting in changing attitudes over time, which supported the enforced behavior change (see Figure 6.6 and Figure 6.7). Lund and Aaro (2004) argued that whilst the evidence suggested that attitude change approaches are quite ineffective, attitude change should not be viewed as only a mediator of behavior change, but as having the following potentials to drive the factors:

- Influence precautionary actions and initiate passive measures (changing safety-related behaviors)
Summary Text 6.11 An Illustration of Improving Safety Behavior through Supervisory Practices

In interventions in three companies, an oil refinery, a baked goods processing plant, and a milk products processing plant, throughout a 3-month period floor supervisors (level 1 managers) were provided with feedback from their immediate supervisors (level 2 managers) about safety-related interactions with their workers. Level 2 managers were provided with weekly feedback on each floor manager’s performance and were instructed to inform their floor supervisors how their performance compared with those of other floor supervisors. When giving feedback to their floor supervisors, level 2 managers were required to: (1) communicate approval or disapproval, (2) inquire about reasons for each floor supervisor’s success or failure, (3) identify workers who facilitated or inhibited their progress, and (4) set themselves specific goals for the next fortnight.

Twice weekly the research team gathered information about safety-related and productivity-related supervisory interactions using a brief experience sampling methodology questionnaire and gave feedback to supervisors regarding the proportion of safety-related episodes out of all reported episodes. Senior (level 3) managers received the same information as well as information about the frequency of workers’ safety behaviors. The correlation between the floor supervisor’s behavior and workers’ safety behavior was highlighted to senior managers.

The intervention was designed to change floor supervisors’ self-monitoring of safety behaviors and reward workers for such safety behaviors as wearing protective gear and handling machines and materials safely. Workers’ safety behaviors were measured by trained observers from the research team using a behavior checklist developed by the safety officers and line managers in each company. After the intervention, supervisors’ safety-related interactions increased significantly in all three companies, which resulted in workers engaging in more safe behaviors and fewer unsafe behaviors. For example, after the intervention in the oil refinery, compliance with electrical grounding procedures, use of spark-free hand-tools, horizontal and vertical movement in access paths, use of protective gloves, shoes, and safety glasses, and cleaning up oil spills rose by 15% from baseline measures. In the processing baked goods company, workers practiced the three safety behaviors of appropriate machine handling, appropriate materials handling at both ends of the line, and cleaning slippery floors 14% more often than baseline measures. Workers’ safety behaviors in the smaller milk products processing company, namely earplug use, cleaning slippery and cluttered floors, and door closing also improved. Workers’ ratings of their supervisor’s concern about using safe behaviors and their supervisor’s expectations about safety in different situations improved in all three companies. A four-month postintervention follow-up found continued improvement in workers’ safety behaviors with continued supervisory monitoring. For example, in the oil refinery, targeted safety behaviors increased by 35% from baseline measures.

Summary Text 6.12  Safety Training Effectiveness in Three Food Service Companies

A new curriculum for training food service workers in workplace safety procedures was evaluated in comparison with status quo training. Workers’ safety knowledge and occupational injury claims in a university cafeteria (Company A), a fast-food restaurant (Company B), and a cafeteria and food stands (Company C) were measured. Within each company operational units were assigned randomly to either the new or traditional training. The new curriculum was designed to train workers about workplace health and safety. Simple-to-use training materials including manuals, prompt cards, videotapes, and posters were developed from focus groups conducted with food service managers. The new curriculum comprised ten modules on different topics, such as driver safety and handling hazardous materials.

One consultant trained two managers from the units assigned to receive the new curriculum across two days at each company. This consisted of introducing managers to the new curriculum, reviewing an evaluation plan, and using specific instructions to administer the safety-training program. Managers trained existing workers within two weeks of their training and trained new workers within 30 days of their start date in the modules of cuts, burns, slips, and lifting.

New curriculum-trained workers were tested immediately after training and again, three months later, on their knowledge of the safe work practices covered. Workers receiving status quo training were tested on their knowledge of safe work practices within 30 days of receiving a letter from their risk manager explaining the evaluation program. They were retested three months later, following a reminder letter from the risk manager. The impact of training on occupational injuries was measured by collecting information on number of workers’ compensation cases in each unit per quarter. Company A’s compensation claim data were not analyzed due to inconsistent reporting.

Results suggested that the safety training increased knowledge and reduced injuries. Knowledge test scores were higher in the new training units than in the status quo training units; however, these differences were associated with education level, age, and extent of job hazards. Reduced injury rates associated with the new training only approached significance in Company C. No effects of the training content mediators of workload, transfer of training climate (managers’ perception of support from supervisors, peers, and subordinates), or supervisor/worker ratio were related to reported injury rates in Company B or Company C. Neither demographic variables nor knowledge test scores were related to lower injury rates.

Findings suggested that although occupational health and safety training led to greater knowledge, and in some cases reduced work-related injuries, the influence of other factors, such as demographic variables and organizational climate, remained to be fully explained. It was concluded that training curricula required tailoring to trainees’ characteristics.

Summary Text 6.13 Does Using a Child Safety Seat Equate to Safe Vehicle Travel for Children?

When installed and used correctly child safety seats can reduce the risk of fatal injuries in infants and toddlers by 71 and 54%, respectively. Despite this, only one out of five safety seats are used correctly. The authors’ discursive account outlined the following as the main reasons for child safety-seat misuse:

- Ineffective educational interventions and universal safety-seat attachment mechanisms aimed at correcting child seat misuse
- Ineffective instruction manuals
- Poor information provision by physicians, retailers, and day care providers
- Continued use by consumers of manufacturer recalled child safety-seat models
- Parental failure to check correct installation of safety seats
- Parental confusion due to differences in child safety-seat models, passenger vehicle models, and seat-belt systems
- Lack of parental participation in available safety-seat checkpoints
- Caregiver naivety about their own vulnerability for misusing children’s seat

Parents are often unaware of their misuse of child safety seats and their perceptions of risk from misuse are much lower than actual risks. Caregivers’ perceptions of personal vulnerability, therefore, require heightening before behavioral change will follow. Caregiver misperceptions could include the following factors:

- Assuming that they can overcome the situational demands of installing a seat correctly.
- Believing that parents who fall victim to misuse somehow deserve it, leading to a false sense of security (see discussion on attributional effects in Chapter 3).
- Believing that a few adjustments when installing a safety seat will not make a big difference because they are a safe driver.
- Believing that the risk of misusing safety seats is reduced because the potential hazard is voluntary, familiar, forgettable, controllable, preventable, and well understood (see discussion on hazard dimensions in Chapter 2).

An intervention plan incorporating risk communication techniques to maximize parents’ level of participation in effective child passenger safety was proposed including the following three components:

- Establish community locations (e.g., neighborhood pediatricians, general practitioners, and local retailers) for parents to turn to for safety-seat advice
- Make these locations well known to the public
- Increase caregivers’ perceptions of risk of misusing their children’s seats
To increase caregivers’ risk perception creating a sense of outrage is recommended. Outrage can be achieved by generating a sense of danger and a need for high efficacy among caregivers. Interventions require that a threat is perceived and that self- and response efficacy are high so that adaptive responses, such as following installation recommendations, are employed to produce correct use of child safety seats.


- Shape public opinion toward accepting passive measures and legislation (effective structural change cannot be achieved without acceptance)
- Mobilize social support for behavior that will reduce injury risk (e.g., support for not drinking and driving)
- Change social norms (as more people adopt a particular attitude toward a certain behavior, this will result in more pressure to conform)
- Encourage development of a more safety-minded culture (the long-term use of attitude change measures can influence underlying culture — see Chapter 11)

### 6.8 Safety climate and safety attitudes

At the beginning of this chapter, we noted the importance of attitudes to improving health and safety, and yet the previous section illustrated how little effect changing attitudes may have on reducing injuries. This would seem to be quite a contradiction. However, as noted by Lund and Aaro (2004), attitude change has tended to be viewed solely as a means of changing behavior. As seen in this chapter, the attitude–behavior link is complex, and although behavior change cannot normally be achieved simply by changing attitudes, the interrelationship is important — for example, insofar as behavior change can only be maintained in the long term when it is supported by attitudinal change (see Chapter 3).

Attitude change models focus on the individual, targeting an individual’s own attitudes in order to influence his or her behavior. However, there will be further influences on one’s behavior, including the social context for the actions, as presented in the TPB model (Section 6.6), which includes subjective norm — the individual’s perception of the normative pressure to perform the behavior, and perceived behavior control — the individual’s perception of the degree to which performing the behavior is under his or her volitional control (an important early finding from psychometric studies of risk perception, see Chapter 2). Empirical testing of the model, within the context of road use, has shown that the subjective norm can have a much more powerful effect on behavioral intentions than can a person’s own attitudes (Parker et al., 1992a, 1992b). Thus, an individual’s perceptions of significant others’ attitudes and beliefs (and his or her motivation to comply with them) will affect his or her behavioral intentions. Within a group context, the social norm describes group members’ behavioral expectations (see Chapter 8). The TPB has had little application to workplace safety, and so may underestimate the influence of the social context on workers’ behavior, where rewards and punishments associated with engaging in particular behaviors are strongly affected by the attitudes of others, including coworkers, supervisors, and managers. Tomás et al. (1999) investigated some of these relationships in structural equation models and found that safety behavior was significantly predicted by workers’ safety attitudes, coworkers’ response to safety, perceived workplace hazards, and
Summary Text 6.14 Does Using the Driving Decisions Workbook Improve Older Drivers’ Knowledge and Self-Awareness?

Eby and colleagues found that completing the Driving Decisions Workbook, which took approximately 30 min, increased self-awareness and general knowledge in older drivers. The Driving Decisions Workbook is a self-assessment instrument for drivers who may be starting to experience declines in their driving abilities or loss of confidence in certain driving situations due to aging. It provides feedback about good driving decisions generated by readers, suggests appropriate driving restrictions and clinical evaluations, and informs readers about age-related declines in driving abilities. In addition, older drivers perceived the Driving Decisions Workbook as useful, particularly as a tool for facilitating discussions within families of older drivers. Responses of older drivers were positively correlated with overall driving performance on a standardized road test. Significant correlations were also noted between performance on the road test and responses on the health conditions, cognitive, and psychomotor abilities and experiences/attitudes/behavior domains of the workbook. Differences were found between men and women and also between drivers aged 65–74 years and drivers aged 75–90 years.

A convenience sample of 99 licensed drivers in Michigan, aged 65 to 90 years (56% female) completed (1) the Driving Decisions Workbook, (2) a short questionnaire assessing increases in self-awareness and general knowledge upon workbook completion, and (3) a standardized 15-min performance-based (e.g., use of signals, checking mirrors, vehicle speed, and lane positioning) road test examining numerous maneuvers, such as lane changes and controlled turns.

The study’s main findings are:

- After completing the Driving Decisions Workbook, 75% of respondents reported being more aware of changes that could affect their driving.
- Fourteen percent discovered a change in themselves of which they had not been previously aware.
- About 40% reported that completing the workbook made them think more about the possibility of taking a driving refresher course.
- Approximately 33% reported that they would be more likely to have their vision, cognitive capacity, and psychomotor abilities tested by a physician after completing the workbook.
- All respondents found the workbook to be at least a little useful and would recommend the workbook to older friends and family members who drive.
- About 75% of respondents reported that they would use the Driving Decisions Workbook in the future if it were available.
- As the number of potential problem areas identified by the workbook increased so did the number of performance errors observed during the road test.
- Responses on the Driving Decisions Workbook were more closely related to actual driving for men and for those who were aged 65 to 75 years than for women and those aged 75 years and over.

Reading the Driving Decisions Workbook for 30 min, therefore, may be a useful first-tier assessment instrument and educational tool for older drivers, and for
increasing knowledge and self-awareness of changes in driving abilities related to aging and the effects of these changes in driving. The Driving Decisions Work- 
book may further encourage older drivers to drive more safely and to seek clinical assessment as well as facilitating discussions about driving within their families.


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Summary Text 6.15 Managing Safety within U.K. Nuclear Reactor Plants

Changing worker behaviors as opposed to worker attitudes is the focus of several organizations’ safety management practices. One approach, behavioral safety process (BSP), was evaluated within the U.K.’s nuclear industry in three representative reactor sites and among key stakeholders over a 4-year period. The investigation concentrated on personal commitment to, perceptions of, and experience with, the BSP outlined below. The study describes how workers regarded behavioral approaches to safety management and identifies current and future potential for individual and organizational learning.

Semi-structured interviews with key personnel within the company and plant observations using approximately 10% of workers at all levels of two of the reactor sites were conducted. Questionnaires were also completed by BSP observers and workers were observed using BSP during site safety meetings. Within participating nuclear power plants there was a positive commitment to behavioral safety at all levels. Workers articulated several specific examples of individual learning and possibilities for learning enhancement by using BSP. For instance, 30% of all injuries involved cuts and abrasions to hands. Through BSP, it was decided that the optimal solution would be to provide workers with waist bags containing PPE, to be worn at all times. After the bags were issued the percentage of cuts to hands reduced. BSP thereby demonstrated success by allowing workers to perceive a direct link between performing specific behaviors and their safety consequences. In another example, one worker reported that while observing a colleague completing a work task, acid splashed onto the colleague’s face causing his mask to crack. Afterward the colleague informally reported that he was only wearing full PPE because he knew that this worker was watching him perform the task.

Questionnaire results indicated that the BSP was embedded at all levels and within all representative nuclear sites. Workers reported that BSP created a safety first organizational climate and that BSP was an effective motivational tool for behavior and attitude change. Safety motivation increased following praise regarding the safe and appropriate completion of work tasks. Trust among key stakeholders, management, and workers and consistency between the BSP and organizational culture were reported to be important in developing and maintaining BSP.

supervisory response to safety (see Figure 6.11). Siu et al. (2004) found that while safety attitudes predicted reported work injuries in a sample of construction workers, they did not directly predict accident rates, although there was an indirect path through psychological distress (see Chapter 7).

6.8.1 The concept of safety climate

Lund and Aaro (2004) suggested that attitude change can have a significant impact on injuries through its effect on social norms — that is, the framework of behavioral expectations shaped by group members’ shared attitudes. For example, where workers develop more positive attitudes toward safety, this can promote the establishment of safety-related behavioral expectations, which become part of the accepted behavioral repertoire shared by a work group. Donald and Canter (1994) defined the safety climate of a workplace in terms of the extent to which all workers share attitudes toward safety, which allow them to retain control and responsibility for injury prevention. That is, workers must not only have favorable safety attitudes, but also maintain a sense of individual responsibility and personal authority for safety. This important element of safety climate has been identified in a number of studies (Coyle et al., 1995; Cheyne et al., 1998). Workers need to believe that
they have ownership or responsibility for safety, but also be authorized by the organization to act on those beliefs; as noted by Turner (1994), a degree of authority is needed to activate the motivation to care about safety. Hofmann et al. (1995) labeled the individual attitudes and behaviors discernible in safety climate as the microelements of an organization, which themselves are determined by the macro-elements of the safety management system and practices.

Studies using structural equation modeling (SEM) have supported this hierarchical relationship between different elements of safety climate. For example, Cheyne et al. (1998) measured the physical work environment (i.e., basic environmental work conditions: lighting, ventilation, working space, and humidity), physical hazards, and attitudes to safety. Factor analysis of attitudes to safety found five dimensions, in respect of attitudes toward the issues, which are as follows:

1. Safety management
2. Communication
3. Individual responsibility
4. Safety standards and goals
5. Personal involvement

Cheyne et al.’s model indicated that individual responsibility mediated both the relationship between personal involvement and safety activities and between workplace hazards and safety activities. Personal involvement and attitudes toward workplace hazards had no direct influence on engagement in safety activities, rather their influence was determined by individual responsibility — the extent to which an individual worker has ownership of safety issues.

Organizational safety cognition measures — mainly perceptions of, and attitudes toward safety, commonly take the form of safety climate self-completion questionnaire surveys, of which there are many examples (Zohar, 1980; Cox & Cox, 1991; Dedobbeleer & Béland, 1991; Cooper & Phillips, 1994; Donald & Canter, 1994; Niskanen, 1994; Coyle et al., 1995; Janssens et al., 1995; Williamson et al., 1997; Cheyne et al., 1998; Cox et al., 1998; Flin et al., 2000; Varonen & Mattila, 2000; Davies et al., 2001; Glendon and Litherland, 2001; Silva et al., 2004). For reviews, see Cooper and Phillips (2004), Guldenmund (2000), and Seo et al. (2004). These measures typically find between two and seven separate factors or safety climate scales. However, no consistent factor structure has yet emerged for safety climate, which Seo et al. (2004) attributed to not specifying the influence of two critical safety dimensions — management commitment and supervisor support. Seo et al. (2004) also demonstrated the importance of developing psychometrically robust safety climate scales.

6.8.1.1 Safety climate and perception
Another important psychological concept in relation to safety climate is that of perception, which is discussed in Chapter 3. Whilst the intrinsic level of hazards and safety measures put in place for worker protection determine injury likelihood within a workplace, subjective risk is determined by how that risk is perceived by the workforce (see also discussion of subjective risk in Chapter 2). Because people are subject to a number of attributional biases in how they estimate the likelihood of events occurring, risk perceptions may vary significantly from actual risks (see Chapter 3).

Perceptual processes are significant in shaping the safety climate as they are used to interpret information that workers sense about the safety of the workplace — for example, adequacy of safety measures, extent to which senior managers are committed to safety, and quality of communication. Thus, safety climate has been equated with the concept
Chapter six: Attitudes, values, and risk behaviors

of psychological climate, which comprises nonaggregated individual perceptions of the environment; these reflect how individuals organize their experiences of that environment. Neal and Griffin (2004) argued that safety climate should be defined purely in terms of these perceptions of the work environment, with other variables, such as attitudes toward safety, treated as influences upon, but not elements of, the safety climate. Thus, safety climate should be treated as conceptually distinct from individual antecedents of safety, including attitudes toward safety, attitudes toward the organization, and dispositions (such as personality traits). They defined safety climate as, “perceptions of the policies, procedures and practices relating to safety,” which at its broadest level reflect, “employee perceptions about the value of safety in an organization” (p. 18). This definition in terms of psychological climate is reflected in earlier work, such as Brown and Holmes (1986), Dedobbeleer and Béland (1991), and Zohar (1980). With reference to previous studies, Dedobbeleer and Béland (1991) noted that, “employees were believed to develop coherent sets of perceptions and expectations regarding behavior-outcome contingencies and behaving accordingly... safety climate was viewed as an individual attribute as opposed to an organizational attribute, the term psychological climate was applied to the two models” (p. 97). Similarly, Niskanen (1994) argued that safety climate referred to, “a set of attributes that can be perceived about particular work organizations... and which may be induced by the policies and practices that those organizations impose upon their workers and supervisors” (p. 241). Griffin and Neal (2000) identified five first-order factors, which in turn loaded onto a common higher-order factor, relating to perceptions of safety climate. These are listed as follows:

1. Management values
2. Safety communication
3. Safety practices
4. Safety training
5. Safety equipment

These aspects of climate, which refer to perceptions of the work environment, are reflected in the dimension of safety climate identified as management commitment to safety. For example, Dedobbeleer and Béland (1991) identified a two-factor model, in which management commitment was indicated by workers’ perceptions of management’s attitude toward safety practices, management’s attitude toward workers’ safety, actions taken by supervisors to enforce safety, and management safety activities including safety instructions and availability of proper equipment. Worker involvement was indicated by workers’ perceptions of the presence of regular safety meetings, risk taking, likelihood of injuries, and control. Thus, this definition of safety climate as a psychological climate effectively omitted the second dimension of workers’ involvement or responsibility for safety, which as noted earlier, is a particularly important mediating variable. Tomás et al. (1999) found that safety behavior was significantly predicted by workers’ attitudes, coworkers’ safety response, supervisory safety response, and hazards. However, a perceptual measure of climate had no direct link with behavior but was mediated by the latter variables. Thus, there is some disagreement amongst researchers as to the definition of safety climate and how it links with other important factors to influence safety performance. Glendon and Litherland (2001) attempted to resolve these differences by proposing that safety climate might be conceptualized as operating on the following three levels:

1. Operational — which accesses safety climate factors impacting most directly upon work performance and that deal exclusively with perceptions (Wilson, 1998; Glendon & Stanton, 2000).
2. Intermediate — comprising perception-oriented measures but with some attitudinal items, reflecting generic factors, such as management commitment and safety system (Williamson et al., 1997; Clarke, 2000; Flin et al., 2000; Chapter 11).

3. Highest — using purely attitudinal measures (Donald & Canter, 1993; Niskanen, 1994), which could tap into some aspects of safety culture.

At the highest level described by Glendon and Litherland (2001), safety climate reflects to some extent the underlying culture of the organization with respect to safety. For example, Cox and Flin (1998) considered safety climate to be a manifestation of safety culture expressed through workers’ attitudes and behavior, a description also given by Cheyne et al. (2003). Safety culture is generally taken to be more embracing than safety climate, although the two terms have similar meanings. Whilst culture implies a notion of residing within an organization, climate has more passive connotations, reflecting attitudes and perceptions of organization members to both internal (e.g., management actions) and external (e.g., economic) influences (Glendon, 2006). For example, the Ladbroke Grove rail accident inquiry concluded that: “climate is the observable, tangible part of culture. Culture is the understanding of people’s fundamental values with respect to say, risk and safety” (Cullen, 2001a, p. 2). Thus, safety climate can be defined as reflecting shared attitudes and perceptions of organizational members toward internal and external influences on safety. It may be regarded as an indicator of safety culture within the workforce as a whole (Mearns et al., 2003), but only provides a snapshot picture of the longer-term, more enduring safety culture of an organization. Cheyne et al. (2003) regarded safety attitudes to be a component of safety climate, which in turn was a manifestation of safety culture. The distinction between safety climate and safety culture is further discussed in Chapter 11.

Some researchers have sought to determine whether different groups of workers within an organization or sector report different attitudes or perceptions of safety, or whether management and workers express different attitudes to safety. For example, Cox et al. (1998) found differences between safety attitudes of workers, supervisors, and managers in the U.K. manufacturing sector, for example, that permanent workers had more positive attitudes on some issues than did other groups. Similar findings have also been reported in the U.K. rail industry (Clarke, 1999) and for U.S. haulage firms (Arboleda et al., 2003). Different subcultures or subclimates are likely to exist at different levels within an organization (Trice & Beyer, 1993; Gonzales-Roma et al., 1999; Harvey et al., 1999). This can result in differences in safety attitudes at different levels (e.g., managers, supervisors, and workers) within an organization, and between different groups of workers (Alexander et al., 1995; Cox et al., 1998). Gillen et al. (2002) found different perceptions of safety climate between unionized and nonunionized workers. Cheyne et al. (2003) found that while managers, supervisors, and workers shared the same safety climate factor structure, their perceptions of the factors and their interrelationships were quite different. Sampling different employee groups from an Australian rail sector organization, Glendon and Evans (2005), and McInerney (2005), found significant differences between several employee groups, including managers and supervisors, on a safety climate measure designed specifically for use within the rail sector.

6.8.2 Safety climate and safe behavior

A key issue for some researchers has been whether safety climate can predict various aspects of safe (or unsafe) behavior. To this end measures have included unsafe behaviors (Hofmann & Stetzer, 1996; Cabrera & Isla, 1998; Tomás et al., 1999; Brown et al., 2000), accidents (Mearns et al., 1998, 2003; Siu et al., 2004), behavioral observation (Krause et al., 1990a,
A number of studies have found that safety climate mediates organizational factors and worker behaviors (Neal et al., 2000; Barling et al., 2002; Griffin et al., 2002; Zohar, 2002b). Some researchers have found a relationship between safety climate and behavioral safety measures (Brown & Holmes, 1986; Williamson et al., 1997; Mearns et al., 1998; Clarke, 2000; Varonen & Mattila, 2000; Cooper & Phillips, 2004; Seo et al., 2004; Silva et al., 2004), while others have not (Alexander et al., 1994; Glendon & Litherland, 2001). Glendon and Litherland (2001) suggested possible reasons for some researchers not finding a relationship. First, safety climate scales may tap a different aspect of safety than behavioral safety measures do. Safety climate scales are subjective self-reports, while behavior observation represents a more objective methodology. Different measurement methods may reflect different aspects of safety, so that safety climate scales and behavioral measures are complementary rather than overlapping measures of safety. A second possible explanation is that some behavior observations may not be sensitive enough to identify differences in safety performance, particularly if safe behavior is already at a high level. Safe behavior measures may also be limited to behaviors that can be readily observed (e.g., PPE use) and may not reflect the complete range of safety performance. From their findings, Cooper and Phillips (2004) suggested that if behavioral measures are appropriate and sensitive enough, then a relationship with safety climate can be found. In either case, a safety climate survey offers a valuable tool for identifying trends in an organization’s safety performance (Coyle et al., 1995; Cox & Cheyne, 2000; Seo et al., 2004).

Zohar’s (1980) definition of safety climate emphasized the influence of climate on behavior, in that climate acts as, “a frame of reference for guiding appropriate and adaptive task behaviors” (p. 96). Thus, workers develop an understanding of which behaviors and activities are deemed acceptable based on their perceptions of the safety climate and are rewarded accordingly by the organization. For example, a positive safety climate might actively encourage and support workers in making safety suggestions, whilst in a negative safety climate, workers might observe that safety suggestions are dismissed or discouraged. Where perceptions of safety climate are more favorable (indicating a positive safety climate), workers are less likely to engage in unsafe acts (Hofmann & Stetzer, 1996) or to have suffered an injury (Brown & Holmes, 1986; Williamson et al., 1997; Mearns et al., 1998; Varonen & Mattila, 2000). There is also evidence that a positive safety climate maintains safety-related organizational citizenship behaviors (OCBs), including involvement in safety activities (Cheyne et al., 1998) and safety participation (Neal et al., 2000). Reviews of several empirical studies have provided evidence of a significant relationship between safety climate and injury involvement (Shannon et al., 1997; Seo et al., 2004), indicating that safety climate might be regarded as a mediating variable between organizational characteristics and workers’ unsafe behaviors (Clarke, 2000). Empirical studies have supported a mediational role for safety climate (Neal et al., 2000; Barling et al., 2002; Griffin et al., 2002; Zohar, 2002a), which has been found to mediate the relationship between organizational climate (Neal et al., 2000), leadership style (Zohar, 2002b) and local...
leadership (Griffin et al., 2002) on measures of safety performance (see Chapter 11 for further discussion).

Kopelman et al. (1990) proposed that the influence of climate on behavior is mediated by cognitive and affective states, through particular pathways — for example, climate perceptions impact on work motivation, which in turn affects job performance, or climate perceptions impact on job satisfaction, which in turn affects psychological well-being and withdrawal. As noted in Chapter 3, there is a strong significant relationship between safety motivation and safety compliance (and, to lesser extent, with safety participation), indicating a possible pathway for the relationship between safety climate and injury involvement. For example, negative perceptions of the safety climate impact on safety motivation leading to decreased compliance (see Chapter 11). Recent work has focused on group-level safety climate (Zohar, 2000, 2002a), as opposed to organizational safety climate, where climate is defined in terms of how supervisors prioritize safety issues. Another mechanism for the impact of climate on behavior might be considered from a team or group perspective (see Chapter 8 for further discussion). Increasingly, researchers are using more sophisticated statistical modeling techniques to unravel some of the complex relationships and interactions between safety climate components (Cheyne et al., 1998, 2003; Tomáš et al., 1999; Griffin & Neal, 2000; Neal et al., 2000; Seo et al., 2004; Siu et al., 2004). It can be predicted that future research will involve developing ever-more detailed models of the operation of safety climate, its impact on safety-related behaviors, and its relationship with other facets of the work environment.

6.9 Conclusions

In this chapter, we have explored the nature of attitudes focusing upon the vital link between attitudes and behavior in the context of managing workplace safety and risk, also with reference to driving attitudes and behaviors. The other main focus has been the important topic of attitude change and the strategic approach of ensuring congruence between attitudes and behavior in effecting change in the workplace or other environments. Workplace attitudes are relevant to safety and risk issues because they are one component of safe behavior, which in turn is an important feature of the overall safety culture of an organization (Chapter 11). However, attitudes are only one of the variables that influence a person’s behavior and it is therefore essential that those seeking to effect behavior change address a range of factors that also affect behavior. These include: previous behavior (e.g., habits), social norms and pressures (see Section 6.6 and Section 6.7), risk cognition (Chapter 2), motivation (Chapter 3), individual differences (e.g., personality — Chapter 5), and workplace factors that can facilitate or inhibit the desired behavior, very much under the control of management (Chapter 9). Thus, attitudes are one of the factors that influence, and are influenced by, safety-related behavior.

Attitudes are complex multidimensional representations of certain aspects of individuals’ cognitive functioning. This chapter has illustrated the importance of a thorough and systematic approach to attitude and behavior change, which is based upon a sound and relevant theoretical approach to the relation between behavior and other factors. A considerable volume of evidence has accumulated over the past 60 years in respect of how behavior and attitudes may be influenced and changed. By applying structured approaches, human behavior issues relating to workplace safety and risk can be seriously addressed. While the number and variety of theories relating to attitudes and behavior may initially appear confusing, most of these share common features and can be encapsulated within a set of generally agreed principles. However, the attitude–behavior link is complex and any model or theory failing to reflect this would be neither credible nor useful. One intractable problem in
seeking to change attitudes and behavior is variability between individuals. This diversity means that some people will change fairly readily, a majority may change after a certain amount of pressure, while a minority may change very reluctantly, if ever. Thus, it may be expedient for a change agent to accept that some individuals will be very resistant to change. However, efforts to change attitudes need not necessarily be expended through targeting attitudes themselves; indeed it may be more cost-effective to devote resources to alternative methods. Attitude change may facilitate social support for behavior that will reduce injury risk (e.g., support for not drinking and driving), change social norms (as more people adopt a particular attitude toward a certain behavior, this will result in greater pressure to conform), and encourage development of a more safety-minded culture (the long-term use of attitude change measures can influence underlying culture). Thus, whilst the attitude–behavior link is an important relationship to understand, it should be recognized that attitudes have wider relevance in efforts to improve safety.

The notion of safety attitudes has been encapsulated within the concept of safety climate, which can offer benefits to organizations in respect of being a proactive measure of safety that has been found to be associated with several other safety indices. If repeated at intervals within an organization, it gives voice to large numbers of workers, can indicate where safety improvements are required, and can be used to assess the efficacy of safety-related changes — and indeed other changes, for example, improvements in communication. It can be used to determine differences between groups of workers, including contractors, differences between managers and workers, between different plants or units within an organization, and between different organizations within the same sector. In the longer term we can expect to see safety climate measures used to benchmark organizations internationally (at least within — if not across — industries) in terms of safety.
chapter seven

The role of stress in safety and risk

This chapter considers a topic of widespread concern to many people, that of stress and how to deal with it effectively. After reviewing the stress process and ways of conceptualizing stress, a number of workplace stressors are considered, specifically in relation to work injuries. Later in the chapter the focus shifts to individual and organizational level intervention strategies.

7.1 Introduction

Why should safety and risk scientist practitioners be concerned with psychological stress (which can present a mental hazard) as well as with physical (e.g., visible hazards) and physiological (e.g., long-term damage) risks? First, psychological stress is an important component of health, safety, and welfare and there is thus at least a reasonable ethical requirement to safeguard this aspect of workers’ well-being. A second reason is that beyond a certain point, individuals under stress perform less than optimally and stress can therefore adversely affect productivity, quality and, ultimately, safety. Research evidence supports causal links between stressful working conditions and greater injury involvement in various contexts, including company car drivers (Cartwright et al., 1996), transit operators (Greiner et al., 1998), medical practitioners (Kirkcaldy et al., 1997), construction workers (Siu et al., 2004), and veterinary surgeons (Trimpop et al., 2000). A third reason is that, in an increasingly litigious society, recent years have seen a growing number of “cumulative trauma” compensation claims against U.S. employers (National Institute of Occupational Safety and Health, 1986; Karasek & Theorell, 1990) and a number of successful personal injury claims in the United Kingdom (Earnshaw & Cooper, 2001).

The same trend has also been evident in Australia for some years (Miller, 2003), with approximately 6000 stress claims reported in 2000–2001 (National Occupational Health and Safety Commission, 2003). It is probable that these data do not fully reflect the incidence of work stress in Australia as many cases go unreported due to the negative stigma associated with occupational stress (Caulfield et al., 2004). New Zealand witnessed its first work-related stress fine in 2005 following a prosecution under the Health and Safety in Employment Act. A pattern emerging in the United Kingdom is that recipients of incapacity benefits on grounds of mental or behavioral disorder are increasing, while recipients of benefits for musculoskeletal disorders are decreasing significantly (Turner, 2004). This is probably partly due to growing awareness of broader
health and safety issues and also to a continuing decline in manufacturing jobs. Spiers (2005) reported data from the U.K. Health and Safety Executive indicating that about half a million people in the United Kingdom experience work-related stress at a level that they believe is making them ill, while up to 5 million people reported feeling at least very stressed by their work. Small wonder that stress has even been described as an epidemic that has been exacerbated by workplace practices such as electronic monitoring of work performance, teleworking, and global best practice production methods (Peterson, 2005).

The concept of cumulative trauma relates to the development of mental illness as a result of continual exposure to occupational stress, for example, the California Labor Code states that workers are entitled to compensation for disability or illness caused by “repetitive mentally or physically traumatic activities extending over a period of time, the combined effect of which causes any disability or need for medical treatment.” In the United Kingdom, legal implications of stress-induced personal injury were highlighted by the landmark case of Walker v Northumberland County Council. In this case, the judge expressed the view that the employer’s duty of care extended beyond physical injury to psychiatric damage and that an employer had a duty to provide his or her workers with a reasonably safe system of work and to take reasonable steps to protect him or her from risks that are reasonably foreseeable (Earnshaw & Cooper, 2001).

As a significant amount of work-related stress results from organizational culture and relationships, stress is a problem for organizations and not merely for individuals. Stress and its management or control is widely recognized as a workplace problem. Cox and Griffiths (1996) argued that organizations needed to assess the risk posed by psychosocial hazards as well as from physical hazards, that is, those aspects of work design, and the organization and management of work, and their social and organizational contexts, which have the potential for causing psychological or physical harm (Cox et al., 1993, 1995). Although much legislation governing health and safety requires risks of effects of physical hazards on health and safety outcomes to be assessed, attention has also focused on assessing the risk of psychosocial hazards on health outcomes (Cox et al., 1995; Cox & Griffiths, 1996). Although the European Framework Directive on Health and Safety at Work (1989) emphasized the employer’s duty to ensure the safety and health of workers in every aspect of their work, only a minority of European countries have special legislation relating to psychosocial hazards.

Stress is multidimensional and complex, having both objective (e.g., physiological measures) and subjective (e.g., cognitive appraisal) components. A definition incorporating both these components was proposed by McGrath (1976), who conceptualized stress as a sequence of events, in which a perceived imbalance occurred between demand and response capability, where consequences of not meeting demands were perceived as important. Psychological stress is experienced as an individual phenomenon and has links with motivation and personality. However, many of the origins of stress are generally held to lie externally, although, as will be seen, the issue is not clear-cut because stress is experienced as a result of interactions between individual variables (e.g., personality, coping style, attitudes, and expectations) and environmental factors (e.g., organizational culture and rate of change). Costs of stress-related illness associated with work have been variously calculated — for example the U.K. Health and Safety Executive (HSE) has estimated that work-related stress costs the United Kingdom around £4 billion annually (HSE, 2002b). The following sections describe the nature of occupational stress, before continuing to examine implications of workplace stress for health and safety management. Burnout and posttraumatic stress disorder (PTSD) are not covered in this chapter — for reviews of these topics see Byrne (1993), Kroll (1993), and Maslach (1982).
7.2 Theoretical models of stress

A distinction has been drawn between eustress, which is associated with positive arousal and motivation, and distress, which accompanies feelings of extreme anxiety, depression, and low self-esteem. Although it must be recognized that sources of pressure are necessary to motivate individuals to strive toward goals and may be perceived as a positive challenge, extreme pressure, where an individual has difficulty coping, is likely to result in negative outcomes. Given the implications for maintaining the health and safety of individuals (and organizations), we use the term stress to refer to the latter.

Numerous models of stress have been proposed to describe the process involved. Stress may be identified with external pressures; following the basic engineering analogy, that when stress is applied strain results. This model ignores individual differences in respect of the reaction to stress, that is, what one person perceives as stress, another may perceive as a challenge. Another conceptualization locates stress as a response within the individual, so that stress is a set of experiences. Stress operates upon many physiological aspects of bodily functioning. When confronted with a perceived threat, the hypothalamus and pituitary glands release a hormone (ACTH) into the blood. When this reaches the adrenal glands, adrenalin and related hormones are also released into the blood and flow to all organs, muscles, and cells of the body, producing the activation (flight or fight) response. This response results in a number of bodily changes, shown in Summary Text 7.1, which are designed to prepare the individual to meet the threat.

The human flight or fight response evolved to meet environmental threats that required an immediate response (e.g., natural hazards, wild animals, and hostile members of other groups) and thus the behavioral reaction usually occurred straight away. As the rate of social change in human society has outstripped our evolutionary capability to adapt to all these changes, most of the threats we commonly encounter do not require an immediate response. Thus, the evolved response is often blocked and we are obliged to find other ways of coping with threats. It is the experiences that result from blocking the flight or fight response that are referred to as stress. To counterbalance the stress response, evolution has also provided us with a relaxation response. This becomes operational when a threat passes and the body reverts to more normal functioning through a relaxation process in which the phenomena described in Summary Text 7.1 are reversed. Generally, both the stress response and the relaxation response are not under voluntary control.

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Summary Text 7.1 Characteristics of the Flight or Fight Response

- Pupil dilation and increased sensory perception (increases capacity to take in relevant stimuli from the environment)
- Involuntary vocalization (crying out — as for a warning)
- Reduced salivary secretion (dry mouth) and inhibited gastric activity (to conserve blood for the muscles)
- Hyperventilation and irregular breathing (increases amount of oxygen required to run away or fight)
- Increased blood pressure, pulse rate, and peripheral circulation plus reduced bleeding (increases flow of oxygenated blood to the muscles)
- Increased muscular tension, capacity, and activity (state of readiness for action)
control, being governed by the involuntary (or autonomic) nervous system, which has two branches: the sympathetic branch governs the stress response and the parasympathetic branch controls the relaxation response. The voluntary nervous system activates all the behavior that we choose to undertake, including putting ourselves into stressful situations. However, various coping responses, described later in this chapter, can be brought under voluntary control so that they can influence the stress and relaxation responses.

Contemporary definitions of stress tend to favor a transactional perspective. This emphasizes that stress is located neither in the person nor in the environment, but in the relationship between the two (Cooper et al., 2001). Within this perspective, the term stress refers to the overall transactional process, rather than to specific elements of the process, such as the individual or the environment. Stress arises when an individual appraises the demands of a particular encounter as about to exceed available resources and, therefore, to threaten their well-being, and necessitates a change in individual functioning to restore the imbalance (Lazarus, 1991).

The transactional model has two stages to appraisal of the threat (potential stressor). In the primary appraisal stage the individual asks, "Is this situation important to me?" and "Is it challenging or threatening?" If the situation is appraised as being important, then at the secondary appraisal stage the individual asks, "How can I cope with it (options are considered, for example, using past experience of similar situations)?" "Can I affect the situation (control)?" and "What resources (e.g., social support from colleagues) are available to me?" In reality, secondary appraisal (perceived coping ability) affects primary appraisal (perception of threat) because a potential stressor that can be readily dealt with will not remain a threat. For example, if the individual is confident, on the basis of past experience, that they can cope with the situation it will not be perceived as threatening. Stressors refer to events that are encountered by individuals, whilst strain refers to the individual's psychological, physical, and behavioral responses to stressors (Beehr, 1998). Stressors take the form of pressures that are mediated by various environments. Effects of stress can take a variety of forms including, psychological, physiological, and behavioral. In response to a threat from stressors, coping mechanisms serve to reduce their impact upon the individual. One way in which an individual may seek to cope is by tackling the causes of stress directly, known as problem-focused coping; whilst an alternative (though not mutually exclusive) approach is for the individual to change the way he or she feels about the situation, called emotion-focused coping (see Section 7.5.3.2).

One problem with a multidimensional concept such as stress is the large number of variables that can be associated with it. For example, almost anything we encounter in life may be considered to be a potential stressor, depending upon our perception or attitude to it at the time. Some writers (Briner, 1993) have criticized this rag bag approach to stress on the grounds that there are too many variables for sensible study and that causal links between them are either very small or impossible to detect. Examples of variables that have been associated at some time with stress are given in Summary Text 7.2. Clearly, not all the features described will affect everyone, but a combination of some of these, together with others not mentioned, are likely to be experienced by most people for at least some of the time. Holmes and Rahe (1967) allocated points for various significant life events (e.g., bereavement, marriage, divorce, and moving house), which they alleged could produce stress in people. This was used to produce a cumulative score, which would indicate a person's critical stress level. However, subsequently it has been found that daily hassles, such as household concerns, time pressures, inner concerns, financial and work issues, produced more stress than much less common major life events (Lazarus et al., 1981).
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Summary Text 7.2 Pressures That Can Act as Stressors

Life pressure inter alia from: community (keeping up with neighbors), noise (e.g., traffic, aircraft, neighbors), marital disharmony, sex (e.g., lack of), conflicts with children, ethnic relations, gender relations, medical condition, finance, diet, inadequate housing, bereavement, traumatic experience, driving, and physical danger.

Organizational pressure inter alia from: role ambiguity, role or interpersonal conflict, role overload (too much work), responsibility for others, size of organization, abilities inadequate for task, task makes too few demands, lack of opportunities for self-development, fluctuating workload, lack of control over job, lack of participation, poor communication, poor relations with colleagues, discriminatory practices, unsettling industrial relations (IR) problems, lack of feedback on work performance, not appreciated, not promoted, too little scope for initiative, position in hierarchy, organizational culture, change processes, and threat of/actual redundancy.

Job pressure inter alia from: ambient environment (too hot/cold), other physical hazards, others smoking, harassment, overcrowding, workplace layout, workplace design, job design, poor welfare facilities, excessive workload, unreasonable production targets, machine pacing, repetitive work, long working hours, restricted social contact, shiftwork, conflict with superior, workgroup demands for conformity, having a sedentary job, heavy work, vibration and motion, pollution, and perceived dangers.

Stress can be exhibited, both in the short term and long term in a wide variety of possible ways. Short-term effects may be annoying, but long-term chronic stress effects are most likely to be damaging. Effects of stress are generally identified as being physical/physiological, psychological (cognitive), emotional, behavioral, and medical: some of the main ones are identified in Summary Text 7.3. Stress indicators are many and varied, affecting individuals and organizations as well as families and other groups. Research reviews indicate that psychological strains, such as anxiety and depression, are strong correlates of work-related stressors (Jackson & Schuler, 1985; Jex & Beehr, 1991; Kahn & Byosiere, 1992). Whilst these may be temporary conditions, experience of one strain can increase vulnerability to other types of strain, for example, long-term effects of job dissatisfaction may include physical ill health and poor psychological well-being.

As far as long-term medical effects are concerned, the process that seems to operate is that the stress response, if unrelieved over time, can eventually reduce immune system effectiveness, thereby decreasing our defenses against physical disease and illness. There is substantial evidence to link stress with high blood pressure and heart attacks (Cooper, 1996), cancer (Cooper & Watson, 1991), diabetes mellitus (Kisch, 1985), irritable bowel syndrome and skin problems, such as eczema (Quick & Quick, 1984), and a variety of other conditions. Cohen et al. (1991) found that people were more prone to catching colds when under stress, suggesting immune function impairment. Other studies have also found reduced immune system effectiveness to be associated with stress (Kiecolt-Glaser et al., 1987). At a cellular level, it has been shown that chronic stress affects the ability of the body’s cells to divide and to remain healthy — hastening the aging process as well as compromising immune function.
Summary Text 7.3 Indicators of Strain

Physiological: Increased secretion of catecholamine, adrenalin, and cholesterol, raised blood pressure (hypertension), increased heart rate, dryness of throat and mouth, loss of/excessive appetite, and hyperexcitation.

Physical: Increased muscular tension, changes in breathing rate, elevated pulse, cold hands and feet, perspiration, sleeplessness, constant tiredness, headaches, backaches, indigestion, nausea, trembling, frequent urination, diarrhea, elevated voice pitch, circles under the eyes, restlessness, blurred vision, skin rashes, colds and minor illnesses, and change in sexual response (e.g., impotence).

Emotional: Greater displays of emotion, depression, irritability, anger, low self-esteem, apathy, anxiety (state), development of phobias (irrational fears), nervous laughter, defensive reactions to other people’s remarks, more judgmental of self and others, emotional withdrawal, emotional outbursts, crying, hostile feelings, frustration, tension, boredom, irritability, monotony, and unreality.

Psychological (cognitive): Inability to concentrate on tasks, sudden change in ways of thinking about or dealing with tasks, tendency to make more mistakes, difficulty in making simple decisions, increased forgetfulness, general decrease in performance, tendency to lose perspective, excessive daydreaming and fantasizing, less rational thinking, reliance on old programs, inability to concentrate, increased caution, and poor judgment.

Behavioral: Sudden changes in work (e.g., personal) habits (e.g., hygiene), lethargy, nervous laughter, increased use of nicotine/alcohol/other drugs, increased absenteeism, poor timekeeping, increased labor turnover, increased requests for early retirement, increased injury rate, increased disputes/strikes, refusal to take orders, alienation, speeded up (manic type) behaviors, avoiding work and other obligations, speech difficulties, increased clumsiness, increase in compulsive behaviors (e.g., shopping, cleaning), change in food intake, impulsive behavior, easily startled, taking too little exercise, taking short cuts, loss of interest in work, decrease in work performance, petty theft and vandalism (e.g., at work), sabotage, short tempered, inefficiency and incompetence (e.g., at work), inability to maintain personal relationships (at home and at work), low morale, reduced product quality, low productivity, marital and family breakdown, and social isolation.

Medical: Coronary heart disease (CHD), hypertension, stroke, ulcers (gastric, intestinal), colitis, irritable bowel syndrome, constipation, migraine headaches, allergies, asthma, hay fever, skin conditions (e.g., dermatitis), cancer, rheumatoid arthritis, multiple sclerosis, myalgic encephalomyelitis (ME), diabetes mellitus, injuries, obesity, (various) mental disorders (e.g., neurosis, mental breakdown), chronic insomnia, nightmares, panic attacks, and suicide.

(Epel et al., 2004). Much of the stress literature focuses on health-related outcomes of stress, whilst behavioral responses to stress, including job performance, turnover, absenteeism, use of alcohol, smoking, substance use, and destructive behaviors, are the least studied of all forms of strain, despite their importance to organizations (Cooper et al., 2001).
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7.3 Workplace stressors and injuries

Cooper and Marshall (1976) categorized the sources of occupational stress as follows:

- Intrinsic to job
- Role in organization
- Relationships at work
- Career development
- Organizational structure and climate
- Home–work interface

As will be seen from Summary Text 7.2, the organization and work environment together provide many opportunities for stressful encounters and ill health, ranging from working conditions to the role of the individual within the organization (Cooper, 1986).

These broad categories have been supported by other research, including Cox (1993), and Cartwright and Cooper (1997). Those that are intrinsic to the job include physical aspects of the working environment, such as noise and lighting, and psychosocial aspects, such as workload, and vary in importance depending on the job, for example, health care professionals may experience high workload, long work hours, time pressure, and inadequate free time (Wolfgang, 1988; Sutherland & Cooper, 1990), whilst money-handling and the threat of violence at work can be stressors for bus drivers (Duffy & McGoldrick, 1990). Sources of pressure are derived not only from inherent job factors, but also from the organizational context, such as the structure and climate of the organization (e.g., management style, level of consultation, communication, and politics). Research shows that organizational stressors can have more impact, even in seemingly stressful jobs, than can intrinsic job factors, for example, police (Hart et al., 1995; Thompson et al., 2001), ambulance staff (Glendon & Coles, 2001), and teaching occupations (Hart, 1994; Bradley, 2004). Hart et al. (1995) found that daily hassles associated with police organizations (e.g., communication and administration) were the main predictor of psychological distress amongst police officers, rather than harrowing aspects of the job itself, such as attending road traffic crashes. Sparks and Cooper (1999) emphasized the need to measure a broad range of stressors in order to reflect specific situations. A number of empirical studies have found that job-specific stressors are important in predicting outcomes for particular occupations (e.g., general practitioners, Cooper et al., 1989; anesthetists, Cooper et al., 1999) and that generic stressors vary between occupational groups (Sparks & Cooper, 1999). Significant differences have also been found between work groups and between departments within organizations, reflecting different subcultures (Cooper & Bramwell, 1992).

Sparks et al. (2001) identified four sources of stress, which have grown in importance, given the nature of recent changes in the modern business world: job insecurity, long work hours, control at work, and managerial style. Trends in working practices across Europe have witnessed an increase in work pace (Paoli, 1997) and the emergence of alternative work schedules, with some workers completing work shifts in excess of eight hours (Rosa, 1995), whilst others work compressed schedules so that a working week of 36 to 48 h is completed in three or four days (Sparks et al., 2001). In Europe, it is increasingly common to base work schedules on weekly, monthly, or yearly work hours (Brewster et al., 1996). Although EU legislation on working hours (EC Working Time Directive, 1990) has resulted in a slight decline in annual work hours, in other countries, particularly where labor markets have been deregulated (e.g., Australia, New Zealand,
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United Kingdom, United States) work hours have increased (Bosch, 1999). For example, an OECD (2004) survey reported that 40% of men and 12% of women in the United Kingdom work more than 45 h per week. A meta-analytic review of the literature found significant relationships between long work hours and workers’ mental and physical ill health (Sparks et al., 1997).

The psychological contract between employer and worker is being undermined to the extent that many workers no longer regard their work as secure (Cooper, 1999). A European survey (International Survey Research, 1995) conducted across 400 companies located in 17 countries revealed that employment security declined significantly between 1985 and 1995. This trend is reflected in worker perceptions of job insecurity, which are having serious effects on health and well-being in European workers (Borg et al., 2000; Domenighetti et al., 2000). North American workers are experiencing similar effects, for example, McDonough (2000) found that, for Canadian workers, perceived job insecurity was significantly associated with reduced general health and increased psychological distress. The introduction of lean production methods has been found to result in negative effects on psychological outcomes, including worker well-being (Parker, 2003). Although researchers have examined many of the negative effects of the changing world of work, few studies have explicitly examined effects on safety-related outcomes. One possible mechanism for the effects of workplace characteristics on safety outcomes is mediated by occupational stress. This possibility is discussed below.

Stress is considered to be responsible for 60 to 80% of all workplace injuries (Cooper et al., 1996). For example, in a study of 778 vets, Trimpop et al. (2000) used a questionnaire measure of job stress to gauge the presence of stress in the working environment (e.g., “I experience permanent stress involving the working atmosphere” and “I find my work strenuous”); job stress was found to be a significant predictor of work injuries. Kirkcaldy et al. (1997) found that job stress among a sample of 2500 doctors was a major predictor of work-related injuries and incidents. Experience of workplace stressors may have direct effects on performance, that is, increasing injury liability, or effects may be indirect, for example, being mediated by worker health and well-being. Exposure to long-term stressors will result in psychological and physical symptoms of ill health (e.g., depression, dissatisfaction, and physical illness); these symptoms can lead to lower performance and increased injury risk. For example, Houston and Allt (1997), in a study of junior house officers, found that psychological distress was linked to significant medical errors, as well as with everyday errors, supporting an association between stress symptoms and human error in organizations. In a maritime environment, Wagenaar and Groenweg (1987) found that workers made more frequent errors under high situational stress than would be expected by chance, and that social pressure had greater influence on job performance than did formal rules and procedures. Cooper and Cartwright (1994) identified individual symptoms (e.g., depressed mood, and raised blood pressure) as leading to mental and physical ill health, and also organizational symptoms (e.g., high absenteeism, high labor turnover) that led to frequent and severe injuries. This indicated that stress may also have effects at an organizational level to increase injury likelihood — for example, high absenteeism may lead to staff shortages, thereby increasing workload on remaining personnel and making errors more likely.

Workplace stressors that have been investigated by researchers in relation to work injuries have focused on intrinsic job characteristics (e.g., quantitative workload, work schedules, and exposure to risk and hazards), organizational roles (e.g., role ambiguity, role conflict, and role overload), relationships at work (e.g., quality of interpersonal relationships, and lack of social support from others in the workplace), and career development (e.g., job insecurity), with some attention given to the home–work interface. These are discussed in the following sections.
7.3.1 **Intrinsic job characteristics**

A number of intrinsic job characteristics have been identified as sources of strain, including the following:

- Quantitative overload — the amount of work required and time frame in which the work must be completed; a major source of strain is working under time pressure to meet deadlines
- Qualitative overload — where the individual does not have the opportunity to exercise skills or to develop potential ability
- Work hours — number of hours worked and work schedules, for example, as in shiftwork
- New technology
- Exposure to risk and hazards

Investigations of perceived time pressure and work demands upon work injuries have revealed mixed results. Work demands may have direct effects on injury risk as workers who perceive that they are under pressure to increase production may deviate from safety rules that impede their progress, or perform tasks with less care, increasing the likelihood of errors. Work pace (Zohar, 1980; Cooper & Phillips, 1994) and conflicts between safety and production have both emerged as significant factors in the safety literature (Diaz & Cabrera, 1997; Mearns et al., 1998). The introduction of new technology, such as computers, has led to problems associated with the use of visual display units (VDUs) and a range of work-related upper limb disorders, commonly referred to as repetitive strain injury (RSI) — see, for example, Peper and Gibney (2000).

### 7.3.1.1 Workload and work pace

Quantitative overload might be represented as having too much to do or having to perform tasks that are too difficult. While some people put great pressures on themselves and others, overload can result from insufficient delegation and poor time management. An extreme instance of job overload is trauma associated with work. Greiner et al. (1998) used observational job analysis to measure stress factors for 308 transit operators performing driving tasks. They found that two stressors were significantly related to vehicle crashes: time pressure and time binding (autonomy over time management). The risk of vehicle crashes was significantly increased for high time-pressure operators and for the medium time-binding group. The findings suggested that job design changes that reduced time pressure to meet deadlines and increased control over the timing of tasks, such as guaranteed rest breaks and flexible timing, would help to reduce vehicle crashes. Matthews and Desmond (2001) outlined strategies for reducing stress in a driving context through design and training techniques.

Gillen et al. (2002) found that perceived job demands (measured using the Job Content Questionnaire) were significantly related to injury severity amongst construction workers who had suffered falls (when confounding variables were controlled), such that higher job demands were associated with less severe injuries. An important variable to consider, in addition to the level of work demands, is the degree of autonomy or control that workers can exercise over the work environment. In Karasek’s (1979) demands–control model, strain occurs when high job demands are combined with low control, but not when control is high (see further discussion, Section 7.3.2). In Greiner et al.’s (1998) study, in addition to work demands, time binding (autonomy over time management) was a significant variable. Although Gillen et al. (2002) found the interaction between job demands and decision latitude was not significant, the authors noted that, “although most reported high
psychological job demands, they also reported a high degree of decision latitude” (p. 46). A number of studies support a relationship between autonomy and work injuries (Harrell, 1990; Hemingway & Smith, 1999), indicating that greater job autonomy is associated with fewer injuries. Parker et al. (2001) found a significant relationship between job autonomy and safe working. This relationship was fully mediated by organizational commitment, indicating that level of perceived control affects the degree to which workers feel committed to the organization, which in turn leads to more positive safety behavior. Implications of these findings for managing many workplace risks could include ensuring that once people are skilled and competent at their jobs, then in most cases they should be given sufficient autonomy to do their jobs without interference. In some circumstances, particularly where workers are able to exercise autonomy over their work, over-supervising could serve to reduce safety.

In addition to overload, job underload, such as repetitive, boring, routine, and under-stimulating work, has been associated with occupational stress. There may be inevitable periods in many jobs when boredom has to be accepted, even those in which task performance is critical for safety, for example, pilots or air traffic controllers. Boredom and disinterest in the job may adversely affect worker responses to emergencies. The nature of repetitive work varies between jobs, as do individuals’ susceptibilities to stress from such work. Cox (1985) described repetitive work as a discrete set of activities, repeated over and over again in the same order without planned interruptions by other activities or tasks. Activities are simple and unskilled, often with a short time cycle. Features of repetitive work are switching off and letting your mind go blank — strategies used, for example, by many assembly workers for coping with repetitive and monotonous tasks. A source of dissatisfaction and stress could be lack of control over the task (see later this chapter, Section 7.4.4), with workers enjoying little autonomy or responsibility. Underused skills and knowledge are frequently associated with repetitive work, as are high levels of machine pacing, often at relatively isolated workstations with reduced social contacts, low job complexity, and a lack of participation. Workers engaged in repetitive work suffer poorer health than do other occupational groups, which could be exacerbated by shiftwork that involves night working (Cox, 1985). In their study of repetitive work, pacing and short time cycle at a large car factory, Broadbent and Gath (1981) used the following health indices:

- Anxiety — feelings of tension and worry
- Depression — lethargy, inability to make an effort
- Somatic symptoms — for example, stomach upsets, giddiness
- Obsessional problems — for example, perfectionism, failures in control due to unwanted thoughts

The main findings from this study are outlined in Summary Text 7.4. From the findings, it seems that pacing rather than short cycle times, is a health hazard, and that people can become stressed without being dissatisfied with the job. Again there are indications that attention to managing risks of repetitive work could pay dividends in terms of increased worker health.

7.3.1.2 Work schedules and shiftwork

A number of studies have found shiftwork to be a stressor, particularly where it involves night work, the most obvious manifestation being disturbance of sleep patterns. Further research findings can be found as follows, regarding the effects of sleep and circadian rhythms on performance (Campbell, 1992), effects of time of day and performance (Smith, 1992), sleep deprivation (Tilley & Brown, 1992), vigilance (Nachreiner & Hänecke, 1992),
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Summary Text 7.4 Findings from a Study of Repetitive Work among Car Workers

- Workers doing repetitive work disliked the job but were not necessarily unhealthy.
- Workers who were well paced in their work showed a higher level of anxiety.
- Workers with a pronounced obsessional personality (i.e., meticulous, conscientious, and precise) were not less satisfied than others but they suffered more anxiety when they worked in paced jobs. Thus, it seems that those with an obsessional personality type (or trait) are unsuited to paced jobs. A worker who likes to check his/her work meticulously is likely to become anxious if he or she has no control over the speed of work.
- Short work-cycle times (under a minute) were not connected with either job dissatisfaction or ill health when compared with work cycles of up to half an hour in repetitive jobs.
- A slightly higher proportion of workers in paced jobs, compared with those in other jobs, may require psychiatric help.


and acute and chronic fatigue (Craig & Cooper, 1992). Other effects include disturbance of neurophysiological rhythms (e.g., blood temperature, metabolic rate), blood sugar levels, mental efficiency, and work motivation. Such effects may ultimately lead to stress-related disease (Monk & Tepas, 1985). Shiftwork may be exacerbated by repetitive tasks, one possible outcome of which is injuries. In a review of shiftwork and injuries, Carter and Corlett (1981) suggested that minor injuries were more likely to be due to overarousal or hyperalertness, associated with careless and disturbed behavior. More serious injuries and errors of omission tended to be due to low levels of alertness and automatic cerebral functioning, for example, as in monotonous tasks. Reviews of the effects of shiftwork on health include Harrington (1978) and Monk et al. (1996). Evidence suggests that performance deficits have implications for increased injury risk. For example, Leonard et al. (1998) assessed effects on junior hospital doctors, of working 32-h on-call shifts and the results showed adverse effects on psychological well-being and also significant detrimental effects on the doctors’ alertness and concentration when conducting simple tasks.

7.3.2 Organizational roles

Various aspects of role have been identified as sources of occupational stress. For example, role ambiguity (being unsure of what you are supposed to do), which may result from communication failure, can be distressing because it can lead to feelings of being out of control or being controlled by others. Role conflict (e.g., being expected to do two or more incompatible things) and role strain (e.g., doing something you feel you ought not to be doing) can also be stressful. Problems connected with role conflict were demonstrated in a study of dentists (Cooper et al., 1978). The dentists considered themselves to be inflictors of pain rather than healers and felt that their clinical role clashed with other nonclinical roles, such as performing administrative duties and building up their practice. In addition, their work roles interfered with their private lives. One adverse health outcome associated with the
dentist’s role was abnormally high blood pressure. Where a role entails responsibility for people and their safety, there is potential for occupational stress. For example, responsibility for people’s safety and lives was identified as a major source of long-term occupational stress for air traffic controllers (Crump et al., 1981). Carrying out work roles often involves developing relationships with others. Poor relationships with one’s superior, colleagues, and subordinates have been related to occupational stress, which may result in psychological strain and job dissatisfaction; good work relationships tend to have the opposite effect (see Section 7.3.3).

Other considerations affecting movement between roles in the organization hierarchy, or the lack of such movement, hinge upon career development. People may experience occupational stress as a consequence of being over-promoted or failing to obtain a job promotion, or they may experience confusion about their status in the organization, or feel a lack of job security. Individuals are liable to experience these feelings differentially, depending upon their career anchors as well as their fundamental career motivation (e.g., security, autonomy, entrepreneurship — see Schein, 1978, 1990). Blockages to career development may be particularly pronounced among women managers (Davidson & Cooper, 1983). The most adverse health and job satisfaction factors were associated with career development and related issues, for example, sex discrimination in promotion, inadequate training, insufficient delegation of assignments to women, and male colleagues being treated more favorably. Interactions between work and home roles have also been studied. Workers under stress could find the home a refuge from a competitive and demanding work environment. However, there is a danger of tensions from the work role spilling over to the domestic environment with detrimental consequences (Thompson et al., 2001). This may be aggravated in the case of dual career partners in a situation where both are experiencing occupational stress. Inability to balance competing demands of home and work successfully can be a major source of stress for many people, particularly evident when work is taken home frequently and the full holiday entitlement is not used.

Some evidence supports an association between role-related stressors and occupational injuries. Hemingway and Smith (1999) found that workload, role conflict, and role ambiguity were significantly related to work-related injuries for 252 Canadian nurses. The authors suggested that lack of job clarity could have a direct effect on injuries as this leads to the individual operating in unfamiliar situations, thereby increasing injury likelihood. In a sample of 362 Australian blue-collar manufacturing workers, Iverson and Erwin (1997) failed to find significant associations between workload, role ambiguity or role conflict, and occupational injuries. However, they found that workers undertaking more routinized jobs sustained fewer injuries. The authors suggested that workers undertaking routinized jobs were assigned less responsibility, which decreased their probability of injury, a finding that is supported by other studies on injuries amongst blue-collar workers (Hansen, 1989; Harrell, 1990).

### 7.3.3 Work relationships

Evidence suggests that the quality of interpersonal relationships and communication are significantly associated with work injuries. Trimpop et al. (2000) found that working climate (communication and relationships with staff) was significantly related to work injuries. From a longitudinal study of 161 manufacturing workers’ self-reported safe working practices, Parker et al. (2001) found that communication quality had a significant positive relationship with safe working — after controlling for prior level of this variable. Studies investigating the role of social support from coworkers and supervisors in relation to safety suggest an association with reduced injury rates (Sherry, 1991; Iverson & Erwin, 1997). Whilst a lack of social support may act as a source of strain (stressor)
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for workers (e.g., an unsupportive supervisor can contribute to feelings of job pressure), there is also evidence to suggest that social support acts as a moderator (buffer) in the stress–strain relationship (see Section 7.5.3).

Work relationships may also be experienced as a source of pressure when they are characterized by bullying, the experience of which can have severe negative effects on victims’ health and well-being (Hoel et al., 1999). Bullying can be reflected in actions designed to deliberately humiliate, ridicule, and socially isolate the person and is a form of behavior that can be exercised in subtle and devious ways, such as giving the victim an exceedingly difficult work target to achieve or denying them crucial information that is necessary to execute a task properly, thereby allowing the perpetrator to criticize the quality of the victim’s work performance. It can take place in the context of normal social interaction when, for example, colleagues make insulting remarks or play practical jokes at the other person’s expense (Leymann, 1996). Doyle (2003) advised those who feel they are being bullied to keep a diary of incidents because while any one incident alone may appear trivial, an aggregation of incidents can create misery and humiliation for those at the receiving end, eventually leading to a demoralizing experience with a real fear of facing the work day, or perhaps worse. Summary Text 7.5 gives some examples of bullying at work and how organizations might deal with this problem.

7.3.4 Job insecurity

Although there has been no empirical work on career development as a stressor in terms of the effects of promotion and career advancement on work injuries, Probst and Brubaker (2001) examined the effects of job insecurity (unemployment threat) on worker safety outcomes. They found job security to be significantly related to safety knowledge, safety motivation, and reported compliance with safety policies. Injuries were predicted by safety motivation, and to a lesser degree, by safety knowledge and compliance. The authors noted that, “workers operating under conditions of job insecurity choose to ignore critical safety policies and cut corners to maintain or increase their production numbers in an effort to retain their job” (p. 155). The relationship between job insecurity and safety motivation was partially mediated by production demands, suggesting that workers who felt less secure perceived a greater emphasis on production, which led to lowered motivation to attend to safety issues. This explanation relates to the notion that we all have finite cognitive resources, which must be divided between concerns—in this case for job security and maintaining productivity, leaving reduced capacity for safety-related activities (Probst, 2004a). A further, indirect effect could occur via the impact that lack of job security has in terms of increasing job dissatisfaction and psychological distress (such as anxiety) (see Section 7.5.2 for indirect effects of stress on work injuries). There is some evidence that certain aspects of safety climate (see Chapter 6) may moderate the relationship between job insecurity and safety outcomes (Probst, 2004b). This possibility is discussed further in Chapter 11.

The empirical work reviewed suggests that stressors at work contribute significantly to workplace injuries. However, there is also limited evidence to support a relationship between job stress and work-related injuries, such as vehicle crashes. Gulian et al. (1990) found that driver stress in a sample of U.K. drivers was associated with reports of work stressors, such as worries about redundancy and retirement. The authors suggested that work demands could influence some drivers’ general attitude and reactions toward driving. However, these results were not repeated in a sample of Japanese drivers (Matthews et al., 1999), where relatively small associations were found between occupational stressors, such as work demands and driver stress. Trimpop et al. (2000) found that for a sample of veterinary surgeons, job stress was significantly correlated with work injuries but not with car crashes.
Summary Text 7.5 Case Studies Illustrating Bullying at Work

Case study 1: An example of where bullying at work resulted in a victory for the person bullied

A computer analyst with nine years’ service resigned from a company in the financial services field, Credit Lyonnais Rouse, London, after being at the receiving end of public abuse from the financial director. Apparently the financial director swore at him in an open-plan office for allowing an old printer to remain on a filing cabinet in contravention of company rules. The case was brought to an industrial tribunal, which heard evidence from the financial director that he was unrepentant, claiming that he gave the analyst a severe, well-merited and public reprimand. From this statement one can conclude that the financial director’s behavior was not an unexpected aberration but part of his management style. The chair of the industrial tribunal rebuked the financial director, saying that he neither apologized nor sought to make amends for his discourteous behavior. The computer analyst was awarded £11,000 for constructive dismissal (Fursland, 1995).

Case study 2: Example of an initiative taken by an organization committed to confronting bullying and other undesirable workplace practices

The Director of Human Resources, Chelsea and Westminster Healthcare NHS Trust was quoted in the Trust’s in-house newsletter as saying that the Trust is committed to the physical and psychological health, safety, and welfare of its employees (Trust News, 2001). The Trust believes that all individuals have the right to be treated with dignity and respect at work and affirms that harassment, discrimination, or bullying at work, in any form, is unacceptable and is firmly committed to promoting a working environment free from all forms of hostility, so that staff are enabled to achieve their full potential, contribute more effectively to organizational success, and achieve higher levels of job satisfaction.

The Trust introduced a Dignity at Work Policy, which specified the different forms that harassment could take. The document provides advice on both formal and informal ways in which staff can tackle the problem. In particular any employee who believes that he or she is being bullied or harassed should avail themselves of the opportunity to discuss the situation confidentially with someone who is impartial, empathetic, and trained in issues of equality. The Trust set about recruiting a team of Harassment Advisers: The Harassment Adviser will be part of a team. The aim is to provide a professional, yet informal and friendly service, which staff can use with confidence, and which is independent of line management systems. Staff who are interested in this role are asked to come forward, and they will receive special training on a course lasting three and a half days. When trained they will offer confidential advice, guidance, and support to any member of staff who feels they are being harassed.

7.4 Individual differences and job stress

It has been suggested that because individuals differ in their reactions to stress, that individual differences will play an important role in the effect of job stress on injury liability (Sutherland & Cooper, 1991; Lawton & Parker, 1998). Therefore, it is important to explore
the role that individual differences can play in the relationship between stress and injury involvement.

7.4.1 Personality

Bolger and Zuckerman (1995) suggested that personality may play an important role in the stress process by influencing individuals’ exposure to stressful events (differential exposure), which then leads to outcomes, such as injuries; the relationship between personality and injury involvement is mediated by stress (see Figure 7.1). People with different personalities seek out different types of jobs — for example, Sutherland and Cooper (1991) found a high proportion of extraverts working on drilling rigs (the most hazardous area on offshore oil platforms), whilst Farmer (1984) found that a sample of pilots were more aggressive and dominant than the norm. Different jobs have different safety characteristics, requiring different skills and abilities — for example, where vigilance is required (such as air traffic control) errors are most likely to result in injuries. However, a well- defended system is most at risk from violation of safe working practices (Lawton & Parker, 1998), suggesting that individual differences are important in determining how individuals perform in varying work environments. The work of Sherry (1991) on person–environment (PE) fit has suggested that a poor PE fit is related to injuries. A poor PE fit is likely to result in direct effects on individuals’ behavior, but also indirect effects, as greater stress can increase injury likelihood.

An alternative view, and one that is more investigated in the literature, is the differential reactivity hypothesis, which maintains that certain dispositional variables may moderate the impact of job stressors on outcomes. There are several mechanisms by which personality may moderate the effects of stress, including the effect that personality has on individuals’ appraisals of situations (Cohen & Edwards, 1989) and their choice of coping strategies (see Figure 7.2). Individuals respond to stress in different ways depending on their personality, leading to a further effect via coping strategies — which also moderate the relationship between stress and injuries. Work by Matthews and colleagues (1996, 1998) demonstrated that drivers’ stress responses increase crash risk on the road. An aggressive response to driver stress was most predictive of increased crash involvement (Matthews et al., 1998). Aggressive driving predicted more frequent and more error-prone overtaking — behavior that is related to increased frequency of use of confrontational coping strategies in interaction with other vehicles (Matthews et al., 1998).

Evidence supports the role of a number of personal characteristics as moderating the stress–strain relationship, including Type A behavior pattern (TABP), negative affectivity, locus of control, and self-esteem (Spector & O’Connell, 1994). These individual differences are discussed in relation to work injuries in Section 7.4.2 to Section 7.4.5.

Figure 7.1 Stress as a mediator between personality and injury involvement.

Figure 7.2 Personality as a moderator of the relationship between stress and injuries.
Summary Text 7.6 Type A Behavior Characteristics

Extreme competitiveness, striving for achievement, aggressiveness, haste, impatience, restlessness, hyper-alertness, explosiveness of speech, tenseness of facial muscles, feelings of being under time pressure, feeling challenged by responsibility, and committed to work so that other areas figure little.

7.4.2 Type A behavior pattern (TABP)

TABP is characterized as displaying very high levels of concentration and alertness, achievement striving, competitiveness, time urgency and aggressiveness on one hand, and irritability, hostility, and anger, on the other (Friedman & Rosenman, 1974). People who are characterized as being Type A are easily provoked and always concerned with meeting deadlines. Summary Text 7.6 outlines typical Type A behavioral characteristics: Type B behavior is the opposite of Type A.

Individuals who are susceptible to TABP tend to be professional/managerial (typically white and male), aged between 36 and 55 years, and living in urban environments. Type A personalities show a tendency to suppress stress symptoms and fatigue because they believe that illness might interfere with completing important tasks. Where a Type A person feels a lack of control at work, conflict can ensue. This conflict can give rise to stress, which in turn contributes to some uncertainty in setting work goals, handling information, and task performance (Davidson & Cooper, 1981). Individuals high on TABP may actively position themselves in situations that require ambition, drive, and competitive behavior and therefore expose themselves to a more stressful working environment. Sutherland and Cooper (1991) concluded that certain personality characteristics, such as TABP, predisposed some individuals to perceive the work environment to be stressful and also to be injury-involved. Some evidence supports the differential exposure hypothesis in terms of injury involvement. For example, evidence suggests that individuals who demonstrate high TABP are more crash involved (Perry, 1986; Evans et al., 1987; Sutherland & Cooper, 1991; Magnavita et al., 1997), although West et al. (1993) found that TABP was associated with faster driving but not with increased crash risk.

Two questionnaire measures, the Jenkins Activity Survey (Jenkins et al., 1971) and the Bortner Rating Scale (Bortner, 1969) have been developed to determine associations between TABP and crash involvement. Perry (1986) found significant correlations between scores on the Jenkins Activity Survey and number of crashes (0.29) and violations (0.35) and a questionnaire measure of driving impatience in a sample of 54 students. However, no account was taken of risk exposure, age, or sex. A study of bus drivers in the Unite States and India using the Bortner Rating Scale (Evans et al., 1987) found that drivers characterized as Type A in both countries had higher crash rates than did those characterized as Type B, and that for an Indian sample TABP was associated with more frequent braking, passing, and sounding the horn. Sutherland and Cooper (1991) found that TABP was associated with significantly more work injuries, greater job dissatisfaction, poorer levels of psychological well-being, and higher levels of stress.

It is possible that greater crash involvement is associated with TABP in individuals who display anger/hostility, as these individuals are more likely to express aggression; general anger is predictive of anger as a response to impeded progress on the road, which is predictive of an aggressive response (Lajunen & Parker, 2001). TABP would be related to crashes due to increased propensity for violations, such as speeding. This is supported by West et al. (1993), who found that TABP was significantly predictive of driving speed,
and by Perry (1986), who found a significant relationship between TABP and violations. However, because much of the research relating to TABP is conducted within a road traffic environment, more research is needed to determine whether these findings can be replicated within a work context. The TABP concept has also been criticized. It has been suggested that it may cover two or more underlying dimensions, which are canvassed to differing degrees by different measures; the Bortner scale, for example, appears to factor into one dimension of competitiveness and one of speed (Edwards et al., 1990).

There is some support for TABP as a moderator of the stressor–strain relationship (Payne, 1988; Moyle & Parkes, 1999) but other studies demonstrate little support (Burke, 1988; Edwards et al., 1990; Jamal, 1999). Ganster et al. (1991) suggested that individuals who display anger/hostility toward people may be more prone to experience adverse consequences of stressful work conditions (compared with TABP individuals who are low on this dimension), as only this dimension, not TABP as a whole, was related to physiological outcomes. Similar results were found using the Jenkins Activity Survey, where the anger/hostility dimension was associated with physical illness (Lee et al., 1993).

George (1992) argued that TABP is not associated with psychological strain or distress, but that there is evidence to suggest greater risk of physical health problems. Choice of coping strategies may influence the impact of high TABP on injury involvement — for example, a person may cope with work overload by working overtime, thereby increasing fatigue and increasing injury or error likelihood. Some stressors may be self-created, for example, an abrasive personality can create interpersonal conflicts.

7.4.3 Negative affectivity

Negative affectivity (NA) reflects a relatively stable predisposition to experience low self-esteem and negative emotional states (Watson & Clark, 1984). The tendency to experience negative emotions (NA) has a significant positive relationship with occupational injuries (Iverson & Erwin, 1997). NA may act as a vulnerability factor as high scoring individuals are more susceptible to the effects of stress-inducing environments (Parkes, 1990). Spector et al. (2000) outlined six mechanisms for the effects of NA in the stressor–strain relationship. There is some evidence to support each mechanism, suggesting that NA does not have a simple relationship within the stress process. Evidence suggests that each of the first three explanations could account for the relationship between NA and injury involvement (see Summary Text 7.7). In addition, high NA has been associated with the use of relatively ineffective coping strategies (Sutherland & Cooper, 1991; Dorn & Matthews, 1992; Iverson & Erwin, 1997).

7.4.4 Locus of control

Locus of control (LoC) has been considered in both a general sense (Rotter, 1966) and as related specifically to issues such as health (Calnan, 1988; Niven, 1989; Schank & Lawrence, 1993) and safety (Jones & Wuebker, 1993). In going through life, some people make their way by reacting to situations as if they were ruled by fate. Other people, in similar situations, strive to control events to their personal advantage. In the former case, it is as if these individuals felt that the outcome of their efforts are controlled by forces and events external to themselves, while in the latter case the prime belief is that one can exert internal control to exploit situations so that outcomes result from applying personal characteristics and effort. This view of personality is known as the internal–external locus of control, developed by Rotter (1966). Internals consider themselves to be authors of their own destiny so that their health and safety would be regarded as dependent upon their experience, skill, and judgment. In contrast, externals consider that whatever experience, skill, and judgment
Summary Text 7.7 Possible Effects of Negative Affectivity (NA) on the Stressor–Strain Relationship

- Symptom perception — NA directly affects perceptions of stressors (high NA have a negative world view). High-NA individuals were found to report significantly higher levels of eight out of nine stressors, higher job dissatisfaction, and poorer levels of mental health (Sutherland & Cooper, 1991).

- Hyperresponsivity — NA is more sensitive to the impact of stressors, therefore NA has a direct effect on strain. Neuroticism was the strongest single predictor of driver stress (Matthews et al., 1991), suggesting that neurotics may respond more negatively to the presence of stressors, increasing their vulnerability to vehicle crashes.

- Differential selection — high NA-individuals are more likely to be found in jobs that are stressful (low autonomy and job scope). Sutherland and Cooper (1991) expected that high-NA individuals would prefer a nonstimulating environment and would be employed on the production platform, rather than drilling; however, significantly more high NA were found on drilling rigs (more stressful).

- Stress creation — behavior of high-NA individuals gives rise to stress, particularly by creating conflict and difficult social environment.

- Transitory mood — NA is an outcome of mood, affected by job conditions.

- Causality — consistent exposure to stress induces high NA.


they possess could easily be counteracted by the many factors that are outside their control. Either powerful others (e.g., God, employers, managers, politicians, or decision makers) or fate (e.g., luck, chance, fate, destiny, or predetermination) are considered by externals to be the main architects of their future.

Individuals who perceive that injuries happen due to forces outside their control (external LoC) may be less likely to take personal responsibility for safety or to take precautions to prevent injuries occurring. This suggests that an external LoC would be significantly related to injury involvement. However, effects reported in the literature are generally fairly small and inconsistent. Using their safety LoC scale, Jones and Wuebker (1993) found that externals suffered more injuries than internals did. However, studies using the widely used Rotter scale have found that internals have more injuries (Mayer & Treat, 1977; Sims et al., 1984) or that there is little relationship (Janzen, 1983; Guastello & Guastello, 1986; Iversen & Rundmo, 2002). Looking at self-reported traffic crashes, Clement and Jonah (1984) found that male externals reported more crashes, but that female internals reported more crashes (both were quite small effects). A meta-analysis of traffic injuries (Arthur et al., 1991) suggested a small–moderate effect for external LoC on crash involvement.

There is tentative evidence that LoC has a buffering effect on the stressor–strain relationship (Cohen & Edwards, 1989), although Semmer (1996) indicated mixed evidence in occupational settings. This suggests that an internal LoC could also influence injury involvement by buffering the individual from the negative consequences of stressors, protecting worker health and well-being, thereby reducing injury likelihood. Again, there is little reported evidence to support this hypothesis in relation to work injuries.
7.4.5 Self-esteem

Individuals with low self-esteem are more reactive to adverse conditions as they respond more to external cues; they experience uncertainty about the correctness of their thoughts and emotional reactions, seek social approval, and tend to be more self-critical, they also use more passive coping strategies (Ganster & Schaubroeck, 1995). Evidence supports self-esteem acting as a buffer against negative effects of stressors (Cooper et al., 2001). A few empirical studies link self-esteem with road traffic crashes, but there is little in relation to work injuries. Norris et al. (2000) found that lower self-esteem was significantly associated with more traffic crashes, a similar finding being reported by Smith and Heckert (1998). However, in a sample of young male drivers, Vavrik (1997) found a significant relationship between high self-esteem and crashes — male adolescents may use risky driving as a way of showing off and increasing self-esteem (see Chapter 5).

The relationship between low self-esteem and vehicle crashes may reflect the dislike of driving dimension of driver stress (Gulian et al., 1989; Matthews, 2001). In general, driver-stress outcomes may result from appraisals that the demands of driving exceed or tax the person’s ability to cope with those demands. The dislike of driving dimension reflects the individual’s negative appraisals of personal competence as a driver. This aspect of driver stress would relate to people who are low in self-esteem, as these individuals regard failure as self-diagnostic and thus more stressful (Brockner, 1988), affecting the way that they appraise situations. In terms of driving behavior, individuals who score high on dislike of driving perceive themselves as low in skill and judgment and tend to adopt emotion-focused coping strategies, which generate worries that can interfere with vehicle control thereby increasing their crash potential (Dorn & Matthews, 1992). In contrast, some individuals may gain self-esteem from driving (Vavrik, 1997) — through risky and aggressive driving. This may relate to a different dimension of driver stress, namely driving aggression, which may be associated with negative appraisals of other drivers as hostile and threatening. This leads to the adoption of confrontational coping strategies, which generate risky and dangerous behaviors, thereby increasing crash risk.

7.5 Mechanisms linking stress with injuries

The link between occupational stress and work-related injuries remains under-researched. However, it appears that there are two major ways in which occupational stress affects work injuries — direct effects on workers’ behavior and indirect effects mediated by worker health, well-being, and work attitudes (Clarke & Cooper, 2004). Table 7.1 summarizes associations between stress and injury involvement. Several factors moderate the relationship between stressors and stress outcomes, including level of social support, coping strategies employed, and individual personality characteristics.

7.5.1 Direct effects of job stress on injuries

Reason (1995) described an active failure pathway, where organizational factors lead to violation-promoting and error-producing conditions in the workplace, increasing the likelihood of unsafe acts, which can lead to injuries. Job stress can therefore directly affect unsafe acts (e.g., mistakes, slips, and lapses that can result in injuries) by acting as violation-promoting and error-producing conditions. For example, Reason listed, “high workload, deficient tools and equipment, time pressure, fatigue, low morale and conflicts between organizational and workgroup norms” amongst the, “local conditions that promote the commission of errors and violations” (p. 1710). Parker et al. (1992a) distinguished between error-producing factors, which adversely affect
### Table 7.1 Effects of Job Stress on Work Injuries

<table>
<thead>
<tr>
<th>Source</th>
<th>Effects on work injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute stressors (e.g., time pressure, noise, excessive workload)</td>
<td>Reduction in workers’ capacities (e.g., slower reaction time, suboptimal decision making processes)</td>
</tr>
<tr>
<td></td>
<td>Distractions increase error likelihood</td>
</tr>
<tr>
<td></td>
<td>Taking shortcuts (violations)</td>
</tr>
<tr>
<td></td>
<td>Effects are temporary, for duration of the stressful period</td>
</tr>
<tr>
<td>Ongoing (chronic) stressors (e.g., time pressure, work overload, oppressive management style)</td>
<td>Direct effects (e.g., lack of job clarity leads to working in unfamiliar situations) increase error likelihood</td>
</tr>
<tr>
<td></td>
<td>Indirect effects mediated by reduced mental and physical health (depression, anxiety, dissatisfaction, physical ill health) lead to lowered capacity and motivation</td>
</tr>
<tr>
<td></td>
<td>Effects are long term</td>
</tr>
<tr>
<td>Stressful working environment leads to high absenteeism and staff shortages</td>
<td>Remaining staff experience increase in work pressure, leading to increased injury likelihood.</td>
</tr>
<tr>
<td>Relationship between stress response and injury involvement is moderated by personality characteristics</td>
<td>Creation of violation inducing conditions</td>
</tr>
<tr>
<td>Stress mediates the relationship between personality and injuries</td>
<td>Certain individuals (e.g., high Type A) are predisposed to perceive the work environment to be more stressful</td>
</tr>
<tr>
<td></td>
<td>Individuals, with these personal characteristics, have increased injury likelihood</td>
</tr>
<tr>
<td>Social support has an indirect effect on injuries by buffering the individual against the effects of job stress</td>
<td>Certain individuals may actively position themselves in situations that expose them to a more stressful working environment</td>
</tr>
<tr>
<td></td>
<td>Individuals respond to stressors differently depending on their personality, leading to a further effect via coping strategies, which moderate the relationship between stress and injuries</td>
</tr>
<tr>
<td></td>
<td>Lack of social support results in psychological strain, which in turn reduces capacity and increases injury liability (error producing conditions)</td>
</tr>
<tr>
<td></td>
<td>Social support also has a direct effect on safe behavior by increasing safety motivation</td>
</tr>
</tbody>
</table>


Information processing, and violation-promoting factors, which influence attitudes, beliefs, and group norms. Error-producing factors include: high workload, inadequate knowledge, ability, or experience, poor interface design, inadequate supervision, change, stressful environment, and mental state (e.g., fatigue, preoccupation, distraction, and anxiety).
Thus, direct effects of stress on unsafe acts (e.g., errors and violations) are likely to occur as a result of error-producing conditions, such as high workload, stressful environment (e.g., high demands combined with low control), and mental state (e.g., fatigue, distraction, and anxiety), and violation-promoting factors, such as low morale and time pressure. Violations, whilst having negative consequences per se, also bring perpetrators into areas of greater risk, where errors are less readily forgiven (Reason, 1995).

7.5.1.1 Effects of acute stressors

Much research examining the impact of stress on work injuries has focused on the effects of acute stressors (e.g., time pressure, noise, threat, and workload) on human performance. Steffy et al. (1986) developed a model of the relationship between stress and injuries in which stressors cause acute reactions (e.g., anxiety, fatigue), which decrease cognitive and performance capacities, such as reaction times and judgment, thereby increasing error probability. The increased injury risk is temporary, as alleviation of stress symptoms (e.g., anxiety) results in the return of the worker’s capacities to normal levels (Murphy et al., 1986). A stressful environment may also distract the worker from the task, increasing error likelihood, encouraging violations, and promoting suboptimal decision making. Acute stressors can affect the commission of violations by acting as violation-promoting conditions, that is, a temporary effect in which experiencing a stressor (e.g., time pressure) encourages shortcuts and rule bending. Experiencing acute stressors, such as excessive time pressure or work overload, can lead to supervisors turning a blind eye to rule violations to reach production targets. Thus, acute stressors can lead to temporary adjustment of what is deemed acceptable, placing production over safety as a priority. Risk management implications of such situations could include learning from some of the methods used by so-called high-reliability organizations (LaPorte & Consolini, 1991; Weick & Sutcliffe, 2001; Ash & Smallman, 2003; see also Chapter 11).

A further effect of experiencing high levels of stress symptoms (e.g., experiencing unpleasant emotional states and high emotional arousal) is maladaptive decision making (Janis & Mann, 1977). For example, faulty decision making resulted from the heightened tension experienced as a result of acute stress in the case of the shooting down of an Iranian airliner by the USS Vincennes (see Summary Text 7.8). Ways of coping with psychological stress are characterized by different forms of ineffective information processing strategies (unconflicted adherence, unconflicted change, defensive avoidance, and hypervigilance) — see Summary Text 7.9. Effective decision making is characterized by vigilance. For issues related to group decision making, see Chapter 8.

7.5.1.2 Effects of chronic stressors

Whilst acute stressor effects are largely cognitive, influencing the way in which individuals process information, chronic stressors (i.e., those continuing over extended time periods) can also affect cognitive processes, but are likely to have more wide-ranging effects on motivation, attitudes, behavior, and physiological function. Exposure to long-term stressors can directly affect performance (Hemingway & Smith, 1999), but can also result in psychological and physical symptoms of ill health (e.g., depression, dissatisfaction, and physical illness), which can lead to lower performance and increased error proneness — see discussion of indirect effects in Section 7.5.2.

Evidence suggests that exposure to a stressful working environment has a direct effect on how we process information. Hockey et al. (1996) suggested that stress directly affects performance by encouraging shortcuts in cognitive processing as a means of reducing mental effort. Reason (1990) argued that while stress does not cause errors it can lead to adopting certain cognitive styles that result both in higher rates of absentmindedness and
Summary Text 7.8 Account of the Shooting Down of an Iranian Airliner by the USS Vincennes

USS Vincennes was operating in the Persian Gulf, near the Strait of Hormuz, on the morning of July 3, 1988, when one of its helicopters was fired on by three Iranian gunboats. Five minutes later, Vincennes detected an aircraft taking off from Bandar Abbas airport. The ship radioed seven warnings to the plane, to which the aircraft failed to respond. Captain Will C Rogers III identified the plane as a hostile F-14, approaching at an altitude of about 7000 feet and descending, and ordered two surface-to-air missiles to be fired. It was subsequently revealed that the aircraft shot down by the Vincennes was in fact not an F-14 fighter, but an Iran Air Airbus A300 civilian jetliner en route to Dubai. All 290 people aboard (including 66 children) were killed.

On the face of it, it would appear almost inexplicable that a professional and well-trained U.S. Navy crew could make such a mistake: an F-14 fighter plane is much smaller (about one-third of the size) and sleeker than a passenger plane. The Iran Air Airbus was also flying on a recognized commercial route, and had been climbing (not descending) at an altitude of about 12,500 feet (not 7000 feet) when it was shot down. It was also holding a steady speed, and not rapidly approaching the warship, as its captain claimed.

Consideration of the mitigating factors described below can illuminate the captain’s decision making under psychological stress:

- Due to the sand haze that shrouded the Gulf, the approaching plane was not visible to the naked eye, so the crew had to depend upon their instrumentation.
- The plane would have appeared as a smaller dot on the radar than might have been expected, as it was flying toward the warship head-on.
- The Bandar Abbas airport, from which the aircraft had taken off, served both civilian and military craft, and acted as the center of Iran’s F-14 operations. Aircraft taking off from this airport were automatically tracked.
- Although he had initially identified the plane as a commercial airliner, Petty Officer Anderson, could not find the flight listed. Warnings sent out to the aircraft, four over the military emergency channel, and three over the civilian emergency channel, received no response, possibly because all the plane’s channels were in use, or the warnings used the wrong frequencies. None of the warnings were broadcast over air traffic control. Andersen then identified the plane as a military aircraft.
- The crew were aware that the previous year the USS Stark had been fired upon by a fighter plane, killing 37 U.S. sailors. This would certainly have raised anxiety and expectations.
Chapter seven: The role of stress in safety and risk

Summary Text 7.9 Ineffective and Effective Information Processing Strategies

Ineffective strategies:

- Unconflicted adherence — ignores information about risk of losses, continues present course of action.
- Unconflicted change — uncritically changes to new course of action, ignoring risk consequences.
- Defensive avoidance — identifies serious risks in both alternatives — three ways of coping through procrastination, shifting responsibility to another or rationalization (only attending to positive aspects of possible solutions).
- Hypervigilance — obsessed with serious risk of loss, vacillation between alternatives, rapid search for other options — characterized by reduced memory span and simplistic, repetitive thinking (a “panic” reaction).

Effective strategy:

- Vigilance — identifies and assesses risks, looks for relevant information, and evaluates risks involved in alternatives before making a decision.

Allt (1997) found that psychological distress in doctors was linked with significant medical errors, in addition to everyday errors. Melamed et al. (1989) argued that preoccupation with disturbing work characteristics, such as stressors, could act as a distracting factor reducing attention to danger cues. This highlights the contribution of job stress to the type of mental state associated particularly with skill-based errors such as preoccupation and distraction (see Chapter 4).

Experiencing occupational stress in situations characterized by both excessive work demands and psychological distress is significantly associated with fatigue (Hardy et al., 1997). Rosa (1995) found excess fatigue, sleepiness, and significant loss of sleep to be typical of workers on extended work shift schedules (10 to 12 h shifts). Moreover, within an extended shift, Rosa et al. (1989) found evidence of performance deficits, decreased reaction time and grammatical reasoning performance, and increased subjective fatigue after a 7-month period of 12 h shifts (compared with the previous 8 h shift pattern). This evidence suggests that fatigue is significantly associated with work stressors, particularly high work demands and long hours, which results in reduced performance and increased error likelihood.

Whilst acute stressors may lead to a temporary adjustment of safety priority (e.g., placing production over safety when under time pressure), when high exposure to stressors comes to be experienced as the norm — rather than the exception — a permanent change in workplace safety climate can occur, such that workers develop negative perceptions of the organization’s commitment to safety, as evidenced in actions and attitudes of managers and supervisors (see Chapter 6). The relationship between job stress and safety culture is discussed further in Chapter 11.

7.5.2 Indirect effects of job stress on injuries

The following sections consider indirect effects of stress on injuries, both in terms of work-related attitudes, such as job satisfaction, as well as general health and well-being.
In each case, job stress influences a third variable (e.g., attitudes, health), which in turn influences injuries, the effect being indirect or mediated (see Figure 7.3).

### 7.5.2.1 Work-related attitudes

One possible mechanism for the indirect effects of job stress on injuries is that it is mediated by work-related attitudes, including job satisfaction, organizational commitment, and job involvement. The most commonly measured attitude in relation to job stress is job satisfaction, or rather job dissatisfaction, which is frequently used as an indicator of psychological strain. The link between occupational stress and job dissatisfaction, such that increased stress results in greater job dissatisfaction is well documented (Jackson & Schuler, 1985; Jex & Beehr, 1991; Kahn & Byosiere, 1992). Evidence also suggests a causal relationship between job dissatisfaction and work-injury involvement. For example, job satisfaction is significantly lower for workers who have experienced a job-related injury (Holcum et al., 1993; Lee, 1998). In cross-sectional research, it is possible that this relationship reflects a lowering of job satisfaction as a result of experiencing an injury, as well as a causal link between job dissatisfaction and injury involvement. However, in support of a causal relationship, low morale and negative work attitudes are associated with attentional deficits and skill-based errors (Edkins & Pollock, 1997) and are significantly predictive of future errors (Van der Flier & Schoonman, 1988). Probst and Brubaker (2001) found that job-security perceptions were strongly related to job satisfaction, which in turn was an important predictor of safety motivation and knowledge — in both cross-sectional and longitudinal analyses, suggesting that job satisfaction does significantly impact on workers’ safety behavior. Job satisfaction is also related to risk perceptions. In hazardous work environments, greater perceived risk is associated with low job satisfaction (Fleming et al., 1998) and satisfaction with both workplace conditions and work in general (McClain, 1995). These findings suggested that job satisfaction is linked with enhanced safe working, whilst job dissatisfaction is associated with lowered job performance and increased injury liability. Implications for risk management include giving adequate attention to job dissatisfaction and other potential factors that can affect safety.

There is also support for the hypothesis that experiencing an injury results in lowered job satisfaction. Using a sample of 9908 Australian workers across eight different occupations, Barling et al. (2003) found that workplace injuries resulted in a perceived lack of influence and a distrust of management, both of which predicted job dissatisfaction. This could suggest a circular relationship whereby experiencing an injury further exacerbates the job dissatisfaction — injury involvement relationship — making future injuries more likely.

### 7.5.2.2 General health

The injury causation model developed by Oliver et al. (2002) included direct effects of organizational involvement (supervisor’s response, coworker’s response, and safety...
Chapter seven: The role of stress in safety and risk

management) and the physical work environment (environmental conditions, noise, workload, and hazards) on work injuries. Significant paths in the model support indirect effects, mediated by general health (anxiety checklist, GHQ anxiety, and GHQ depression). The mediating role of general health supports the proposal by Cox and Cox (1993) that stress processes mediate effects of both organizational and physical hazards on the individual. Other research supports an association between health promotion and reduced injury rate (Shannon et al., 1997; Mearns et al., 2003). This suggests that better worker health and well-being may act to increase resistance to stress, which in turn reduces injury liability; whilst, on the other hand, workers suffering psychological distress, such as anxiety and depression, are more prone to errors and injuries. Possible methods of maintaining worker health and well-being in the workplace, such as health promotion programs, are discussed later in the chapter (Section 7.6).

7.5.3 The role of moderating factors

A number of factors may moderate the relationship between job stress and work injuries, that is, the relationship is stronger or weaker depending on a third variable (the moderator), such as social support or coping strategies employed (see Figure 7.4). For example, strong support from coworkers and supervisors may weaken the relationship between job stress and injuries, such that even where stressors are present, because social support helps to protect the individual from negative effects of stress, they are less likely to result in injuries. The role of social support will first be discussed and then coping strategies. The role of personality was discussed in relation to injury involvement, including its role as a moderator in the stress–injury relationship earlier in this chapter (Section 7.4.1). Individual differences, such as personality, also influence choice of coping strategies.

7.5.3.1 Social support

Social support is important as it is thought to buffer job stress, that is, individuals who have access to social support are better protected from psychological strain (House, 1981; Kirmeyer & Dougherty, 1988). However, reviews of the literature indicate only weak support for stress-buffering effects of social support on psychological strain (Cooper et al., 2001). There is some evidence that buffering effects may be washed out in the presence of chronic (ongoing) stressors (Lepore et al., 1991) or even have a reverse buffering effect, heightening rather than mitigating psychological strain (Kaufmann & Beehr, 1986).

In organizational settings, immediate colleagues and first-line supervisors often provide social support. Supervisory support is defined as amount of consideration expressed by an immediate supervisor for subordinates (Michaels & Spector, 1982) and

Figure 7.4 Effects of moderating factors on the relationship between job stress and work injuries.
coworker support as amount of consideration expressed by coworkers (Blau, 1960). Schaubroeck and Fink (1998) found that significant demands–control–support interactions were more consistent for supervisory support than for support from coworkers, such that high support ameliorates effects of high strain (low control, high demand) jobs. However, three-way interactions typically account for a small proportion of the variance (1 to 3%) (Parkes et al., 1994). House (1981) differentiated between the four kinds of social support as follows:

- Instrumental — giving direct help, often of a practical nature
- Emotional — showing interest, understanding, caring, and sympathy with a person’s difficulties
- Informational — giving information that may help a person deal with their problems
- Appraisal — providing feedback about a person’s functioning that could enhance their self-esteem

Research into effects of social support on stressor–strain relationships has focused on instrumental and emotional support. In terms of injury reduction, social support could take an informational role, by providing information to workers on how to deal with safety-related problems, having a direct effect on worker behavior. It could also have a buffering effect, reducing psychological strain associated with workplace stressors, by providing instrumental support (by helping an individual attend to their problems) and emotional support (by modifying their perception that the stressor is damaging their well-being). Buffering workers against psychological strain, particularly over time, could help to ameliorate adverse effects on job performance associated with mental and physical ill health. However, in terms of managing the risks, effort is required to sustain those effects in the longer term.

Iverson and Erwin (1997) examined supervisory and coworker support in relation to occupational injuries experienced by Australian manufacturing workers, where social support variables were operationalized by a modification of the House (1981) scale. They found that supervisory and coworker support had a significant negative relationship with occupational injuries, such that greater support was associated with fewer injuries. In this setting, the relationship was thought to stem from supervisors and coworkers providing greater levels of task and informational assistance to workers in carrying out their jobs, that is, increased level of informational support. Hemingway and Smith (1999) reported similar findings in a study of occupational injuries amongst nurses, which included supervisor support as an element of organizational climate (subscale of work environment scale — Moos & Insel, 1974). Supervisor support was negatively correlated with unreported injuries and near injuries (but not with reported injuries). Significant correlations were also found with peer cohesion for reported injuries and near injuries, indicating that a close relationship with colleagues was associated with fewer injuries. Gillen et al. (2002) used the Job Content Questionnaire (JCQ) to measure decision latitude, psychological demands, and social support (supervisor support and coworker support) in a sample of construction workers. They found no significant correlations between psychological job demands, decision latitude, or social support with injury severity. However, supervisor support approached significance ($r = 0.12, p = 0.056$). In a longitudinal study of manufacturing workers, Parker et al. (2001) found that supportive supervision had a lagged positive effect on safe working 18 months later. Therefore, there is consistent evidence of a significant relationship between social support, particularly from supervisors, and occupational injuries/safe working, suggesting that social support encourages safer working and reduces the number of occupational injuries experienced by workers. Implications for risk management include developing and implementing appropriate policies for supervisory support.
Further research has examined the influence of managers’ concern for workers’ general well-being, related to the element of individualized consideration (leader shows interest in the personal and professional development of subordinates — Bass, 1985). The nature of leadership, and its relationship with health and safety, is discussed in Chapter 9. A supervisor whose leadership style is characterized by individualized consideration would be more likely to demonstrate concern for subordinates’ welfare, including emotional support. Zohar (2002b) argued that a leader’s concern for members’ welfare influenced safety behavior; supervisory response to safety was an interactive function of concern for members’ welfare and senior management’s safety priorities. Greater concern for subordinates’ welfare is based on closer individualized relationships, which promotes safety-related supervisory practices and, in turn affects workers’ safety behavior. Hofmann and Morgeson (1999) found that high-perceived organizational support was predictive of safety communication, which in turn indirectly affected injuries via safety commitment. Examining supervisor support for safety separately from management support, Thompson et al. (1998) found that these two variables mediated different relationships — supervisor support mediated the relationship between supervisor fairness and safety compliance, whilst management support mediated the relationship between organizational politics and safety conditions. Parker et al. (2001) reported a significant positive relationship between supportive leadership and safety communication, with a lagged effect on safety-compliance behavior. This research indicated that supportive supervisors build more positive relationships with their subordinates, encouraging more open, informal communications, which in turn, leads to higher levels of safety commitment and compliance amongst workers.

Other studies have employed measures reflecting social support that have a more specific emphasis on safety. The instrument employed by Oliver et al. (2002) gauged safety support and behavior and was based on measures developed by Melia et al. (1992). Supervisory support reflects supervisors’ attitude toward safety — positive or negative contingencies that the supervisor gives and supervisors’ safety behavior. Tomás et al. (1999) reported significant positive relationships between workers’ safe behavior and both supervisory response and coworkers’ responses. Social support, measured by supervisory support and coworker support, included by Oliver et al. (2002) as organizational involvement, had a significant direct effect on injuries, but also significant indirect effects, mediated by general health and safe behavior. These findings support an earlier suggestion that social support may reduce injuries by two means — directly by facilitating safe behavior and indirectly by buffering workers from psychological strain, thereby protecting their mental well-being.

### 7.5.3.2 Coping strategies

Most people use a number of types of coping strategies to deal with stress (Folkman & Lazarus, 1988). A popular distinction is between problem-focused strategies — which involve dealing directly with the problem, and emotion-focused strategies — which involve dealing with feelings about the problem. In general, proactive problem solving has a more positive effect upon personal well-being (Folkman et al., 1986), while emotion-focused coping has been linked with poorer long-term psychological adjustment (Billings & Moos, 1984; Terry, 1991). Although this link with well-being may depend on the nature of the problem, where the source of the stress is intractable, those individuals who prefer more problem-focused coping strategies may actually fare less well than those who prefer emotion-focused coping if tackling the problem has little effect and could result in feelings of powerlessness and frustration. Another distinction that has been made in respect of coping resources is between those that are internal (relating to personality) and those that are external (relating to social situations or organizational strategies).
In a literature review, Kinicki et al. (1996) found that both environmental and personality factors influenced choice of coping strategies, but that relationships between coping strategies and outcomes are inconsistent and moderating effects are not always found. Cooper et al. (2001) noted that dispositional coping style is likely to moderate the influence of environmental factors (stressors) on outcomes (strain), whereas coping behaviors mediate the effect of stressors on strain (coping with high workload by working harder reduces strain associated with the initial demands). Harris (1991) suggested that the range of coping strategies available was to some extent determined by organizational values, culture, and norms. Organizational factors can influence both primary appraisal (the meaning of a particular encounter) and secondary appraisal (availability of coping resources). Ferguson and Cox (1997) classified the functions of coping strategies as: emotional regulation, approach, reappraisal, and avoidance. Both problem-focused and emotion-focused coping strategies can be effective depending on the situation and how an individual appraises it (Erera-Weatherley, 1996).

Much of the evidence related to injury involvement highlights the negative effects of emotion-focused coping strategies. The above discussion identified certain personality characteristics, including TABP, negative affectivity, LoC and low self-esteem, as predisposing individuals to choose more passive, emotion-focused coping strategies, or to be less flexible in their choice of coping strategy. For example, a study examining LoC in student nurses confirmed that internals were more adaptive at modifying their coping strategies after having appraised a stressful situation. This flexibility was not displayed by externals, who appeared to alter little their mode of coping (Parkes, 1984). Using emotion-focused coping is likely to be less effective in many situations, leading to continued stress and increased injury vulnerability. There can also be long-term deleterious effects, both in terms of worker health and safety implications, where emotion-focused coping may lead to heavy drinking, smoking, or drug use. In a literature review, Stallones and Kraus (1993) estimated that for work injuries involving motorized vehicles, up to 27% involved a positive blood alcohol concentration. This evidence suggests that excessive alcohol use plays a significant role in approximately one in four work-related road fatalities. In relation to workplace injuries, Zwerling (1993) estimated that alcohol impairment was related to 10% of fatal injuries and 5% of nonfatal injuries. Although there is some evidence that cannabis use is associated with greater injury involvement (Crouch et al., 1989), there is a lack of reliable empirical research on drug use and work injuries (Guppy & Marsden, 1996).

### 7.6 Stress interventions

Interventions designed for dealing with occupational stress usually fall into three action types: primary — eliminating, reducing, or altering stressors in the working situation; secondary — designed to prevent workers who are already showing signs of stress from getting sick and to increase their coping capacity; and tertiary — treatment activities directed at workers showing strong stress reactions and rehabilitation after sickness absence (Cooper & Cartwright, 1994; Kompier, 1996). Kompier (1996) identified the following four possible types of prevention and intervention:

1. **Primary** — work environment: changing job content — for example, job enrichment, worker participation, career development activities, team building, and social support.

2. **Secondary/tertiary** — work environment: measures directed at workers showing signs of stress — for example, special work schedules.
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3. Primary — individual/group: selection, preemployment medical examination, health promotion, and wellness programs — for example, corporate fitness program, relaxation training.

4. Secondary/tertiary — individual/group: directed at individuals with serious stress-related problems — for example, rehabilitation, stress counseling, relaxation, and psychotherapy.

The last of these categories, secondary and tertiary levels of intervention targeted at individuals, are most common (Kompier & Cooper, 1999). Jordan et al. (2003) found 40% of stress interventions to be focused on organizational factors, 55% at both organizational and individual level, and 70% at an individual level. These focus on the individual, either through programs encouraging more healthy lifestyles — for example, keep-fit centers on site, dietary advice, relaxation and exercise classes, or else they provide education on how to develop more effective stress management skills. Tertiary interventions act to mitigate an individual’s stress symptoms — for example, by helping individuals to cope with their anxiety through relaxation and biofeedback. Positive effects of an improved lifestyle can feed back into the stress process by boosting individuals’ resistance to stress. Secondary interventions operate by improving individuals’ coping strategies and by replacing maladaptive coping styles with more successful ones, thereby making the workforce less vulnerable to stress. Such stress interventions should lower the risk of negative outcomes by increasing stress resistance, that is, a more stress resistant workforce should be less likely to experience stress symptoms, rather than by affecting their exposure to stressors. Primary interventions focus on managing stressors; for example, where the nature of the job could lead to stress, the task or the work environment might be redesigned, or where the organization’s structure or climate is the source of stress, a more participative management style might be encouraged. These interventions reduce exposure to stressors and therefore reduce risks from negative outcomes (see Table 7.2). The following sections consider stress interventions as either focused primarily at individual workers or at the organization or work group.

7.6.1 Individual-level stress interventions

Whilst some workers may show an indication of being under stress, such as high perceived stress levels and ineffective coping strategies, others will report high levels of physical or psychological ill health in reaction to stressors. In the former case, secondary action is needed to prevent workers from developing stress-related symptoms — for example, by increasing their capacity to cope with stressors. In the latter case, workers are already suffering stress-related illness and require treatment activities (tertiary action) — for example, stress counseling, rehabilitation, or psychotherapy. Primary interventions that involve preventive action may also be targeted at individuals, but these tend to be much rarer than secondary and tertiary interventions. Techniques include health promotion programs, training and education, and selection and placement. In a review, Giga et al. (2003) found that the most widely used individual-level techniques were cognitive behavior therapy (CBT) and relaxation (each featuring in 30% of interventions), whilst training and education were used in 15 to 20% of interventions, selection featured in only 1% of intervention programs. For a brief description of CBT and a related therapy, see Summary Text 7.10.

Secondary and tertiary levels of intervention often focus on the individual, either through programs that encourage more healthy lifestyles — for example, relaxation classes, or provide education on how to develop more effective stress management skills. Tertiary interventions act to mitigate individual stress symptoms, for example, helping individuals
Table 7.2 Examples of Stress Management Interventions at Three Levels

Primary level
Scope: Preventive — reduce number and intensity of stressors
Target: Alter work environments, technologies, or organizational structures
Examples: Job redesign, worker participation, flexible working, and management style

Secondary level
Scope: Preventive/reactive — modify individuals’ responses to stressors; improve individuals’ coping strategies; replace maladaptive coping styles
Target: Individual
Examples: Stress management training, communication, and information sharing

Tertiary level
Scope: Treatment — minimize damaging consequences of stressors by helping individuals cope more effectively
Target: Individual
Examples: EAPs, stress counseling, relaxation, biofeedback, and CBT


to cope with their anxiety through stress counseling. Positive effects of improved lifestyle can feed back into the stress process by boosting individuals’ resistance to stress. Counseling can improve workers’ psychological well-being by increasing their confidence and self-esteem (Berridge et al., 1997). Secondary interventions operate by improving individuals’ coping strategies and by replacing maladaptive coping styles with more successful ones, thereby making workers less vulnerable to stress. Based on self-report measures, stress management activities seem to have a modest effect in temporarily reducing experienced stress and positive effects tend to diminish in the long term (Murphy, 1988; Cooper et al., 1996).

Counseling is frequently offered to survivors of serious incidents, such as a major disaster or witnessing a traumatic injury. There is reason to believe that this intervention may not be as effective as is generally believed. Doyle (2003) cited research evidence provided by Rick and Briner (2000) who concluded that sometimes counseling did more harm than good if it obliged the victim to relive the experience and compounded the original trauma. A further limitation was that counseling varied in quality. However, victims appreciated the altruism of those who funded the counseling service (e.g., employers, government). It could be that evolution has scripted us to repress threatening experiences that are liable to be unhelpful in regaining our psychological health. The dilemma for managing the risk associated with traumatic experiences may be resolved by the offer of, but not the obligation of, counseling to those affected.

Safety and risk scientist practitioners seeking to manage the risk of a range of stress-related negative outcomes could usefully be informed by interventions that are prescribed for individuals within a wider social context. The notion of resilience is gaining increasing currency as part of a more general positive psychology movement. The underlying philosophy is that strength-based developmental models should increasingly supplant deficit-based models of human functioning. At its simplest level, the individual is seen as a balance sheet of risk and protective factors, in which maladaptation to stress is more likely to occur when risk factors outweigh protective factors in a given context. Risk factors include both individual characteristics and external circumstances that increase the likelihood of
Summary Text 7.10  CBT and RET — A Brief Description

Cognitive behavioral therapy (CBT) was devised by Beck et al. (1985). It focuses on changing illogical thought patterns that underlie depression. Beck et al. assumed that depressed individuals pursue illogical thinking and that this is the root of their problem. CBT techniques are based on the assumption that cognitive structures shape the way that people react and adapt to a variety of situations encountered in their lives. The most widespread use of CBT is in treating depression, but it can also be used to treat anxiety. Beck et al. described the following three major cognitive patterns in depression listed here as the cognitive triad:

- A negative view of oneself
- A negative interpretation of experience
- A negative view of the future

People with these cognitive patterns are prone to react to situations by interpreting them in the light of the cognitive triad (Andreasen & Black, 2001). For example, an unsuccessful applicant for a job that attracted many able candidates has his or her perception shaped by the stated cognitive triad, and may reason as follows: “I did not get the job because I am not really bright, despite my good college record, and the employer was able to figure that out” (negative view of self). “Trying to find a decent job is so hopeless that I might as well give up trying” (negative view of experience). “I am always going to be a failure; I will never succeed at anything” (negative view of the future). CBT techniques focus on teaching clients or patients new ways to change their negative beliefs and assumptions about themselves, the world, and the future. As a treatment it tends to be relatively short term and highly structured. The major goal is to help people restructure their negative cognitions so that they view reality in a less distorted way and learn to react accordingly.

In contrast to Rational Emotional Therapy (RET), CBT does not attempt to disprove ideas harbored by the depressed person. However, even though the specific techniques are different, the major goals of CBT and RET are similar — helping people to recognize and reject false assumptions that are key ingredients of their problems (Baron, 2002). Therapist and client work together to identify the client’s assumptions, beliefs, and expectations, and to formulate ways of testing them. For example, the unsuccessful job applicant referred to above, states that he or she is a total failure. The therapist may then ask for a definition of failure, probing the extent of the perceived failure, and later explore areas of the client’s life where success has been achieved. There is evidence to indicate that individuals learn to reinterpret negative events with outcomes that are encouraging (Bruder et al., 1997).
while reducing the number of risk factors, even by one, can have a correspondingly disproportionate positive impact upon an individual’s well-being. Protective factors are those individual characteristics and environmental conditions that can moderate an individual’s vulnerability to stress. An example of the former would be an easygoing temperament (e.g., Type B behavior pattern), while examples of the latter would include supportive family, social, or work environments. Risk management interventions would proceed on the basis that each individual’s balance sheet is unique and that a successful program would target those individuals with a negative stress balance sheet by aiming to reduce the number of risk factors and to promote protective factors for them. Protective factors include good physical health, mental activity, psychological health (e.g., positive self-evaluations, optimism, and feeling of being in control), and strong social networks.

7.6.1.1 Employee assistance programs (EAPs)
Organizations provide workers with access to EAPs in order to help those who are experiencing stress-related problems (tertiary action). EAPs, which are often supplied by external providers, offer a number of services, including counseling, advice and referral to other sources of support, and specialist treatment. Workplace counseling is usually offered as part of an EAP. This process is aimed at helping people to explore a problem and finding alternative ways of dealing with it so that something can be done about it. The overriding goal is to help clients to help themselves and to take responsibility for their own lives. It is based on a belief that within individuals there is a capacity to grow in maturity and to take on responsibility if conditions are right. Counsellors are expected to be sympathetic, genuine, nonjudgmental, and able to create an atmosphere of trust and acceptance in the quest to understand in an empathetic way the client’s behavior and the reasons for it. Other counseling skills include active listening, clarifying issues, reflecting on what comes across in the disclosures, summarizing the position put forward by the client, and offering guidance.

Evidence suggests that organizations benefit from good return rates on their investment in counseling services and EAPs. For example, U.S. figures have demonstrated that companies made savings to investment returns of between 3:1 and 15:1, after introducing stress counseling (Cooper & Cartwright, 1994). These savings may be related to effects that EAP usage has on absenteeism rates. For example, Cooper and Sadri (1991) found that an in-house stress counseling program in a large organization reduced absenteeism by 60% in 1 year. For descriptions of the history, coverage and operation of EAPs see Berridge and Cooper (1993) and Berridge et al. (1997). Given the upward trend in workers prepared to take legal action against employers as a remedy for suffering job-related stress, EAPs and stress management programs make increasingly good business sense. However, in evaluating a number of studies of EAPs, Shapiro et al. (1993) concluded that the cost-effectiveness of EAPs could not be taken for granted. Other evaluation studies have also presented mixed results. From a sample of 61 police officers, Doctor et al. (1994) evaluated the effectiveness of an EAP in terms of absenteeism and health but found no significant effects over a 12-week evaluation period. However, Michie (1992, 1996) examined the effectiveness of an EAP in samples of nurses; in both cases, significantly reduced anxiety, and depression and life satisfaction were observed after 6 months. In a sample of city council workers, Reynolds (1997) also found that workers’ physical and psychological well-being improved as a result of stress counseling. Other intervention programs have included an EAP as part of a package of measures, which also included organizational-level interventions (Peters & Carlson, 1999; Adkins et al., 2000) — however, these studies did not report on the effectiveness of individual elements of the package.
7.6.1.2 Stress management programs

Strategies for coping with stress, for example, arising from organizational change, are usually categorized as either individual or organizational in origin. An effective stress management program is likely to involve both types of strategy (Callan, 1993). Stress management programs became popular in the 1970s (Hackman & Suttle, 1977) and the 1980s witnessed a proliferation of such programs (Manuso, 1984). Although U.S. companies led the way in providing worker health care, stress management, and fitness programs, they are becoming increasingly popular with European employers. There is evidence that such programs are associated with reduced absenteeism and medical costs (Cooper, 1986; Giga et al., 2003). Principles of such programs include the following:

- Create an environment for maximum participation
- Build bridges between home and work for greater understanding of domestic and family needs
- Use training to increase skills, awareness, and interpersonal relations
- Create an organizational culture of openness, communication, and trust so that inability to cope can be expressed and help requested

Stress management programs commonly focus on developing skills in identifying and managing stressors. As people in stressful situations may resort to maladaptive behavior (such as smoking or drinking alcohol to excess) or to inappropriate responses (such as working harder but making more mistakes or unrealistic promises), the aim of stress management programs is to educate workers to identify potential stressors and learn to apply adaptive coping strategies. Adaptive responses could include: planning, organizing, prioritizing assignments, and enlisting others’ support (Murphy, 1985). Cox and Ferguson (1991) noted that in using coping strategies we seek to problem solve, reappraise a (potentially stressful) event, or avoid stressful encounters. In a longitudinal study of 79 social workers, Koeske et al. (1993) found that control-oriented coping strategies clearly acted as work stress buffers, while those who used avoidance coping strategies reported higher levels of negative consequences 3 months later. Problem solving or a problem-focused approach to coping represents a learning style in which an individual seeks to acquire abilities to control outcomes, thereby leaving them better able to cope with future stressful encounters. Thus, while the learning task itself may be stressful, due, for example, to trial and error, the objective is to avoid or to mitigate future stress rather than to avoid current stress. Event reappraisal corresponds with an emotion-focused coping style (Folkman & Lazarus, 1988) in which the individual changes their attitude or perception of the way they feel about a stressful encounter. In practice, coping strategies are likely to be used in combination — for example, Glendon and Glendon (1992) found that ambulance drivers’ use of problem-focused and emotion-focused coping strategies for dealing with stress were significantly correlated.

Apart from the coping behavior adopted by individuals, organizations can offer a range of techniques, under the stress management label. These techniques include the following:

- Biofeedback — in which individuals learn to recognize and respond to, for example, muscle and skin activity (see discussion of sense modalities in Chapter 3).
- Relaxation — which involves focusing on breathing and muscle calming activities to release tension.
- Meditation — which includes a variety of techniques, of which the most popular is Transcendental Meditation, in which the individual develops a mental state where the mind is relaxed but fully alert.
• Cognitive behavior therapy (CBT) — which focuses on changing illogical patterns of thought that underlie depression; techniques focus on teaching clients new ways to change their negative beliefs and assumptions about themselves, the world, and the future (see Summary Text 7.10).

When applied to a work situation, stress management techniques may emphasize prevention and imparting skills to help workers, such as relaxation training, rather than treating stress-related problems. Participating in stress management training should not only reduce stress symptoms during the course of an intervention program, but also provide skills to help manage stress in the future. There is evidence that both meditation and relaxation techniques are successful in alleviating stress symptoms (Toivanen et al., 1993a, 1993b; Wiholm et al., 2000) and enhancing coping strategies (Alexander et al., 1993; Hyman, 1993), with some indication of long-term improvement (Sheppard et al., 1997). CBT has also demonstrated significant improvements through increased coping abilities and awareness of stress (Firth-Cozens & Hardy, 1992; Gronningsaeter et al., 1992; Freedy & Hobfoll, 1994). However, while some studies have indicated long-term improvements (Kushnir & Malkinson, 1993), including an impact on general life satisfaction, suggesting that skills may transfer to nonwork domains (Reynolds et al., 1993), others have shown no long-term effects (Whatmore et al., 1999). Techniques are often successfully combined within stress management programs (Tsai & Crockett, 1993; Peters & Carlson, 1999).

7.6.1.3 Health promotion programs

Recent years have seen a steady growth in worker health programs. U.S. employers generally take greater responsibility for paying workers’ health insurance costs, principally because of the absence of a national health service. However, many larger companies offer more comprehensive programs. There are signs that this trend is increasing in the United Kingdom, partly because of increasing provision of private medical insurance by employers. Paternalism and philanthropy may have a part to play in this development in some large and long established companies. However, increasingly employers adopt an HRM position that investing in workers’ health produces dividends. These could include increased productivity, lower medical and disability costs, reduced absenteeism and staff turnover, and improved satisfaction and morale (Murphy, 1984). The substantial increase in medical care expenditure in the United States has helped to generate interest in ill health prevention programs. U.S. employers are also more vulnerable to legal action in respect of occupational stress when they have failed to take preventive measures. Hence, they are motivated to do so. In the United Kingdom, many employers view workplace health promotion programs as a promising strategy for coping with rapidly increasing healthcare costs, which could act as the primary justification for embracing preventive measures (Ashton, 1990; Jenkins & Warman, 1993). In recent years major U.K. healthcare specialist insurance companies have promoted preventive measures such as health screening, stress management programs, and occupational health advice, doubtless believing that healthier workforces will result in fewer claims. For organizations, this could mean reduced future premiums. However, such a fall in premiums may be forestalled if screening leads to the diagnosis of illness requiring medical attention and consequent claims.

Changing attitudes and behavior in respect of health is discussed in Chapter 6 (particularly Figure 6.9), the health belief model being a prime example of such an approach. Health promotion programs are broader in scope than the preventive strategies outlined above, ranging from purely educational schemes to promote health to learning to take one’s
own blood pressure, or altering one’s lifestyle to become more healthy, in terms of exercise or diet. For example, exercise (aerobic) is generally regarded to be a valuable technique in combating stress and it is interesting to note that many body movements imitate the body’s natural response to stress — for example, action based on flight or fight. Certainly, the pursuit of various lifestyle and health habits (e.g., physical fitness, sleeping) has been found to be associated with reducing the impact of work stress (Steffy et al., 1990). Exercise has also been found to help in improving self-esteem and mastery and thus can also contribute to problem-focused coping (Long & Flood, 1993). However, individual differences mean that regular exercise can help some, but not necessarily all, individuals. In a review of 95 studies of links between physical activity and CHD (Coronary Heart Disease) risk, van Dooren and de Geus (1993) reported that heart disease is almost twice as prevalent in inactive compared with active individuals. While a causal link between physical activity and CHD risk has been found (Powell et al., 1987), the results are not overwhelming and van Dooren and de Geus (1993) considered that fitness has only a modest effect on alleviating stress. They concluded that individuals do have control over a number of CHD risk factors, although exercise has to be combined with other beneficial actions (e.g., diet, attitude to life) to reduce CHD risk significantly. Health promotion programs may also act as an avenue for delivering social support, as they are often group-based rather than individual-based. Thus, they can serve as social support interventions, as well as stress-reduction techniques (see Section 7.6.2.3).

7.6.2 Organizational level stress interventions

Organizational level interventions often focus on stressor reduction (primary action), for example, where the nature of the job could lead to stress, the task or the work environment might be subject to redesign; or, where the organization’s structure or climate is the source of stress, a more participative management style might be encouraged. Such measures are most often considered in relation to changing the work environment, but may not always be practicable or desirable. For example, many jobs are characterized by high demands, where the nature of the demands cannot be changed. Karasek (1979) defined high demand–low-control jobs as stressful, but high control can mitigate negative effects of high demands, creating a challenging active job. Control may be increased through participation or increased autonomy. However, some organizational level interventions may involve secondary or tertiary action, where they are targeted at high risk groups or workers already experiencing stress symptoms, such as coworker support groups. Some aspects of the work environment may not be amenable to change, particularly certain aspects of the job itself, level of job security, or job-related pay and benefits; thus, it may be more appropriate to develop selection and recruitment procedures, first to ensure that appropriate individuals are attracted and selected for these posts, and second that appropriate support and training is offered to help post-holders. Cox et al. (2000) considered training to be primary prevention, rather than secondary, as it enhances task-related knowledge and skills. A number of organizational stress interventions are addressed in the following sections. In the United Kingdom risk management guidance for stress at work, including developing a stress management policy is provided by the HSE (2001b, 2004), and the Advisory Conciliation and Arbitration Service (2004).

7.6.2.1 Work redesign

There is a relatively limited literature on risk reduction at the primary level, as few studies have focused on work redesign or restructuring (Israel et al., 1996; Giga et al., 2003).
However, evidence suggests that primary interventions have a significant impact both on individuals’ stress symptoms and on organizational outcomes, including productivity and absenteeism. Reviewing findings from 1500 projects funded by the Swedish Working Life Fund, Brulin and Nilsson (1994) found that productivity improved on average by 10%, including production errors and delivery times. Kawakami et al. (1997) demonstrated significant effects on stress symptoms and absence levels following a 1-year intervention program involving changes to the work environment, job redesign, and training. Another means to reduce workers’ stress levels focuses upon improving communication. Cartwright et al. (2000) found that improvements in communications within a U.K. Government department led to significant enhancements in job satisfaction and perceptions of control. Evans et al. (1999) also found significant reductions in stress symptoms. However, neither of these studies examined performance.

Whilst interventions that focus on work design alone are relatively uncommon, interventions combining changes to the work environment with increased participation are increasingly employed by organizations (Giga et al., 2003). Evidence suggests that this combination is particularly powerful in terms of improving absence and performance rates (Matrajit, 1992; Bond & Bunce, 2001). For example, Terra (1995) reported a 50% decrease in sickness absence and improved productivity following the introduction of job redesign and self-regulating teams. Although outcome measures tend to emphasize productivity or sickness absence, Kvarnstrom (1996) demonstrated that a stress intervention involving participation, training, and job redesign resulted not only in significant reductions in turnover and absenteeism, and a major improvement in production, but also a significant decrease in workplace injuries. Changes to the level of skill discretion and authority over decisions are also outcomes resulting from participation interventions (Theorell et al., 2001); this is discussed further in Section 7.6.2.2.

7.6.2.2 Participation and autonomy

Karesek and Theorell (1990) developed a model based upon the dimensions of decision latitude (high or low) and (job) demands (high or low), resulting in the $2 \times 2$ matrix of behaviors shown in Figure 7.5, where decision latitude refers to the opportunity for significant use of judgment and discretion in a job. When this factor is high and combined with a demanding job, people experienced job satisfaction and reduced depression. The opposite appeared to be the case, particularly with respect to satisfaction, when jobs were rated low in terms of decision latitude and demands posed by the task (Karasek, 1979). To relieve job strain, it is suggested that workers should be given greater scope for decision-making and use of discretion at work but at the same time not to overreach individual capabilities in the quest to obtain more substantial job responsibilities. Karasek’s theory is an example of an approach to stress that is primarily environmental, in which individual (e.g., personality) characteristics play little part. However, in a development of the original model, Karasek and Theorell (1990) link the job factors of demands and control, and the two potential outcomes — strain and active learning — to key personality variables (feelings of mastery and accumulated strain or anxiety).

While Karasek’s model has been very influential and has generated considerable research over the past two decades, empirical support for the hypotheses that it generates has been limited, partly due to conceptual and methodological problems associated with it. For example, it has been argued that the core constructs and their interrelationships are poorly articulated and lack integration (Ganster, 1989; Muntaner & O’Campo, 1993; Kristensen, 1995; de Jonge & Kompier, 1997; Jones et al., 1998). In a large-scale longitudinal study of stress in teachers, Bradley (2004) found evidence for Karasek’s additive strain hypothesis — demands, control, and social support predicted stressor and strain, both cross-sectionally
and longitudinally. Bradley also found evidence for relationships between the job factors and worker activity and participation. However, rather than all three job factors acting in conjunction, demands and supervisory support predicted only some outcomes (e.g., number of hours worked), while control and coworker support predicted other outcomes (e.g., self- and other-reported levels of activity). Other indices — for example, participation in activities outside work, were not strongly related to any of the job factors. Exposure to highly demanding jobs was associated with increases over time in levels of neuroticism. Karasek and Theorell (1990) considered that personality variables can be subject to change, whilst exposure to high-control job conditions was associated with increased levels of mastery. The demand–mastery relationship was buffered by perceptions of job control.

In another study, positive health implications (reduced illness among full-time workers, including heart disease among males) of greater control in one’s job, together with greater opportunities for democratic participation at work, are endorsed (Karasek, 1990). Fisher (1985) maintained that compared with white-collar workers, blue-collar workers experienced less control in their work (alleged disadvantages are shown in Summary Text 7.11). Control can be introduced in a number of ways, such as developing autonomous work groups. Studies of such work groups have found positive effects on productivity and other work criteria, but a lack of improvement in well-being, motivation, and absenteeism (Goodman et al., 1988). Evaluation studies of stress interventions using participation and autonomy have had mixed results. For example, Reynolds (1997) found no significant changes in well-being or absenteeism in U.K. public sector workers as the result of a participation intervention. Similarly, Heaney et al. (1993) found that worker well-being failed to improve. However, other studies have shown reduced psychological depression (Bond & Bunce, 2000) and improved attitudes toward innovation (Bunce & West, 1996; Bond & Bunce, 2000). However, participation and autonomy together with primary intervention techniques, such as job redesign and training, appear to be much more successful in reducing stress symptoms and improving performance (see Section 7.6).

Increased job control may not be an appropriate means of reducing stress for all individuals. Although many will find that low control is a source of stress, there are individual differences in the degree of psychological strain experienced. For example, Fletcher and Jones (1993) failed to replicate the interaction effect of high job demands and low job control on measures of strain predicted by the demand–control model. This is supported by research cited by de Rijk et al. (1998), who reported a negative relationship between job autonomy and both emotional exhaustion and health complaints only for those individuals with a high need for autonomy. The increased responsibility and decision latitude associated with greater autonomy can be perceived as an unwanted burden by some individuals, indicating that stress-reduction measures targeted at increasing worker autonomy will not be suitable for all workers. Worker participation and careful monitoring of the effects of any changes is
Summary Text 7.11 Disadvantages of Low Control in Blue-Collar Work

- Working directly on the line, handling a product or process, blue-collar workers are more likely to feel helpless in that they are less able to avoid unpleasant conditions and have less control over how their time is spent at work. In contrast, many staff in managerial positions are more likely to have opportunities to avoid circumstances they do not like, although may need to be aware of not being penalized for such behavior.

- As their work is generally well defined and integrated in an overall production process in a systematic way, blue-collar workers have less scope to modify their task. Should there be unpleasant conditions in the job, usually typified by a greater range of industrial hazards and uncomfortable working conditions than experienced by white-collar workers, they may have few options available to them for coping. The discussion on cognitive dissonance (see Chapter 6, Section 6.5 and Summary Text 3.8) revealed that behavioral options may reduce to complaining — and risking sanctions — or leaving the job, always assuming that there is another one to go to. Changing your attitude to the hazards, that is, putting up with them; may be the line of least resistance.

- Continuing the above point, from a market perspective, compared with white-collar workers, it is usually less easy for blue-collar workers to change jobs because of the lower transferability of their skills, lower income (and consequent lower savings to act as a buffer between jobs), and reduced opportunities.

- Opportunities for social activity at work are greater if the worker enjoys greater discretion. In this sense, the blue-collar worker is also at a disadvantage as she or he can less readily counteract unfavorable conditions at work by exercising control outside mainstream work activity.


needed when implementing stress reduction measures. Sparks et al. (2001) recommended that relevant training support be provided — for example, where appropriate, problem-solving sessions could be held between supervisors and workers to identify job demands or stressors. Strategies could seek to increase workers’ perceived control so that they can cope more effectively (Spector, 2000).

7.6.2.3 Social support groups

External support networks can buffer individuals during times of crisis (Rodin & Salovy, 1989) and individuals with external support tend to rely more on active coping strategies than do those without such support (Billings & Moos, 1984; Holohan & Moos, 1987). Social support refers generally to the existence or quality of social relationships. According to Williams and House (1985), supportive social relationships alleviate stress at work through the mechanisms identified as follows:

- Directly enhancing health through creating a setting in which needs for affection, approval, social interaction, and security are met.
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- Directly reducing stress levels and indirectly improving health by reducing interpersonal tensions as well as having a positive effect generally in the work environment.
- Acting as a buffer between the person and health hazards; as social support increases, health risks decline for individuals exposed to stressful conditions. Conversely, if social support declines then the adverse impact of stress on health becomes increasingly apparent.

Establishing coworker support groups has been found to improve psychological well-being (Bagnara et al., 1999). Grossman and Silverstein’s (1993) evaluation study of the effectiveness of support groups for healthcare professionals found that workers reported reduced stress and improved performance at work. However, the groups experienced high dropout rates, perhaps caused by those workers who most needed help leaving the group. Greater success was associated with groups with high autonomy and decision latitude (see Section 7.6.2.2); these groups perceived their work as more stimulating and received increased feedback from supervisors (Eriksson et al., 1992). Support groups have been successfully combined with individual-level techniques in stress interventions, such as CBT and relaxation; evaluation studies indicating that in addition to reducing stress symptoms, participants’ support seeking skills and adequacy of coping also improved (Larsson et al., 1990: Lees & Ellis, 1990; Elliot & Maples, 1991; McCue & Sachs, 1991), although, as with individual-level interventions, there is some doubt concerning long-term effects. However, in combination with primary organizational interventions, such as work redesign, training, and communication, long-term maintenance of low levels of stress has been reported (Kalimo & Toppinen, 1999; Griffin et al., 2000). For example, Kalimo and Toppinen (1999) examined work and health related factors over a 10-year period for 11,000 forestry industry workers who participated in a stress intervention program involving work redesign, training, and coworker support groups. The study found that a majority of staff rated their psychological working capacity as good and that stress remained low.

Caution needs to be exercised in respect of alleged beneficial effects of social support, because there are occasions when social interaction (and even inappropriate counseling) can have a detrimental effect upon an individual’s health, for example, where conflict and strife is inherent in social relationships. Williams and House (1985) identified measures that enhanced social support and improved the flow of supportive behavior among blue-collar workers. In the absence of a formal social support system, an informal approach for an individual who is experiencing stress is outlined in Summary Text 7.12.

7.6.3 Effectiveness of stress interventions

There is substantial evidence to suggest that many stress intervention programs, such as EAPs, are effective in mitigating stress symptoms (Cooper & Sadri, 1991; Berridge et al., 1997; Highley-Marchington & Cooper, 1998). However, much of the evidence is focused on tertiary measures, such as stress counseling, which are aimed at individuals displaying stress-related symptoms. Although secondary and tertiary levels of stress intervention are effective when targeted at high risk individuals or groups, there has been a tendency for organizations to employ such programs for the workforce as a whole. This has been described as the inoculation approach to stress, as it focuses on the consequences, rather than the sources of stress, reflecting an approach that stress is an inherent and enduring feature of the working environment. This approach can be very successful, particularly in the short-term, although there is some doubt about its long-term benefits. Isolated programs can have temporary effects in reducing stress (Murphy, 1988). Although stress symptoms
Summary Text 7.12 An Informal Approach to Stress Reduction

- Select a person at work you feel you can talk to, someone you don’t feel threatened by and to whom you can reveal your feelings. Don’t select someone who you may be using on an unconscious level at a manipulative level in organizational politics.
- Approach this person and explain to him/her that you have a particular problem at work or outside that you would like to discuss. Admit that you need help and that he or she would be the best person to consult because you trust his/her opinion, like him/her as a person, and feel that he/she could identify with your circumstances.
- Try to maintain and build on this relationship, even at times of no crisis or problems.
- Review, from time to time, the nature of the relationship to see whether it is still providing you with the emotional support that you need to cope with difficulties that arise. If the relationship is no longer constructive or the nature of your problems changes, so necessitating a different peer counselor, then seek another person for support.


are reduced as a result of treatment and job perceptions become more positive, these changes decay over time if workers return to an unchanged work environment, with the same level of stressor exposure. There is also the danger that such programs tend to attract the worried well (Sutherland & Cooper, 1990), rather than those who most need help, particularly where programs are used across the workforce, rather than being targeted at high risk individuals. Whilst companies have tended to focus stress management activities at managerial level, there is evidence to suggest that blue-collar workers, who tend to come from lower socioeconomic groups, are more prone to heavy smoking, alcohol abuse, obesity, and CHD. Thus, workers as well as managers can benefit from stress management programs, particularly those aimed at lifestyle changes.

Cox et al. (2000) and Jordan et al. (2003) recommended that a package of measures is more likely to succeed, particularly where measures are to be implemented at primary and secondary levels and involve preventive action in addition to tertiary action. Thus, in order to prevent and reduce stress symptoms employers need to understand underlying causes of workplace stress. The importance of developing an intervention strategy based on a risk assessment of the health and safety hazards has been emphasized by a number of researchers (Cox et al., 2000; Giga et al., 2003; Clarke & Cooper, 2004). However, reviews of stress intervention programs (Cooper & Payne, 1988; International Labour Organization, 1992; Kahn & Byosiere, 1992; Karasek, 1992; Burke, 1993; Cox, 1993) have suggested that such programs have often failed to emphasize prevention at source. Although still comparatively rare, there are examples of multi-perspective approaches to stress intervention, which include measures aimed at both prevention and remedial action (Giga et al., 2003). Such approaches have a powerful effect, not only in making long-term improvements in mental and physical well-being (Elo et al., 1998; Munz et al., 2001), but also in enhancing relationships, industrial relations, work climate, and increasing awareness of stress as an organizational issue (Nijhuis et al., 1996; Lourijsen et al., 1999; Poelmans et al., 1999; Wynne & Rafferty, 1999). In addition, evaluation studies report significant reductions in sickness absenteeism (Nijhuis et al., 1996; Lourijsen et al., 1999; Poelmans et al., 1999; Munz
et al., 2001) and mishaps and suicides (Adkins et al., 2000), as well as improved productivity (Munz et al., 2001).

7.7 Conclusions

This chapter has discussed some of the mechanisms by which stress can influence injury involvement. Both acute and chronic stressors can significantly affect injury involvement, either directly affecting workers’ behavior (e.g., via unsafe acts and safety behaviors) or indirectly via psychological and physical strain. However, Brief and George (1991) warned against conceptualizing the stress process as occurring at an individual level. Whilst certain individuals may be identified as being high risk in terms of injury vulnerability, it is clear that stressors in the working environment present significant risks in terms of work injuries, as well as worker health and well-being. Any approach to stress intervention needs to focus both on identifying vulnerable individuals and addressing risk factors for the workforce as a whole (Clarke & Cooper, 2004). Sparks et al. (2001) have pointed out that many research investigations and workplace interventions for worker well-being are conducted at managerial level, frequently excluding more subordinate workers (Worrall & Cooper, 1998; Neck & Cooper, 2000). Yet, in terms of work-related injuries, these workers are usually in the front line, and most likely to suffer workplace injuries, although work-related injuries (e.g., as sustained in car crashes) also affect managerial staff. However, because managers contribute to workplace injuries through inadequate decision making, perhaps as a result of work stress, injury involvement should not be considered as the only contribution to injury causation. However, these are latent conditions, rather than active failures, as the adverse effects of managerial actions are not always immediately apparent (Reason, 1997).

The tendency to view the stress process as necessarily a bad thing should be balanced against the necessity of the stress experience. For example, Bandura (1989) contended that the experience of stress, which is aroused in the coping process over a period of time as a result of dealing with stressors, actually enhances the immune function — a position increasingly supported by more recent research, for example, in respect of resilience. Moreover, as individual differences, including personality factors, play a part both in stress perception (being in the eye of the beholder) and in stress-related behaviors and conditions, including illness, not everyone suffers from work-related stress. However, while personality is generally considered to be a relatively immutable association of traits or characteristics (see Chapter 5), there is evidence that behaviors associated with personality characteristics that can affect the stress experience (e.g., Type A behavior) can be influenced to benefit the individual. The notion of control is widely regarded as being central to individual stress management. This is in respect of perceived control over a set of circumstances — as in internal LoC or control over one’s feelings about a situation — as in emotion-focused coping strategies, to hierarchical control — for example, for individuals with powerful organizational roles or who have high autonomy over their work and other aspects of their lives. Interventions aimed at increasing control, either perceived self-control or actual control, in terms of increased autonomy and decision latitude, have been demonstrably successful in reducing stress.

Whilst a certain level of eustress is conducive to human functioning, high levels of stressors may be experienced as distress and require intervention. Most stress interventions are instigated by organizations with the intention of improving worker health outcomes, and therefore positively influence outcomes of commercial relevance, such as absenteeism, productivity, and compensation costs. However, such interventions are often fairly narrowly defined and conceptualized as health initiatives. Morrow and Crum (1998) noted that interventions such as bonus pay, sensitivity training for supervisors, or provision of
on-site exercise facilities tended to affect single outcomes, such as satisfaction with pay, supervision or stress, respectively. Interventions that focused on safety improvements, particularly those aiming to change safety culture, are not only the right thing to do, but are one of the few managerial interventions that appear to have widespread effect. Research has highlighted the interaction between stress interventions, such as health promotion programs and injury reduction (Shannon et al., 1997; Mearns et al., 2003). Positive benefits of health promotion programs (e.g., improved diet, increased exercise, weight loss, smoking cessation, and acquiring stress-reduction techniques) have been demonstrated for workers’ health (Dugdill & Springett, 1994; Demmer, 1995) as well as having favorable results for organizations — for example, reduced medical and disability costs, less absenteeism and turnover, and enhanced corporate image (Conrad, 1988; Daley & Parfitt, 1996; Neck & Cooper, 2000). However, there is little recognition that such programs can be integrated into interventions aimed at improving safety (Clarke & Cooper, 2004). Health promotion programs may influence safety outcomes in two ways; first by demonstrating the organization’s concern for worker well-being — thereby improving its safety climate, and second, improved worker health will provide increased resilience to stress and, therefore, reduce injury liability. This area is discussed further in Chapter 11.
chapter eight

Managing teams for safe performance

This chapter is concerned with managing behavior in work environments. After outlining key functions and benefits of groups, group formation and types of group are reviewed. Factors influencing team effectiveness, including team composition, group norms, cohesiveness, group safety climate and leadership are then discussed, followed by consideration of barriers to effectiveness, such as groupthink. Particular attention is given to safety committees.

8.1 Introduction

In previous chapters we concentrated upon managing behavior at an individual level. However, organizations increasingly employ teams to achieve organizational goals (Ilgen, 1999) and recognize benefits of teamworking, where teams are often capable of producing higher levels of performance than are individuals (Hackman, 1998). Thus, it is important to have some understanding of the characteristics of groups and teams, and implications for safe performance. Objectives of this chapter are as follows:

- Define the notion of a team
- Describe different types of teams and their benefits
- Identify factors contributing to team effectiveness
- Explore mechanisms by which teamworking affects safety performance
- Examine safety committee effectiveness
- Identify and discuss ways of minimizing barriers to team effectiveness

A simple description of a group is a collection of people who consider themselves to be one. Groups operate in many occupational contexts, from the formal setting of a board meeting to the focused discussion of a task force or from the monitoring function of a safety committee to the ad hoc spontaneity of a demonstration against a shared grievance. A prominent feature of a group is rich social interaction. Being with others, even in an ad hoc or loosely formed group, influences our behavior. For example, when faced with an emergency we are more likely to respond quickly if we are on our own than if we are in the presence of others (Latané & Darley, 1968) — a phenomenon known as diffusion of responsibility. If others do not react decisively, then it is likely that we will perceive the situation as not being serious, particularly if circumstances are ambiguous. This slowness to respond may occur in an emergency when life or property is at risk. For example, if an
individual alone in a room sees smoke coming from under the door, he or she is likely to respond quickly. However, a group confronted with the same situation reduces the likelihood of rapid response because of an inclination to discuss the nature of the threat and how best to deal with it (Latané & Darley, 1968). This may be a typical response during a fire on premises, particularly where fire drills are under-rehearsed and people’s attitudes reflect the sentiment that fire drills are a needless imposition. When frightened or threatened, people seek others’ company, preferably those frightened by the same event so as to compare their feelings with others’ to see if their fears are justified. Manstead (2005) and Parkinson et al. (2005) have explored the importance of social context in interpreting emotions (considered as individual experiences in some earlier chapters). Group support in reducing anxiety while waiting for a potentially painful experience (e.g., a diagnostic medical intervention or an injection) is critical, even in situations where group members do not communicate directly with each other (Wrightsman, 1960). Group membership can be a significant source of social support, which can act as a buffer against negative effects of stress and as a positive influence on safety-related behavior (see Chapter 7).

In an evolutionary context, groups were the predominant social form during the major part of human existence, and many human artifacts and migrations could not have come about without effective teamwork in prehistory (West et al., 2004). It is not therefore surprising to find powerful social interactions and emotions arising within a group context. For example, Hart et al. (2000) found that people experienced a higher threat from faces of a different ethnic group, while Olsson et al. (2005) considered that social learning provided the basis for fear conditioning about out-groups. Social identity can relate to a group, community, culture, or nation, and can account for how we perceive ourselves in relation to people who identify with other groups (Vaughan & Hogg, 2005). Groups predated larger organizational forms by many millennia, which could account for the relative ease with which we are able to identify with kinship, community, and work groups compared with our relative unease within large organizations. This could also partly explain why large organizations require complex legal and financial support structures to enable them survive — unlike informal groups, which could be considered to be a more natural human social unit.

In its contemporary guise, group activity (where a group may range in size from two — a dyad — to a much larger number) is central to organizational functioning. Increasingly, it is recognized that the effectiveness with which groups or teams perform is critical to an organization’s survival and success. Thus, it is important that anyone with an interest in extending motivation and reward beyond an individual level has some appreciation of the role and function of groups within an organization. Although group is a more generic term, which can be applied in a wider variety of circumstances, in some cases, the terms group and team can be used interchangeably. Team implies a more formalized or purposeful focus for a group activity, such as project work (e.g., developing a health and safety audit program), strategic development (e.g., planning a 5-year risk management policy) or problem solving (e.g., reducing an organization’s injury rate). For members to consider themselves to be a team, Hackman (2002) identified the following requirements:

- Team members are truly interdependent in the work that they do
- Clear membership boundaries, implying collective responsibility for task completion
- Specific delimited authority to manage their own work and processes
- Relatively stable membership

Guzzo (1996) defined teams as social entities embedded within organizations. Teams may come together to undertake a specific range of tasks or a single task that contributes to achieving an organization’s goals. Whilst there is evidence to suggest that teamworking
Summary Text 8.1 Some Benefits of Group Membership for Individuals

- Fulfillment of individual needs for friendship, affiliation, and support.
- In relating to others the individual has an opportunity to establish self-identity and to maintain self-esteem.
- Use of discussion, questioning, listening, and challenging on a variety of issues allows an individual to test their views and attitudes (see Chapter 6) and to note how other people define and explain events.
- When in a low state, a group can be a source of support in combating negative emotions (e.g., boredom, fatigue) as well as boosting morale and personal satisfaction.
- In organizations, it is not uncommon for individuals to feel insecure, anxious, and powerless as a result of uncertainty and lack of support; a group can assist the individual in combating the worst effects of these conditions.
- Some protection from hostile intentions of other groups or powerful individuals.

improves organizational performance in terms of financial (Macy & Izumi, 1993), efficiency, and quality measures (Applebaum & Batt, 1994), teams do not always make optimum decisions (or even the same quality of decisions made by the most capable team members) because of process loss (Steiner, 1972). Process loss can arise due to a number of intra-group problems, such as introversion, social conforming, diffusion of responsibility and groupthink, amongst others. This chapter considers how teams operate, some things that can go wrong, and some techniques for overcoming difficulties, specifically in relation to safe performance. Although the chapter is concerned primarily with how people interact as part of a group, discussion of this phenomenon requires occasional reference to other topics (e.g., attitudes, see Chapter 6).

8.2 Functions and benefits of groups

Functions and benefits derived from group membership can be identified as having individual and organizational aspects. As far as individual members are concerned, groups provide the following benefits (see also Summary Text 8.1 for greater detail):

- Satisfy affiliation and belonging needs
- Help to establish self-concept
- Support personal objectives and attitudes
- Share activities that are important to group members

Allen and Hecht (2004a) argued that teamwork particularly provides individuals with socio-emotional and competency benefits.

Some functions of groups in task performance are reviewed in Summary Text 8.2. These include the following:

- Distributing work
- Managing and controlling work
- Problem solving and decision making
Summary Text 8.2 Some Task Performance Benefits of Groups for Organizations

- Work can be distributed to a number of people to harness their unique set of skills and abilities; coordination and control is essential to ensure smooth group management.
- A forum can be created in which it is possible to draw on a set of skills and talents to enrich a solution to a problem on the basis that a number of informed individuals is better than one; in this process, information is exchanged, ideas are tested, and the accumulated fund of knowledge and expertise of the group is increased (although an expert individual may outperform a group of less competent people).
- A group can generate new ideas and suggest creative solutions to complex problems (e.g., using brainstorming); in this process it is usual to delay critical evaluation until all ideas have been expressed.
- A group can be a useful vehicle for promoting commitment and involvement among members when people are encouraged and given scope to get involved in setting plans and running organizational activities.
- A group with experienced and skilled members could offer initiation and training to a new entrant.
- A group can be used to settle a dispute between parties and could thereby serve as a forum for reduction of conflict and for negotiation.
- A group has a role to play in implementing decisions as well as in decision making; in particular a group is more likely to carry out a decision that it helped to make rather than one that is imposed.

- Information processing
- Testing and ratifying decisions
- Collecting information and ideas
- Coordinating and liaising
- Increasing commitment and involvement
- Negotiation and conflict resolution
- Inquest, investigation, and inquiry

8.3 Formation and types of groups

A traditional way of describing a group’s life cycle is by the following developmental stages:

- Forming — group members come together
- Storming — initial conflict and hostility, which may give way to trust
- Norming — establishing norms and behavior standards
- Performing — carrying out tasks
- Adjourning — coming to an end
- Mourning — letting go and moving on

Each stage comprises a different emphasis on taskwork (activity directed at achieving the team’s objectives, or what the team is doing) and teamwork (which relates to interactions
between team members, or how they are working with each other). In the traditional model illustrated above, initial emphasis is on team interaction (particularly in storming and norming stages), followed by increased emphasis on goal achievement (performing stage). However, Marks et al. (2001) argued that taskwork and teamwork often co-occur and form a cyclical pattern, whereby team processes guide execution of taskwork, and the way in which tasks are executed impacts the need for processes to govern further team activity. Thus, a group’s life cycle can be described as a series of recurring phases, rather than discrete stages, with different team activities occurring in different development phases (Kozlowski et al., 1999).

8.3.1 Types of teams

Traditionally, groups have been classified in various ways, depending on their nature and function. Groups in organizations may be formal or informal. A formal group, such as a safety committee, is established to perform a particular type of task. Its goals or objectives are usually determined by the organization, as are aspects of the committee’s structure, procedures, and membership. Some formal groups may be relatively permanent—for example, a board of directors; others are temporary, such as an inquiry panel or an incident investigation team. Informal or social groups emerge spontaneously in workplaces, for example, during meal breaks or on outside visits. Physical proximity is important in social group formation; workers on the same shift or in a particular part of the premises associate to fulfill at least some of their social needs—forming friendships, social relationships, and developing feelings of belonging. Social group formation stems from common interest or friendship, and no formal rules govern their operation. Informal groups also occur within the boundaries of a formal group, as people develop relationships through their activities. In a primary group there is much face-to-face contact and a high level of familiarity among members. Family and intimate work groups fall into this category.

Although members of a secondary group share common values and outlook on a number of issues, they do not do so to the same extent nor interact as much as members of a primary group. Workers within an organization may constitute a secondary group, and within that group could exist a number of primary groups—for example, works committee, quality improvement team, and also board of directors. A reference group is a group to which a person aspires to membership (e.g., a higher group in the social stratum) and can influence an individual’s outlook and behavior without he or she being a member of it (although an individual may or may not be a member of his or her reference group). For example, if a risk management committee developed a good reputation for efficient and effective operation then the success of this group might influence nonmembers so that they wished to be associated with its activities. Reference groups may be positive or negative—a person may not wish to be associated with some groups. Three criteria for distinguishing various reference group types, all of which could be relevant to workplace, health, and safety, are as follows:

- Normative — the individual accepts the general values of the reference group and adopts its social norms as a basis for his or her own behavior.
- Comparative — the individual compares him- or herself with reference group members and imitates their behavior.
- Status — the individual seeks acceptance by group members and aspires to membership.
In addition to the above distinctions, team typologies are often based on functional differences. Cohen and Bailey’s (1997) classification of four team types operating in organizations is as follows:

- **Work teams** — continuing work units responsible for producing goods or providing services; usually well defined and fairly stable groups of full-time workers, often led by a supervisor; more recently, however, self-managing teams, where there is no formal supervisor, have emerged (see Section 8.4.1.6).
- **Parallel teams** — groups of workers brought together from across an organization, usually to perform advisory functions, targeted at problem solving or improvement activities — for example, worker involvement groups, task forces.
- **Project teams** — team members drawn from different departments or functions on the basis of their expertise (i.e., cross-functional), in order to focus on a time-limited, often one-off project, such as a new product. A case example of a highly effective project team is provided in Summary Text 8.3.
- **Management teams** — comprise managers from across the organization (e.g., research and development, marketing, manufacturing, and engineering) who coordinate and provide direction for subunits. These may occur at any level, but groups of executives at the most senior level of an organization (top management teams) are increasingly formed to make collective decisions.

Of these types of teams, perhaps the most familiar, and most often studied in relation to health and safety, is the work team. It is important for management, or for safety and risk professionals, to understand the nature of work teams that they are dealing with, for example, the level of cohesion and processes operating within a group. These factors will not only affect team effectiveness, but also the type of strategies that should be used to influence them. Highly cohesive and influential groups are likely to be favorably treated by management, whilst other types of groups (e.g., those that are dependent, vulnerable, or substitutable) are likely to be subject to higher degrees of management control. It should also be recognized that work group goals are not necessarily synonymous with management goals or with other parties’ goals.

### 8.4 Team effectiveness

Many team effectiveness models adopt an Inputs → Process → Outputs (IPO) perspective (McGrath, 1984), where inputs include task design and group composition, processes include communication and conflict, and outputs include performance, innovation, and well-being (West et al., 1998). West (2002) distinguished between team-induced innovation, which tends to be enhanced when external demands (e.g., competitive pressure) are high, and creativity, which is favored in low external demand (e.g., threat) conditions. West maintained that innovation in groups is fostered by knowledge, reflexivity, high member participation commitment to common objectives, and skill diversity. Other models of team effectiveness include those of Guzzo and Campbell (1990), Hackman (1983), Katzenbach and Smith (1993), and West (1996). Hackman’s (1983) influential model identified the following five factors outlined here that directly, or indirectly, affect team effectiveness:

- **Group design** — task structure, group composition, and norms
- **Organizational context** — reward and information systems and training available
- **Group synergy** — internal group dynamics and processes
Chapter eight: Managing teams for safe performance

Summary Text 8.3 Illustration of an Effective Combination of Risk Management and Teamwork

Major engineering work at Dinorwig power station, involving a technique developed within the U.K. Pumped Storage Business (PSB) in conjunction with the equipment supplier, commenced in September 1994. If successful, the technique would provide huge commercial savings to the company, but it was technically extremely challenging and involved a meticulous approach to managing considerable risks. The technique had never previously been used anywhere in the world and therefore had commercial potential beyond immediate benefits to the business.

After 10 years of operation, more frequent maintenance than originally planned had been carried out on a crucial part of the system — the main inlet valves (MIVs) — and replacement of key components (trunnion bearings) was now required. Because the original design life of the trunnion bearings was around half the life of the station no prior provision had been made for changing them during normal maintenance. Standard procedure for replacing the bearings would require dewatering the station (the dry method) and would take over 6 weeks, with consequent considerable revenue loss. Because of the costs of a complete station shutdown, an alternative proposal was explored that would allow trunnion bearing replacement with the station remaining operational (the wet method).

As well as short-term revenue loss that would result from a station shutdown, management was also very aware of a longer-term commercial risk. If the station were out of action for 6 weeks, its customers would need to adapt to the changed situation and it could be difficult winning customers back in a very competitive market. Management was therefore highly motivated to seek a method for this major maintenance task that did not involve dewatering the station. In 1988, a working party was established comprising PSB staff and designers of the MIV trunnion bearings, to investigate an alternative to the dry method. The working party came up with a proposal that would allow the work to be done without dewatering. In 1990, a design study was commissioned to determine the feasibility of the proposed technique. The Head of Mechanical Engineering led the team that developed the wet method. The team included the Principal Design Engineer from the manufacturers, experienced fitters, and a Shift Production Engineer, who was responsible for safety and human resource management (this was the project team).

The technique was tested on site in 1993 and the first full trunnion bearing removal and replacement was successfully completed on the first MIV unit in September 1994. During the 1993 trial and again during the 1994 replacement the team worked long hours dedicated to this single task. From a series of design studies and associated testing and monitoring of plant, a method statement was prepared. This was used during the 1993 trial, modified in the light of that experience and adopted for the 1994 work. The second MIV trunnion bearing change was successfully completed in 1995 using the wet method, incorporating the experience gained on the first occasion. Trunnion bearing replacement work on the other four units was completed over the next 3 years.

In assessing both physical and financial risks of the wet method, at various stages the company’s risk assessment considered the following three major
aspects of risk listed here:

- Water release
- Injury to personnel
- Unit out of action indefinitely or delayed return

Each risk was analyzed to determine how it could be manifested before establishing appropriate control measures. The risk assessment was incorporated into the method statement. As part of the risk assessment process, the company submitted the proposed plan to the National Nuclear Corporation (NNC), a body with considerable experience of power station design, for intensive scrutiny. The NNC’s external assessment approved the work proposed and confirmed that the procedure was satisfactory.

The two main hazards to personnel associated with carrying out the work by the wet method were high-pressure water and handling heavy equipment in a restricted space. Potential consequences of the high-pressure water hazard ranged from the worst-case scenario of an uncontrollable flood to a relatively minor leakage, which could still represent a risk to personnel. Risks associated with handling heavy equipment were comparable with those encountered in normal maintenance operations. An additional risk with this novel procedure was that a point might be reached at which it was not possible either to continue with the work or to restore the unit to its operational state. In this case, the unit would have to remain out of service until the problem could be rectified. In the worst case, this could mean no generating or pumping capability from that unit until it was repaired dry — that is, by dewatering the entire station.

Calculations showed that the estimated cost to the business of such a prolonged absence of capacity from one unit was £17.5 million. The probability of such an outage was assessed at less than 1% — the product of these two figures representing the (business) risk, notionally £175,000. When making a decision on whether to use the wet or the dry method, it had been estimated that the dry method would cost £6 million more per unit than the wet method — that is, £36 million for the six units. After completing the economic risk analyses, the decision was made to use the wet method on the ground of considerable cost savings — set against the 1% probability that a unit would be out of operation for a period and that associated costs would be spread over a period of time.

From a technical and safety aspect, the work took place in the most sensitive part of the plant and there could have been potentially catastrophic consequences if something went wrong. Therefore, the project had to be managed with great care. The approach was extremely cautious and systematic, with meticulous attention to detail. The procedure was developed over an extended period and incorporated skills and knowledge from designers, operations, and craft workers, using a combination of consultancy contracts and teamwork. Considerable attention was paid throughout to integrating design and development experience with operating and craft knowledge. Safety and practical considerations advanced in parallel with technical developments. Due weight was given to training as well as keeping not only team members informed but also other groups within the business who had a need to know. Considerable thought and effort also went into engineering the new components required, not only from a functional aspect, but also from a materials handling perspective. Simulations using real size mock ups were used. All stages involved identifying what could go wrong and devising means of controlling the situation if it did. Worst-case
scenarios and conservative assumptions were made on many aspects of the procedure and the method statement was subject to continuous development.


- Process criteria of effectiveness — levels of effort, relevant knowledge and skills, and appropriateness of strategies applied to the work task
- Material resources — level of resources in relation to task demands

Subsequent models noted the importance of temporal aspects of team effectiveness, including the influence of change and effectiveness at different stages of a project cycle (Kozlowski et al., 1999; Marks et al., 2001). For example, West (1996) described the concept of reflexivity, the extent to which a group reflects on its objectives, strategies, processes, and environment, as reflecting the group’s evolution over time. Further developments, such as the heuristic model of group effectiveness (Cohen & Bailey, 1997) advanced the IPO approach to include the influence of environmental factors on group design (e.g., turbulence in the economic environment, industry characteristics) and to distinguish between team processes and group psychosocial traits (e.g., norms and shared mental models). Cohen and Bailey (1997) argued that group processes, which relate to interactions between team members, become embedded in (but are distinguishable from) emergent psychosocial traits, such as group norms and cohesiveness, shared mental models, and group affect. Marks et al. (2001) described these group psychosocial factors as emergent states rather than traits to reflect their capacity to change over time. Group processes can be divided into three categories (Marks et al., 2001): transition phase processes (focus upon evaluation and planning); action phase processes (comprising goal accomplishment activities, such as monitoring progress toward goals); and interpersonal processes (used by teams to manage interpersonal relationships, such as conflict management and motivation).

It is rare to find research relating to team effectiveness that includes safety outcomes, although there is evidence relating to safety-critical operations that are managed by groups, rather than individuals, such as flight crews and nuclear power plant operators — reviewed in the sections below. Research on team effectiveness has focused on outcomes related, inter alia, to the following items:

- Team’s productive output in terms of those evaluating it
- Team-member satisfaction
- Capabilities of team-members and their willingness to continue working together (Hackman, 1987)

In relation to safety, outcomes encompass task performance (e.g., accurate and error-free), compliance with safety rules and regulations, engaging in safety activities, and interacting with colleagues to exchange information. Task performance may be governed primarily by individual-level variables, such as knowledge and skills, which may be managed at the individual level. However, group-level variables will play a significant role in relation to compliance, participation, and social interaction. For example, the safe performance of teams with a high level of interdependence will depend critically on group-level processes — for example, flight crews or surgical teams. Tesluk and Quigley (2003) suggested that group processes within teams influence safety outcomes, including the
following:

- Monitoring teammates’ performance and providing feedback to others who are not working according to proper procedures
- Communicating and exchanging information
- Helping teammates when needed
- Assisting with production-related tasks by ensuring that team members have what they need to know in order to complete their tasks effectively
- Providing necessary assistance to complete work in a timely manner

The following sections consider some factors that can influence team effectiveness, including reference to safety-critical teams. Evidence relating to formal safety groups in organizations, such as safety committees, is reviewed in Section 8.5.

8.4.1 Team design

Team design refers to staffing issues (such as team size and member identities), specifying member tasks and roles, and organizational support systems (Guzzo & Dickson, 1996). Team effectiveness is affected by a number of intrinsic factors. An illustration of a traditional view is shown in Summary Text 8.4.

The traditional view concerning team size is that generally between 5 and 7 members is regarded as an optimum for team effectiveness. Beyond around 20 members, effectiveness is considerably reduced and there is a tendency for subgroups to form. However, some evidence has suggested that increasing group size may not have negative effects on performance (Campion et al., 1993); in fact, the tendency to split into subgroups may be advantageous as it allows for successful division of labor in managing sizeable tasks (Cohen & Bailey, 1997). In an analysis of various sizes of small groups, Belbin (1993) observed that ideal size is a compromise between the conflicting criteria of maximizing participation (tendency to smaller) and breadth of experience, ability, and knowledge (tendency to larger). While 6 members seems to meet this compromise, teams of up to 10 or 11 members would maximize the second criterion without jeopardizing the first providing that the group has a formalized structure to allow for adequate member participation. Research suggests that greater heterogeneity facilitates creativity and decision making (Jackson et al., 1995).

Belbin’s (1981) approach is that it is teams, and not individual leaders, that are critical to successful management. Central to his approach is the notion of a team role, which describes how members with characteristic personalities and abilities contribute to a team. The design of effective teams from different roles depends to an extent on the task to be completed. Belbin (1981) designed inventories to measure individuals’ team role preferences (later developed to measure other team members’ perceptions as well). The nine team roles that emerged are described in Summary Text 8.5. One person can take more than one role, but has a natural team role that reflects their distinct preferences for behavioral characteristics and thinking style. Furnham et al. (1993) questioned the psychometric properties of the Self-Perception Inventory, which measures preferred team role, suggesting that the nine roles fall into the following three main types listed here:

- Serious, hardworking roles
- Sober, dedicated roles
- Extraverted, divergent-thinking roles

Senior (1997) tested Belbin’s proposition that a balanced team would be associated with team effectiveness in eleven teams based in private and public sector organizations. She
Summary Text 8.4 Characteristics of Effective and Ineffective Groups

<table>
<thead>
<tr>
<th>Effective</th>
<th>Ineffective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informality, relaxed atmosphere,</td>
<td>Formality, tense atmosphere, indifference,</td>
</tr>
<tr>
<td>involvement, interest</td>
<td>boredom</td>
</tr>
<tr>
<td>Much discussion, high</td>
<td>Domination by few, contributions often</td>
</tr>
<tr>
<td>contributions</td>
<td>irrelevant</td>
</tr>
<tr>
<td>Understanding/acceptance of</td>
<td>Aims ill-defined/misunderstood, conflict</td>
</tr>
<tr>
<td>common aims</td>
<td>from private aims</td>
</tr>
<tr>
<td>Listen, consider, forward ideas</td>
<td>Unfair hearing, irrelevant speeches,</td>
</tr>
<tr>
<td></td>
<td>members fear ridicule/condemnation</td>
</tr>
<tr>
<td>Examine disagreements,</td>
<td>Disagreements suppressed, large minority</td>
</tr>
<tr>
<td>dissenters not overpowered</td>
<td>dissatisfied, disruptive, minority</td>
</tr>
<tr>
<td>Consensus, decision making,</td>
<td>Lack of consensus, premature decision</td>
</tr>
<tr>
<td>members feel free to disagree</td>
<td>making, formal voting</td>
</tr>
<tr>
<td>Constructive criticism</td>
<td>Personalized destructive criticism</td>
</tr>
<tr>
<td>Feelings and attitudes are aired</td>
<td>Feelings remain under the surface</td>
</tr>
<tr>
<td>Awareness of decisions/actions,</td>
<td>Lack of awareness of decisions, unclear</td>
</tr>
<tr>
<td>clear assignments</td>
<td>assignments</td>
</tr>
<tr>
<td>Leadership role undertaken by</td>
<td>Leadership role jealously guarded</td>
</tr>
<tr>
<td>most suitable member</td>
<td></td>
</tr>
<tr>
<td>Frequent review of group</td>
<td>Not too concerned with group deficiencies</td>
</tr>
<tr>
<td>operations</td>
<td></td>
</tr>
</tbody>
</table>

Characteristics of high performing teams

- Senior managers shape the nature and purpose of the team, which is then allowed to get on with its tasks and exercises flexibility with respect to planning and attending to operational matters. Team members are empowered. By giving a team clear authority and then taking a back seat, management releases collective energy and creativity.
- Successful teams translate common purpose into specific and measurable performance goals. Team goals are related to department or division goals and the focus of attention is on what is required to be done and getting results. This fosters good communication and commitment and if there is conflict it is likely to be constructive and handled well. Feedback on progress toward meeting goals is available and considered important.
- Successful teams should be of a manageable size (between 2 and 25 members, but ideally not more than 12), the number depending on situational demands.
- Successful teams have an appropriate mix of expertise and the team strives to obtain and use complementary skills (e.g., a mix of technical expertise) for problem solving and decision making. Interpersonal skills are mobilized to improve dialogue and interaction and keep the team focused on matters in hand.
- Successful teams develop a common commitment to working relationships. There must be agreement on work scheduling, task allocation, necessary skill and its development, an ideal approach to decision
making, and what is required of team members to justify their continued association with the team. The team deliberates on individuals best suited to various tasks, how roles are related, and reporting relationships between the team and others in the organization. A social contract among members is developed to govern the way they interrelate and to specify their obligations in the light of demands in achieving common goals.

- Members of successful teams hold themselves collectively accountable. Putting the spotlight on individual responsibility is critical to a well-coordinated effort, but effective teams find ways to hold the collective accountable.


found weak support for balanced teams outperforming unbalanced teams. However, not all teams require all team roles (e.g., monitor–evaluator for fairly routine tasks). Dulewicz (1995) found virtually no support for team roles being associated with particular status levels within an organization. Fisher et al. (1998) found that team roles could be described in terms of relationship (chairman, teamworker, resource-investigator, and company worker) and task (plant, monitor-evaluator, completer-finisher, and shaper). The former are good communicators, whilst the latter are task oriented. Individuals may take a primary and a secondary role, but both are likely to come from the same area. A dyad will be most effective with one relationship-oriented and one task-oriented individual. Swailes and McIntyre-Bhatty (2003) found that while some team roles were unidimensional, others were better described as bi-dimensional. Anderson and Slep (2004) found that gender differences mediated some of Belbin’s team roles. While it appears that debate on the precise nature of team roles will continue, the basic principle of team effectiveness requiring a variety of roles remains intact.

Belbin (1993) identified six factors underlying team-role behavior. Of the first personality, like many researchers, Belbin considered that the two key dimensions of extraversion–introversion and anxiety (neuroticism–stability) underlie much of our behavior. However, high intelligence (Belbin’s second factor) can override any adverse personality traits to generate exceptional behavior. The third factor is concerned with underlying values and motivations. Fourth are factors in the immediate environment that operate as constraints (e.g., resources). Fifth is personal experience and cultural factors, which may serve to adapt behavior to certain wider social norms, and sixth is awareness and learning how to play a role to improve personal versatility. Belbin (1993) described the steps required to build a strong team, and these are outlined in Summary Text 8.6. It will be seen that the principles espoused can readily be incorporated within accepted principles of risk management and human resource management.

8.4.1.1 Group norms and expectations
Norms are rules or standards established by group members to denote acceptable and unacceptable behaviors. Norms can cover a variety of situations; for example, quantity and quality of output, production methods, how individuals interrelate, and appropriate dress (see Chapter 6). As with other activities, our behavior in respect of risk-taking is very much influenced by the company we keep, especially our peer group as well as by wider social norms. Thus, while attitudes may be important in influencing our behavior (Chapter 6), the power of a group norm or a wider social norm to determine our behavior should
### Summary Text 8.5 The Nine Team Roles Described by Belbin (1993)

<table>
<thead>
<tr>
<th>Role</th>
<th>Description (and allowed weaknesses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaper</td>
<td>Challenging, dynamic, thrives on pressure, drive and courage to overcome obstacles, task leader, brings competitive drive to a team, makes things happen (can be abrasive and provoke others, can hurt people’s feelings)</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Mature, confident, good chairperson, clarifies goals, promotes decision making, delegates well, sets team goals, coordinates team efforts, leads by eliciting respect (can be seen as manipulative, delegates personal work)</td>
</tr>
<tr>
<td>Resource investigator</td>
<td>Extravert, enthusiastic, communicative, explores opportunities, develops contacts, salesperson, diplomat, resource seeker, good improviser, many external contacts (can be overoptimistic, loses interest once initial enthusiasm has passed, may be easily diverted from task in hand)</td>
</tr>
<tr>
<td>Plant</td>
<td>Creative, imaginative, unorthodox, solves difficult problems, intelligent, source of a team’s original ideas, concerned with fundamentals (may ignore details and be too preoccupied to communicate effectively)</td>
</tr>
<tr>
<td>Monitor evaluator</td>
<td>Sober, strategic, discerning, sees all options, judges accurately, offers measured, dispassionate, and critical analysis, keeps team from pursuing misguided objectives (can lack drive and ability to inspire others or be overly critical)</td>
</tr>
<tr>
<td>Teamworker</td>
<td>Cooperative, unassertive, mild, perceptive, diplomatic, likeable, good listener, builds on others’ ideas, averts friction, calms the waters, promotes team harmony (can be indecisive in crunch situations, easily influenced)</td>
</tr>
<tr>
<td>Implementer</td>
<td>Disciplined, reliable, conservative, efficient, turns ideas, decisions, and strategies into practical actions and manageable tasks, brings logical, methodological pursuit of objectives to a team (can be inflexible and slow to respond to new possibilities)</td>
</tr>
<tr>
<td>Completer finisher</td>
<td>Painstaking, conscientious, anxious, searches out errors and omissions, delivers on time, worries about problems, personally checks details, intolerant of the casual and the slapdash, sees projects through (may be inclined to worry unduly, reluctant to delegate, can be a nitpicker)</td>
</tr>
<tr>
<td>Specialist</td>
<td>Single-minded, self-starting, dedicated, provides knowledge and skills in rare supply (contributes only on a narrow front, dwells on technicalities, overlooks the big picture)</td>
</tr>
</tbody>
</table>
Summary Text 8.6 Stages in Building a Successful Team

- Identify needs — shapers and coordinators particularly strong at this stage.
- Find ideas — plants and resource investigators have a crucial role to play here.
- Formulate plans — weighing options to provide pointers to the right decision and making good use of all relevant experience indicates that monitor evaluators and specialists are likely to have a key part to play at this stage.
- Make contacts — ideas and plans require champions and those who can persuade others of the benefits of a new approach; resource investigators and team workers are likely to be needed here.
- Establish the organization — plans need to be turned into procedures, methods, and working practices and people need to be adapted to the system; this is likely to require implementers and coordinators.
- Follow through — it cannot be assumed that all will be well and completer-finishers and implementers will be needed at this stage.


not be underestimated. Expectations of fellow workers and management, for example, in respect of adherence to safety rules, can strongly influence how individuals behave, contributing to a team’s safety climate (see Section 8.4.1.3) and an organization’s safety culture (Chapter 11).

Kelman (1958) expressed the extent to which an individual relates to the norms or expectations of a group or organization in terms of three levels. His theory of attitudes, already discussed in Chapter 6, can also be related to group behavior. Kelman’s model illustrated that behavior may be influenced by the organization imposing rules (and ensuring workforce compliance) or by groups of workers deciding to behave in a certain way (i.e., a norm) and encouraging identification with this behavior among group members. However, only when individuals themselves believe (i.e., internalize the view) that to behave in a certain way is correct is their own (safe) behavior likely to be consolidated. Subsequently reinforcing individual behavior or inducing behavioral change through organizational rules and group norms that are consistent with this behavior can then provide powerful support for an individual’s behavior. Group norms are often not explicitly defined and it is only when they are breached that they become obvious. A worker who ignores a group safety norm by, for example, persistently ignoring safety rules is a deviant. Pressure can be put on deviants to conform using such methods as verbal or physical coercion, silence, or expulsion from the group. Where a group norm is strongly held (i.e., approval shared throughout the group) and the group is highly cohesive (see Section 8.4.1.2), the more strongly this pressure is likely to be applied. Summary Text 8.7 describes two classic studies of group norms.

An example of a social norm acting to the disadvantage of safe work practice is reflected in the experience of a worker in the telecommunications industry described in Summary Text 8.8. Group norms are analogous with individual attitudes (Chapter 6) and may be changed through similar types of process. Often people’s own experience is a powerful change agent, as in the example in Summary Text 8.8.
Summary Text 8.7 Two Classic Studies of Group Norms

Group norms were first described in an early classic U.S. study of groups of production workers at the Hawthorne Western Electric works near Chicago (Roethlisberger & Dickson, 1939) in which informal norms were established to set an acceptable level of output. Sanctions were used to denote disapproval of deviation from these norms and pressure (e.g., name calling, ostracism, or mild physical assault) was applied to deviants to encourage them to conform. The group also applied social pressure on work quality inspectors and supervisors to get them to conform to the group’s standards. Although these studies have been criticized (Franke & Kaul, 1978), they were very influential in giving rise to the human relations school of management, which is part of the lineage of the soft side of HRM (human resources management). The three main components were:

- Recognition of the prime function of social interaction among group members
- Relevance of the informal group at work
- Importance of taking an interest in workers — generalized as the Hawthorne Effect

An early U.K. study of the effects of group norms on output levels (Lupton, 1963) found a restrictive norm in one factory aimed at regulating output and stabilizing income; this was referred to as the fiddle. In another factory, no such restrictive norm existed. The difference between the two situations was accounted for by economic and social influences, which dictated attitudes to productivity. In this study, group norms related to production levels were significantly influenced by the different orientations that workers brought to their jobs.

Summary Text 8.8 Example of a Social Norm Being Opposed by a Single Worker, Leading to Norms Changing

The worker insisted on wearing safety gloves during certain tasks, a practice not ingrained in established group norms. Pressure was put on this worker to change his behavior and conform. At first disapproval took the form of remarks, such as sissy and reference to how the gloves did not fit well. In fact it was possible to return badly fitting gloves and obtain gloves that fitted. The supervisor, a senior technician who prided himself on his speed and masculinity, felt strongly about the worker wearing safety gloves and eventually instructed him to stop wearing them. A second line supervisor also passed derogatory comments about wearing the gloves, maintaining that the practice reduced productivity. However, it took a couple of incidents, in which splinters from a telegraph pole entered the glove rather than the finger, to convince other members of the work group of the value of safety gloves. Eventually, the supervisor wore gloves during certain processes and it became a group norm to wear them.

Although little studied in relation to safety outcomes, it is clear that group norms and expectations can be significant influences on workers’ behavior, for example, in relation to violations, which Reason (1993) defined as deliberate infringements of safe working practice. However, this definition hinges upon how one defines safe (e.g., do company rules always provide the safest way of working or do workers sometimes know safer shortcuts?). Defining violations in terms of deviations from a norm widens understanding of worker behavior, as deviations can occur inter alia in relation to the following factors listed here:

- Rules, standards, or regulations — formulated by the organization, for example, in response to previous incidents or from risk assessments
- What is regarded as normal or usual — determined by group norms and expectations
- What is adequate or acceptable — related to injury risk (Clarke, 1994)

Deviating from a company safety rule, for example, may also involve a deviation from what is acceptable (the practice is unsafe), but not from what is regarded as normal by a work group (because it is a group norm). Organizational safety climate will be important in determining the extent to which standard working practices (ways of working that are regarded as normal or usual) deviate from company rules (normal violations) (Clarke, 1994). Normal violations that are perceived to be safe by operators are accepted as normal ways of working within the group. However, anomalous violations (Clarke, 1994) are not appropriate behaviors (although they might serve a variety of purposes for the operator for example, saving time or effort, relieving boredom or testing skills) as they are unacceptable and potentially unsafe. The extent of this type of violation varies between work groups (Clarke, 1994) and is largely determined by group safety climate (see Section 8.4.1.3).

The Clapham Junction disaster was triggered by the actions of a worker undertaking maintenance work of the signaling system; as highlighted in Summary Text 4.13. His actions included both normal and anomalous violations that were critical etiological components of the subsequent disaster. An understanding of why violations occur depends both on organizational safety climate and on work group or departmental safety climate. The safety climate should encourage work behaviors that are safe and appropriate. This requires understanding an organization’s safety goals, acknowledging that safety is a high priority, and the knowledge, skills, and confidence to accurately assess workplace hazards (see Chapter 4 and further discussion in Chapter 11). Strongly held norms can be mal-adaptive where they lead to normative and highly routinized behavior, which is rarely questioned, while at group level a team’s ability to develop novel solutions, adapt to changing performance demands, and maintain long-term learning can be damaged (Tesluk & Quigley, 2003). Group norms can also influence a team’s ability to make effective decisions (see Section 8.4.1.5).

8.4.1.2 Cohesiveness

Group cohesiveness is advanced by group members sharing common values, beliefs, and objectives, which promotes sharing of similar ideas and their mutual acceptance. Members of a cohesive group agree among themselves how best to achieve group objectives, emphasize the need for close cooperation in order to complete various tasks effectively, and create conditions for satisfying members’ personal needs. The greater the benefit that members derive from group membership, the more cohesive the group is likely to be. Gully et al. (1995) showed that cohesion is positively related to performance, particularly where tasks are highly inter-dependent.
Work group cohesiveness has emerged as an important variable in predicting both safety initiative and safety compliance (Simard & Marchand, 1995, 1997). In a study of nurses’ occupational injuries, Hemingway and Smith (1999) found that peer cohesion significantly predicted reported injuries and near injuries. As noted in Chapter 7 (see Section 7.5.3.1), group cohesion can act as a source of social support. A number of studies have demonstrated that increased coworker support leads to fewer occupational injuries (Sherry, 1991; Iverson & Erwin, 1997). As cohesive groups tend to develop high levels of psychological safety, cohesiveness may support safety activities. This aspect of team climate can allow group members to suggest alternative ways of working, admit to mistakes and problems, and contributes to learning (Edmondson, 1999). Multilevel research has shown that work group cohesiveness (group-level variable) is linked with organizational citizenship behaviors (individual-level variable) (Kidwell et al., 1997). This suggests that group processes could influence individual safety behavior, depending on group cohesiveness — that is, more cohesive groups enhance the relationship, due to the strength of group norms and the motivation to comply with them. In addition to its effects on safety performance, cohesiveness may help to buffer workers against negative outcomes of occupational stressors (see Section 7.6.2.3). Although group cohesion usually has positive associations, under some circumstances it can have an adverse effect on safety as illustrated in Summary Text 8.9. Strong pressures toward conformity can reduce team adaptability and the ability to learn, and can lead to inappropriate decision making (see Section 8.6.3 on groupthink). A meta-analysis of studies linking cohesion with decision making (Mullen et al., 1993) showed that cohesiveness was particularly detrimental to decision making where cohesion was based upon interpersonal attraction.

**Summary Text 8.9 Illustration of Negative Impact of Group Loyalty upon Safety**

The function of a factory unit was to modify rod-shaped machine tools by cutting or bending them. Before modifying them one end of each pen-sized tool was dipped in a protective molten plastic substance. After modification some of the tools were sandblasted to make them look better. Almost every one of these actions was undertaken in a grossly unsafe manner. One Monday, the manager told six of his subordinates to make the place presentable because the factory inspector was coming around. Three of them were asked to tidy up around the machines and the other three to pick up the boxes of tools from the gangway and place them on a long bench. The manager told the group that they could replace the boxes as soon as the visit was over, and gave them a wink, because the bench was required for other things.

The factory inspector seemed to be viewed as an enemy. The men grumbled about the visit but the manager said, “Surely we don’t want people, like factory inspectors, finding fault with our unit, lads!” This prompted jokes about setting booby traps for the factory inspector. When the factory inspector left, there was evidence of a lot of antisafety behavior. In this case the behavior would suggest that there appeared to be mindless devotion to the group, particularly in the face of an outside authority figure with powers of sanction. The “them and us” sentiment was aroused by the factory inspector’s visit, but the them in this case was the factory inspectorate.

8.4.1.3 Group safety climate

Research has focused on measuring safety climate at an individual level, but aggregating individual responses to define an organization’s safety climate (see Chapter 6). Given the increasing emphasis on teamworking, as discussed in the chapter introduction, this suggests that evaluating safety climate at team level would be a more appropriate unit of analysis in many instances. There is evidence that differential results linking safety climate to safety outcomes can be obtained within the same study, depending on the level of measurement. Hofmann and Stetzer (1996) examined safety attitudes at both individual and team level, and found that more positive safety climate scores were associated with reduced unsafe behavior at team level, but with increased unsafe behavior at an individual level. Similarly, Zohar (2000) found that safety climate had a significant negative correlation with injury rate at group level, but at an individual level, the relationship was close to zero. Clarke’s (2005) meta-analysis demonstrated that the effect of safety climate on injury involvement was larger in studies using a group level of analysis compared with those presenting individual level data. A positive group safety climate may facilitate safety-related behavior, such as encouraging coworkers to behave safely, and provide support needed by individuals in order to reduce the necessity to engage in violations — for example, reducing time pressure on colleagues by providing assistance.

Zohar (2000) argued that work groups develop distinct sub-climates due to differing levels of supervisory commitment to safety. The definition of group safety climate uses supervisory emphasis, in terms of safety, as the referent for subordinates’ perceptions, referring to supervisory practices-as-pattern in relation to the whole group, rather than isolated supervisory actions. Two factors emerged, which were identified as supervisory action and expectation. The former refers to overt supervisory reaction to subordinates’ conduct (i.e., positive and negative feedback) and initiating action concerning safety issues, whilst the latter refers to expectations, mostly in relation to safety issues vs. productivity. Group members agree on relative priorities of various aspects of tasks and behave accordingly. Comparing characteristics of work groups with high and low injury rates, Guest et al. (1994) found that low-injury work groups were more cohesive, more considerate, more trusting of each other, and had supervisors who were more concerned with their workers, made staff feel valued, kept them informed, and treated them fairly. A safety intervention aimed at improving supervisory safety practices was successful in strengthening safety climate and reducing subunit injury rate (Zohar, 2002b; see also Chapter 9). However, interventions at group or organizational level are rare, with most focusing on individual-level factors, such as training, goal-setting, feedback, and incentives (see Chapter 3 and Chapter 6). Simard and Marchand (1997) found that the most important predictor of safety compliance by work groups was a cooperative work group–supervisor relationship and a participative approach toward supervisory safety management. The safety role of supervisors and managers is discussed in Chapter 9.

While Zohar’s (2000) definition of group safety climate is expressed in terms of supervisory influence on workers, research indicates that individuals feel more committed to the work group (i.e., their coworkers or teammates) than to the organization, their supervisors, or managers (Becker, 1992). The work group also has the most powerful socialization effect on new workers (Moreland & Levine, 2001). Thus, while the most influential factor in relation to group safety climate should be coworkers’ attitudes, norms, and expectations, these have featured little in research examining group safety climate. For example, there is no consideration of the development of safety climate within self-managing groups, as the existing definition of group safety climate is dependent on the supervisor as group leader, whereas autonomous, or self-managing, groups have no assigned leader. Group influences, as outlined earlier, can be particularly powerful in the absence of formal management control.
More broadly there has been a tendency to consider safety climate as an organizational-level concept and to emphasize consistency of views (see Chapter 6). However, it may be argued that differences between groups in terms of safety climate may act to stimulate reflection on safety practices and help to discourage complacency. Even at an intra-group level, a degree of skepticism and conflict may be beneficial to maintaining a positive safety climate (despite an emphasis on shared attitudes and beliefs). Jehn (1995) demonstrated that task conflict (disagreements about task content) promoted critical evaluation of problems and consideration of different options when performing nonroutine tasks. Similarly, healthy skepticism about safety may help to maintain a general alertness amongst the workforce toward potential safety problems.

8.4.1.4 Communication
In a classic study of communication networks (Levitt, 1951) a group of five people was set simple problem-solving tasks in different types of interrelationships. Participants were only permitted to communicate using written notes. While this situation is unlike a small group in which communication is face-to-face and where each member can see and hear every other member, it is not unlike some contemporary forms of communication, such as teleconferencing. The studies were more like situations in large organizations where a number of people in different parts of the organization are in touch with one another either indirectly, or if directly, then frequently only through a relatively impersonal medium such as telephone, e-mail, or memorandum. While centralized networks were more efficient in executing simple tasks, complex tasks were performed more effectively by less centralized networks, such as those that enabled all members to communicate with one another (Shaw, 1964). Decentralized networks characterize communication links in virtual teams where there is no face-to-face communication, and all interactions are conducted via information technology, such as e-mail and groupware (Bell & Kozlowski, 2002). A general conclusion from this type of study is that it is important to select the right type of group structure for the task in hand.

In terms of safety outcomes, Hofmann and Stetzer (1998) found that open and free-flowing communications characterized groups that demonstrated effective learning from incidents. The importance of effective and appropriate intra-group communication is also illustrated by studies focusing on communications within flight crews. For example, Sexton and Helmreich (2000) analyzed communications within 3-person flight crews (commander, first officer, and flight engineer), recorded during flight segments on a Boeing 727 simulator, against measures of team performance, including error rates. They found that the type of language used in communications between team members in one segment was significantly related to performance and error rate in a later segment. For example, in one segment the flight engineer made fewer errors when communications in the previous segment were characterized by the commander’s use of achievement-oriented language (e.g., words such as try, effort, goal). In contrast, problems stemming from the working relationship between an airline captain and first officer have been cited in a number of incidents and crashes. In the 1982 Boeing 737 air crash in Washington, the captain ignored the unassertive copilot’s concern about the performance of the aircraft during takeoff (Hawkins, 1987). A U.K. study examining flight deck communication found that nearly 40% of first officers surveyed stated that on several occasions they had failed to communicate to the captain their legitimate doubts about the operation of the aircraft. Reasons for doing so included a desire to avoid conflict and deference to the captain’s experience and authority — known as the cockpit authority gradient. First officers in this study described captains as arrogant and holding strong and intransigent attitudes. However, captains reported that domineering, aggressive, or uncooperative behavior were the most descriptive characteristics of their
fellow crew members. Thus, attributed personality characteristics were a significant source of interaction problems (Wheale, 1984).

Lack of communication between flight crew and the cabin crew was a contributory factor in the Kegworth disaster (see Summary Text 4.4), in conjunction with a number of other mistakes (discussed in Chapter 4). Gersick and Hackman (1990) found that rigid role differentiation among flight crew was a factor in one crew failing to engage a deicing device during preflight checks, which resulted in the plane crashing shortly after takeoff. This problem is not exclusive to the flight deck — similar incidents have been recorded in a medical context, where the hierarchy that exists between nursing staff and doctors has acted as a barrier to communication. For example, Helmreich (2000) described the catalogue of medical errors that led to a young child undergoing routine surgery, dying in theatre (see Summary Text 8.10). Organizational communication is discussed further in Chapter 10.

### Summary Text 8.10 Example of a Fatal Medical Incident

An 8-year-old boy was admitted for elective eardrum surgery. He was anesthetized and an endotracheal tube inserted, along with an internal stethoscope and temperature probe. The anesthetist did not listen to the chest after inserting the tube. The temperature probe connector was not compatible with the monitor (the hospital had changed brands the previous day). The anesthetist asked for another but did not connect it; he also did not connect the stethoscope.

- Surgery began at 08:20 and carbon dioxide concentrations began to rise after about 30 min. The anaesthetist stopped entering CO2 and pulse on the patient’s chart. Nurses observed the anesthetist nodding in his chair, head bobbing; they did not speak to him because they were afraid of a confrontation.
- At 10:15 the surgeon heard a gurgling sound and realized that the airway tube was disconnected. The problem was called out to the anesthetist, who reconnected the tube. The anesthetist did not check breathing sounds with the stethoscope.
- At 10:30 the patient was breathing so rapidly that the surgeon could not operate; he notified the anesthetist that the rate was 60/min. The anesthetist did nothing after being alerted.
- At 10:45 the monitor showed irregular heartbeats. Just before 11:00 the anesthetist noted extreme heartbeat irregularity and asked the surgeon to stop operating. The patient was given a dose of lignocaine, but his condition worsened.
- At 11:02 the patient’s heart stopped beating. The anesthetist called for code, summoning the emergency team. The endotracheal tube was removed and found to be 50% obstructed by a mucous plug. A new tube was inserted and the patient was ventilated. The emergency team anesthetist noticed that the airway heater had caused the breathing circuit’s plastic tubing to melt and turned the heater off. The patient’s temperature was 108°F. The patient died despite the efforts of the code team.

8.4.1.5 Group discussion and decision making

Decisions taken by a group are liable to have a greater effect on an individual’s behavior than if a decision is already made by, for example, a speaker who instructs an audience about the course of action to follow (Lewin, 1958). Lectures tend to result in passive listening, individual members of the audience using their experiences as a basis for accepting or rejecting ideas suggested. Also, each individual is unaware of what other members of the audience are going to decide, and none is therefore exposed to a new social norm as a guide. However, in discussion, group members exchange views and consider advantages and disadvantages of various courses of action. Decisions emerging from such discussion become norms and if decisions are to be manifested in behavior it is likely that most or all group members will act in accordance with group decisions. Zander (1982) recognized the value of discussion groups in advisory and educational contexts as those outlined as follows:

- Helping members to recognize what they do not know, but should know
- An opportunity for members to get answers to questions
- Enabling members to seek and obtain advice on matters that they do not understand
- Providing opportunities for people to share ideas and take advantage of the group’s shared wisdom
- Giving members opportunities to learn about one another as individuals

An experiment involving three companies in the explosives industry in Sweden was conducted using group decision making. The researchers were confident that positive efforts to reduce health and safety risks materialized, and that discussion group participants benefited from greater awareness and understanding of problems connected with health and safety at work, and accepted remedies suggested (Kjellén & Baneryd, 1983). Safety committees provide an opportunity for discussion and exchange of views on health, safety, and workplace risk issues (see Section 8.5). Before accepting too readily the advantages of group discussion it is worth noting circumstances under which group decision making may be less effective, for example, under the following circumstances:

- Tasks or problems are simple or routine
- Problems have a correct solution
- It is difficult to demonstrate solutions to group members
- Problems require subtle, logical reasoning

Over time, team members develop mutual understanding of each other and the task environment, leading to a shared mental model (see Chapter 4 for discussion of individual level mental models). Mathieu et al. (2000) demonstrated that shared mental models could significantly influence such group processes as communication and performance. Experimental studies have shown that performance of flight crews can be improved through cross-training, where team-members develop enhanced mutual understanding by gaining experience of each others’ roles (Blickensderfer et al., 1998; Cannon-Bowers et al., 1998). Shared mental models may contribute to more effective team performance through team members’ ability to adapt to each others’ needs and to unanticipated environmental demands. For example, Foushee et al. (1986) showed that experienced flight crews were better able to coordinate their actions as a team and to monitor and recover each others’ errors. However, there is evidence that over longer periods, familiarity can lead to overconfidence, complacency, and increased errors (Leedom & Simon, 1995). Shared mental models developed over time can lead to discussion bias, where team members tend to discuss common information rather than unique information, which leads to suboptimal performance.
in situations where uniquely held information is important. Kim (1997) found that groups with both task and team experience demonstrated the largest discussion bias. The author hypothesized that this effect was due to the curse of knowledge, where individuals tend to assume that information they hold uniquely is shared. Individuals are more susceptible when situations are familiar.

Evidence suggests that decision-making processes are very important for team effectiveness. Guzzo and Salas (1995) suggested that more reflexive groups, that is, those who reflect on group objectives, strategies, processes, and environment, make more high-quality decisions. Other influential factors include: planning, group norms, and being problem-minded (Maier, 1970) — that is, focusing on the current approach, alternatives, and perspectives, rather than on the solution (West et al., 1998). Guzzo and Campbell (1990) suggested that group potency could predict team effectiveness (i.e., a group’s perception of its likely success and its ability to meet challenges). Gevers et al. (2001) found that potency acted as a moderator in the relationship between perceived time pressure and meeting project deadlines, such that high-potency groups are motivated by increased time pressure, while low-potency groups are discouraged. It is important that reflexivity evident in the orientation phase (action planning and development of strategies) is continued into the execution phase. In relation to safety outcomes, Tesluk and Quigley (2003) suggested that collective efficacy, which they defined as a group’s belief in its ability to work safely, influenced team safety performance, particularly in meeting the challenge of increasing production demands. This factor operates in similar fashion to group potency, by motivating team members. Dangers associated with group decision making, such as risky shift and groupthink, are discussed in Section 8.6.3.

8.4.1.6 Team leadership and self-managing teams

Evidence suggests that team leaders play an important role in team performance (Zaccaro & Marks, 1999). Leadership style has been shown to influence team effectiveness — for example, Eden (1990) found that leader expectations affected Israeli military teams’ performance. It seems that leadership style may influence group processes, such as consensus decision making, which in turn influence team effectiveness (Flood et al., 2000). The team leadership role of supervisors in respect of safety was noted earlier (see Section 8.4.1.3), where supervisors’ leadership style (e.g., the extent to which a supervisor demonstrates interest in subordinates’ well-being) influences group safety climate, which in turn affects work injury rate. Further issues related to leadership and safety are discussed in Chapter 9.

Despite the prevalence of teams, relatively little research focuses on the requirements of team leaders. However, researchers agree on the following two primary functional roles that a leader plays as described here:

- Develop and shape team processes — either establishing new teams from a set of individuals or managing personnel inflows and outflows from established teams.
- Monitor and manage team performance — monitoring team members’ behavior, determining the nature of problems, and implementing effective solutions.

Conventional wisdom relating to leadership functions is challenged in relation to two emerging trends in the nature of teams. First, the increase in self-managing or autonomous teams, where there is no formal leader and leadership functions are dispersed amongst team members, and second in creating virtual teams, where team members are spatially distant and connected by technological communication. This and the following subsection respectively consider these two aspects of teams.
There is limited evidence on the operation of autonomous work groups and occupational safety. As noted in Chapter 7, benefits of increasing autonomy and control at work have been widely studied, indicating a positive association with mental and physical health (Karasek, 1990). Studies of autonomous work groups have found positive effects on productivity and other performance measures, although there is less certainty regarding effects on well-being, motivation, and absenteeism (Goodman et al., 1988; Fisher, 2000). Leach et al. (2005) found that team autonomy was associated with performance and strain through teamwork knowledge, skills, and abilities. A review of 23 studies of autonomous work groups identified two distinct views relating to the benefits of such teams (Metlay & Kaplan, 1992); one noting positive benefits associated with reduced rates of turnover and injuries, the other identifying difficulties related to increased stress levels. The stress literature (reviewed in Chapter 7) suggests that increased control relieves stress outcomes, such as depression, and improves motivation. However, the way in which decision latitude is devolved in autonomous work groups may affect feelings of empowerment within a team. For example, minor decisions, such as distribution of work may be delegated to the work team, whilst the most important decisions (from an organizational perspective), such as productivity targets, are retained centrally. Thus, team members may find that they have increased responsibilities without experiencing increased personal control (Manz & Angel, 1996).

Research from the 1960s and 1970s highlighted some safety benefits of reorganizing workers into autonomous work teams (Trist et al., 1963, 1977; Walton, 1972; Goodman, 1979). In a U.K. coal mine case study, Trist et al. (1963) found that miners who were organized into teams that rotated tasks and functions, as opposed to conventional teams, experienced no change in lost-time injuries, whilst these rose significantly for conventional teams. Benefits of this way of working may relate to the increased knowledge of their own and other miners’ tasks, facilitating better coordination between team members and reduced errors, together with effects of increased variety, which reduces boredom and fatigue. Goodman (1979) evaluated autonomous work teams in a longitudinal study of a coal mine, finding that observed safety behaviors demonstrated a significant improvement. However, other indicators, such as violations and incident data, were ambiguous. Other research (Pearson, 1992; Hechanova-Alampay & Beehr, 2002; Roy, 2003) supported the argument that autonomous work teams have a positive effect on safety, although Cohen and Ledford (1994) found no significant effect for teams in the service sector.

Roy (2003) examined the operation of autonomous work groups in 12 companies in Canada to evaluate their health and safety perspectives. The study noted that in several cases roles played by a formal safety committee (see Section 8.5) had devolved to work teams, so that responsibility for identifying failings and introducing corrective and preventive safety measures now rested with those carrying out the work. Pearson (1992) also noted this characteristic of autonomous work teams. The increase in safety responsibilities may form the motivation of work teams to take greater ownership of safety issues. However, Roy (2003) observed dangers associated with delegating health and safety responsibilities, because managers may be perceived as losing commitment to safety if they assume that work-based teams are undertaking this responsibility. It is vital that managers continue to take a leadership role in safety, as self-managed teams are likely to be acutely aware of the discrepancy between management rhetoric and reality on the ground. Developing appropriate group norms is also an issue, particularly where teams are set production targets associated with team bonus payments. In this case, team members may be subject to even more intense pressure from coworkers to reach production targets than in traditional settings where supervisors exert such pressures. Another leadership role — monitoring and managing behavior, when devolved to the team, will involve team members monitoring each other’s work. This needs to be accepted within a team; otherwise it could become a source of resentment and conflict.
Among others, Goodman (1979) and Pearson (1992) noted the difficulty of isolating effects of autonomous work teams on safety. It is possible that autonomous teamworking is not responsible per se for improving safety, but that employing autonomous teams is one hallmark of a high-performing company (Roy, 2003). As high-performing companies are most likely to have a range of sound health and safety management systems in place, these systems will also contribute to high safety performance and low injury rates. As with the institution of formal safety committees (see Section 8.5), workforce empowerment through autonomous work teams may form part of the broader company safety culture.

8.4.1.7 Virtual teams

A virtual team has been defined as a physically dispersed task group that conducts its business through information communication technology (Townsend et al., 1998). Members may never meet face-to-face but relate to each other, audibly and visually, using computers and telecommunications, for example, sharing information through the Internet, e-mail, and teleconferencing. Through these facilities all members can access the same information before making decisions and can move in and out of teams as circumstances dictate.

Although flexibility is an attractive aspect of the virtual team, a negative feature is lack of face-to-face interaction, which can weaken trust, communication, and accountability—a particular drawback in the early stages of group development process when face-to-face contact is beneficial. The challenge is to encourage positive interaction between virtual team members without the benefit of face-to-face contact. For these teams to succeed they should have clear objectives, full administrative support, appropriate training, and most importantly, top management support (Kreitner et al., 2002). Child (2005) maintained that there is increasing interest in global virtual teams.

For groups that cannot meet face-to-face the Delphi technique can be used for complex problems requiring expertise (e.g., control measures for a major hazard site). In this approach an expert panel is formed and circulated with a questionnaire on the problem domain. Responses are collated and summarized before being circulated to group members with a follow-up questionnaire. The process is repeated until consensus is achieved. An example of the Delphi technique being used within a wider risk domain is from the Economist Intelligence Unit expert panels rating countries on their performance in a range of categories to provide an investment risk rating for any country, described by Hanley (2000). The panels first determined what the critical risk factors for any country were; they were: falling GDP, inflation, capital flight, foreign debt, food production, raw materials, bad neighbors, authoritarianism, staleness of regime, illegitimate regime, generals in power, war, urbanization, Islamic fundamentalism, corruption, and ethnic tensions. This was the risk identification phase. The panels then determined the relative importance of each of these 16 factors by allocating a maximum points score for each (“war” having the highest score of 20, down to “bad neighbors” at 3) the potential maximum being 100 — analogous with the risk analysis phase. Then the expert panel for each country arrived at a total risk figure by allocating points for each individual risk factor for that country — as in a risk assessment. While this approach provided a systematic measure of investment risk for each country, it remains a subjective approach.

A major challenge for virtual team leadership is to continue to perform the functions of leadership by using substitute methods, or to distribute these functions within the team (self-managing team). To ensure effective team performance, Bell and Kozlowski (2002) suggested that virtual team leaders needed to focus on the
following items:

- Provide clear, engaging direction, together with specific individual goals
- Develop appropriate habitual routines
- Set explicit objectives — create a clear mission and develop an appropriate climate
- Set rules and guidelines for appropriate team member behavior
- Monitor external conditions for change
- Facilitate adaptive and appropriate changes within the team
- Motivate team members and facilitate team coherence
- Create a self-managing team by distributing leadership functions within the team

Summary Text 8.11 provides more guidance on ensuring the effectiveness of virtual teams.

Whilst the literature evaluating effects of virtual teamwork on organizational outcomes is in its infancy, there is little to guide safety and risk professionals in assessing safety risks associated with this way of working. However, there are implications for error management in virtual teams where team members are not working face-to-face, and so may fail to

**Summary Text 8.11 Aspects of Good Practice with Regard to Virtual Teams**

A face-to-face small group meeting right at the start is important in nurturing trust building, which develops faster in teams that meet face-to-face than in teams that do not. A distinguishing feature between successful and unsuccessful virtual teams is that the more successful teams made genuine efforts to build trust as detailed below:

- Team leaders should support trust development among team members, and encourage sharing of social information; for example relating to culture or family.
- Agree a code of practice setting out how team members should behave and communicate with each other. This should cover practical things, such as responding to e-mails within a fixed time, and issues relating to psychological support, which could include sending encouraging messages to team members and acknowledging others’ efforts.
- Team leaders or coordinators should be skillful in summarizing information from team interactions (conversations) and make this available to all members, exercising care in generating information in case people become overloaded — for example, from e-mail communications.
- Ensure that everybody understands each other’s role, and keep strong links with the parent organization.
- Virtual teams should have a sponsor right at the top of the organization. A key task for the sponsor is to show interest in the team’s progress and be involved in resolving major issues.
- Strong emphasis on rewarding good performance.

develop the same sophistication in shared mental models, group norms, and feelings of belonging and cohesion.

8.5 Safety committee effectiveness

A number of studies have examined the effectiveness of U.K. safety committees in terms of reducing lost-time injuries (Coyle & Leopold, 1981; Leopold & Coyle, 1981; Beaumont et al., 1982; Reilly et al., 1995). Occupational health and safety committees (OHSCs) are becoming commonplace in U.S. companies, as an increasing number of states require these by law. Figures produced by the National Safety Council indicate that at least 75% of organizations (with 50 or more employees) have adopted them (Commission on the Future of Worker-Management Relations, 1994). Evidence relating to the effectiveness of OHSCs is mixed. While some studies have reported fewer severe injuries following safety committee implementation (O’Toole, 1999), others have reported little or no effect on injuries (Cooke & Gautschi, 1981). Eaton and Nocerino (2000) found that lost-time injuries in public sector departments with safety committees showed a significant rise compared with those that did not. Although this seems counterintuitive, the authors suggested that the most likely explanation is that workplaces with safety committees are the most hazardous, so that the presence of a safety committee acts as a proxy for level of workplace hazards. However, it is also possible that workers in departments with safety committees are more likely to report injuries. Safety committees have also been widely adopted in Canadian companies, and a review of their effectiveness, conducted by the Ontario Ministry of Labor, was published in 1986. Factors that were found to contribute toward safety committee effectiveness are shown in Summary Text 8.12. In addition, Reilly et al. (1995) found that OHSCs were more effective when committees were joint consultative — including both management and union representatives, and had a greater proportion of union members (Eaton & Nocerino, 2000).

In a detailed study of OHSC members in 13 U.S. companies, it was revealed that when members perceived safety committees to be effective they also reported management commitment to health and safety, committee meetings vitality, impressive numbers of positive inspection reports and level of factory safety (Boden et al., 1984). It appears that the existence of effective safety committees is associated with appropriate measures to confront hazards and increase safety (Sheehy & Chapman, 1987). However, it is unlikely that there is a straightforward causal relationship. It is possible that safety committees contribute to a positive safety climate (Turner & Parker, 2004), which in turn affects safety performance. One possible explanation is that safety committee effectiveness and safety improvements are both aspects of broader safety culture (see Chapter 11).

O’Toole (1999) showed that plants that encouraged wider worker participation in safety activities, beyond the safety committee structure, experienced less severe injuries. This indicates the importance of worker participation and consultation beyond safety committee characteristics and functioning. Managerial support for worker participation was also noted, suggesting that perceived management commitment to safety is also influential. The role of management commitment is further illustrated by the finding that, compared with mandatory safety committees (established in compliance with regulatory requirements), voluntary safety committees (initiated by the organization) were more successful in reducing severe injuries. Thus, voluntary initiation of safety committees may indicate a positive safety culture, in which managers are more committed and hold more positive attitudes toward safety. In turn this may affect safety climate, as workers perceive more positive management attitudes toward safety. The possibility of safety measures enhancing safety culture was previously discussed in relation to behavioral safety interventions, which have a similar effect (see Chapter 3).
Summary Text 8.12 Features of Effective Safety Committees

- Committees should involve both managers and workers (whether or not selected by unions).
- Committees should be voluntarily developed by senior managers and designed to maximize worker involvement.
- Senior managers are present to approve decisions and to indicate priority given to health and safety (the standing of a safety committee can be affected by senior managers failing to attend because of more important matters).
- Safety adviser’s role should be ex officio advisory to all members; equal member opportunity to contribute agenda items.
- Membership should reflect representation within the organization; trade union representation, where there is more than one union, should reflect risk areas; regular feedback to and from workers.
- Regular meetings at prearranged dates; maintain good minutes.
- In larger organizations, separate committees should represent individual work areas; above these should be a coordinating committee to deal with issues of concern to more than one work area and with issues that cannot be resolved within local committees.
- Generally health and safety matters should be dealt with close to the scene of action where the response can be immediate; follow up recommendations and concentrate upon important issues.
- Committee members should be firmly committed to the objective of improving health and safety; set high standards for achievement.
- Regular attendance of all members is important in facilitating development of solid relationships.
- Effective health and safety training for all members.
- Compact and manageable size.


8.6 Barriers to team effectiveness

8.6.1 Social comparison and social control

Group membership increases the likelihood of having one’s attitude or outlook changed as a result of exposure to group influences. This is particularly so when a reference group is used as a guiding light by the individual. For example, many students at an exclusive residential college in the United States changed their attitudes as a result of their college membership, treating their contemporaries and senior staff as a positive reference point. However, some students behaved differently and did not succumb to the prevailing progressive attitudes because of their attachment to opposing attitudes derived from experiences outside the college or by remaining independent in outlook (Newcombe, 1943). Applying this finding to safety, it might be expected that a person with “backward” views on safety who joins a group
within an organization that has a high regard for good safety practices, will experience a shift in his or her attitude when the new group is used as a positive reference point. Whether a person changes his or her attitude as a result of membership of a group is likely to depend, inter alia, upon the following factors:

- Gulf between individual and group attitudes
- Initial strength of the attitude
- Individual's personality — for example, how readily they may be reconditioned
- Particular environmental features — for example, the nature and extent of work hazards

Two important features of group influence are social comparison and social control. With regard to social comparison, we tend to compare ourselves with others to test our ideas in a variety of social situations. Sometimes this is to validate our beliefs when another person holds beliefs that are similar to our own; at other times we want to make the correct response in a particular situation — for example, the best way to behave at an interview. We may investigate other people's views before considering the most suitable views to express on religious, social, and political issues as well as use of a particular vocabulary in conversation or the most appropriate clothes to wear at a social gathering. Safety and risk professionals continually compare their views on professional matters with those of other experts in the field, as well as with those of line managers who implement safety policy, for example. As a validity check, people compare their judgments on particular issues with those of others in close proximity.

As highlighted previously, group norms and expectations exert powerful effects on individuals' safety-related behavior. For example, in a manufacturing plant where incentive payments are linked to production targets, there may be intense social pressure applied to team members who refuse to waive safety rules in order to reach the targets that would trigger bonus payments. There is a danger that group norms within autonomous work teams may then develop that embrace unsafe, rather than safe, behaviors (Roy, 2003). For two classic illustrations of the power of groups to influence individual member views and behaviors, see Summary Text 8.13.

With regard to social control, influence is exercised from above rather than horizontally, as in social comparison. Experiments on obedience to authority have shown that a significant number of people are prepared to inflict harm on others either because an authority figure instructs them to do so (Milgram, 1965) or because the system within which they operate encourages certain forms of role behavior (Zimbardo et al., 1982). Other forms of social control are institutional control and brainwashing. In institutional control, the inmate of a prison is often stripped of personal props to his or her identity — for example, removal of personal clothing and furnishing, control of mail, and prevention of frequent association with relatives and friends. In brainwashing, there is an attempt to undermine the individual's stability of mind and self-image by not permitting him or her to relate to friends or identify with his or her normal group. This is achieved by segregating group members, prohibiting group formation, encouraging mutual distrust, manipulating news, and exposing the individual to the desired message in a state of social isolation.

### 8.6.2 Intergroup relations

Membership of one group could predispose members to view other groups with suspicion. This can be demonstrated by findings from studies conducted to reduce friction and prejudice between hostile groups (Sherif, 1967). Members of hostile groups were brought
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Summary Text 8.13 The Power of Group Influence — Two Classic Studies

The influence exerted by a group is particularly apparent when people are conforming to norms. Sherif (1936) and Asch (1958) were two classic studies that examined the impact of group influence.

In Sherif’s experiment, whilst in a darkened room participants were asked to estimate in what direction and by how much a single point of light moved. In reality the light did not move, but it appeared to do so: a visual illusion known as the autokinetieffect. Estimates made by individuals varied much more widely when they were on their own than when in a group in which others’ judgments could be heard. In the groups, individual estimates tended to converge, thereby creating a norm. This experiment exemplifies a highly ambiguous situation in which individuals feel unsure of their judgments. Ambiguity is reduced by information the individual receives from other group members. An inference drawn from this finding in a safety context would be that a safety and risk professional faced with a major incident at work would find an exchange of views with interested parties at the very least valuable, before arriving at the most effective strategy for coping with the aftermath. This illustrates one advantage of a multidisciplinary incident investigation team.

In Asch’s experiment, groups of eight individuals were ostensibly given the task of comparing a series of standard lines with several alternatives to identify the correct match. This was essentially a simple task and you would not expect many mistakes if participants were to provide the answers acting alone. However, in this experiment a genuine participant was required to give a judgment, following the judgments of confederates (i.e., others who were part of the experiment) who had been briefed to give consistently wrong answers. When the confederates produced their consistently wrong answers, a surprisingly high percentage of genuine participants, who were unaware of the collusion between the confederates and the researcher, endorsed the group response contrary to the evidence of their own eyes. Even when genuine participants resisted the group influence, it was apparent that they felt uncomfortable about their isolation. In this experiment, unlike the Sherif one, there is no ambiguity. What is happening is that the individual is giving way to social pressure and conforming to others’ judgments, which happened to be wrong in this case. However, not all participants succumbed to the social pressure, with some strong-willed individuals maintaining confidence in their own judgments. The effects of social comparison will be particularly influential within autonomous work teams, where there is no formal leader, and leadership functions are devolved within the group.

together socially, and accurate and favorable information about one group was communicated to the other. Leaders of the two groups were brought together to bring their influence to bear. However, taking these measures as a way of developing social contacts as a means to reduce conflict did not work. Social contacts in these circumstances may only serve to intensify conflict because favorable information about a disliked group may be ignored or reinterpreted to fit negative stereotyped notions about the other group. A workable strategy for achieving harmony between groups in conflict in this case was to bring the groups together to work toward a common goal (e.g., working on a project requiring active cooperation between the groups for successful completion). It is also necessary for
successful completion of the task to have important outcomes for the groups. In the 1986 Chernobyl disaster, a nuclear power plant was destroyed as a result of a combination of factors, including human error (Munipov, 1991). In seeking to explain events leading up to the catastrophe, Reason (1987) referred to two groups at the plant — operators and experimenters, and relationships between them. Key observations from his analysis were shown in Summary Text 4.8.

8.6.3 Decision-making biases

As stated earlier, a prime function of groups is to make decisions. The ideal decision-making process, for example, as espoused through a risk management tradition, might follow the following sequence outlined here:

- Identify problem — define and diagnose
- Generate alternative solutions
- Evaluate and choose solution from alternatives
- Implement chosen solution to control the problem
- Monitor, review, and appraise the solution

However, this ideal process ignores the fact that there will inevitably be different perspectives on a problem. For example, diagnosing and defining a problem is subjective and interpretive in respect of facts or other information to hand. Similarly, some alternatives will not be tolerated within an organization — for example, solutions that do not generate profits, and so, in reality, the range of alternatives likely to be considered is restricted. Thus, rather than maximize possibilities from group decision making, groups tend to satisfice — that is, to find something that will work even if it is not the best possible option (March & Simon, 1958). Thus, in contrast with the ideal decision-making process, a cycle of decision failure may be more typical of many decisions made by groups, for example, taking the following form:

- Problem arises
- Solution proposed (before options are considered)
- Begin decision process toward this solution
- Further issues emerge (they are ignored)
- Increase commitment to initial solution: try to eradicate problems
- Commit more resources (time, money, and people)
- Failure
- New problems: cycle repeats

If a group embarks upon the decision-making process with a ready-made solution that emerges simultaneously with defining the problem, then decision making is very likely to be directed toward justifying that solution and the process is therefore liable to fail. The whole group may be involved in self-justifying behavior. In a study of 150 strategic decisions within organizations, 60% were observed to follow the path of the decision failures cycle described above (Wilson & Rosenfeld, 1990). Organizations continue to survive despite poor group decision making because of a degree of market tolerance for such decisions. However, once a satisficing decision is made, the tendency is for another problem to arise as a result of a poor solution to a previous one. The type of decision-making biases that affect individuals (discussed in Chapter 3) may also act at a group-level (see Jones & Roelofsmma, 2000, for a discussion), as well as biases specific to the way that groups make decisions, such as group polarization and groupthink (discussed later in this section).
There is a long tradition in social–psychological research examining how individual decision makers are influenced in their opinions by group discussion to reach a consensus. For example, a number of studies have found that groups take riskier decisions than individuals do (Stoner, 1961) — the so-called risky shift phenomenon. For example, when business executives made decisions on investment projects, they tended to settle for more risky decisions as a group than those they had chosen as individuals (Kogan & Wallach, 1967). This may be due to the fact that responsibility for any loss associated with the decision is spread among group members; and because each member feels less personal responsibility for the potential loss, consensus moves toward accepting greater risk. However, it also seems that under some circumstances, groups take less risky decisions than do individuals acting alone (cautious shift), suggesting that a more general phenomenon of group decision making is toward more extreme decisions or group polarization (Semin & Glendon, 1973; Lamm, 1988; Brauer & Judd, 1996). Explanations of group polarization include influence of persuasive arguments during group discussion, particularly for more intellectual or objective decisions, and social comparison/cultural values for more judgmental or subjective tasks (Kaplan, 1987). A third explanation, self-categorization theory, treats polarization as conformity to an in-group norm (Vaughan & Hogg, 2005). Group polarization is likely to affect group processes that are most dependent on group discussion, such as the transition phase processes that include evaluation and planning. However, it can only occur where all the individuals’ initial opinions are in the same direction (Jones & Roelofsm, 2000).

As noted already, an important characteristic of an effective group is cohesiveness (see Section 8.4.1.2). While some storming (conflict of ideas) is necessary, too much confrontation could have adverse effects in being divisive and threatening group unity. Jehn (1995) found that whilst task conflict could be beneficial for nonroutine tasks, relationship conflict had negative effects on satisfaction and increased intentions to leave the group, particularly in interdependent tasks. However, one danger is that too much cohesion could result in inadequate evaluation of issues confronting the group. A highly cohesive group may suffer symptoms of groupthink, a term introduced by Janis (1972) to describe decision making within a small group in the U.S. government during the 1960s Bay of Pigs crisis.

Groupthink can occur whenever groups are involved in decision making, particularly when a group is isolated from alternative views or external advice. Any of the processes described in Summary Text 8.14 may occur as a result of groupthink. Consequences of groupthink include poor decision making and inadequate solutions to problems. A limited number of alternatives is considered, potential gains from alternatives may be overlooked, and assessments of the cost of alternatives that are rejected by the group are likely to be ignored. The group fails to obtain expert opinion on losses or gains; instead there is a tendency to use selective bias in evaluating expert opinion. Group members tend to display a positive interest in facts and opinions that support their preferred policy, but are hostile to information that challenges their views. There is a tendency not to have contingency plans to cope with setbacks. In an analysis of events leading up to the Chernobyl disaster, Reason (1987) focused on two perspectives: the first dealt with cognitive difficulties that people have in coping with complex systems; the second was concerned with the pathologies of small cohesive groups, as in groupthink. Reason (1987) identified five groupthink symptoms as being attributable to the Chernobyl operators — shown in Summary Text 4.8. The Challenger shuttle disaster (1986) was another example of the contribution of groupthink within a small group leading to a major disaster (Moorhead et al., 1991, for a discussion).

Criticisms of groupthink theory include methodological weakness (Tetlock, 1979) and theoretical incompleteness (Longley & Pruitt, 1980; Steiner, 1982). Furthermore, empirical evidence to support the model is mixed (Jones & Roelofsm, 2000). Certain evidence undermines some of the fundamental tenets of groupthink. For example, whereas highly cohesive groups with strong, directive leaders are hypothesized as most vulnerable to groupthink,
Summary Text 8.14 Characteristics of Groupthink

- Excessive optimism leads to a tendency to take risks because of the shared illusion of invulnerability.
- Warning signals, which, if acknowledged, could lead to a reconsideration of policy are discounted or ignored.
- Unquestioned belief in the morality or self-righteousness of the group, which provides scope for ignoring ethical consequences of decisions.
- Tendency to underestimate the significance or strength of enemy or competitor groups — perhaps manifested in descriptions of leaders of these groups as weak or stupid.
- Reluctance to deviate from what appears to be group consensus. A deviant may be listened to at first and then questioned before appeals to logic and group loyalty are made. The deviant is then counseled and may capitulate at that stage. A persistent deviant is likely to be ignored and then ostracized. Cohesion is usually retained if there is only one deviant. If there is more than one, then the group might fragment as two or more can use their strength to influence others (in Asch’s conformity experiment, the presence of one other supporter for the true participant virtually guaranteed that the participant would stick with their view). A lone deviant will eventually fail to convince other group members of their case. Thus, any potential deviant remains silent about his/her misgivings or doubts and is capable of convincing themselves of a lack of substance in these doubts. In any case, there would be direct pressure on any member who expressed strong arguments against the group’s position as being contrary to expectations of loyal membership. Thus, individuals self-censor contrary views.
- Belief that judgments of members are unanimous, simply because members have subscribed to the majority view, creates an illusion of unanimity. Silence is taken as assent, along with self-censorship. Being insulated from outside views assists in developing unanimity.
- New information is likely to be rejected on the ground that it might compromise or conflict with decisions already taken (We’ve made up our mind; don’t confuse us with the facts!).
- Some members take it upon themselves to protect the leader and fellow members from adverse information about the morality and effectiveness of past decisions. Expert opinion that challenges the wisdom of the group’s decisions may be subtly undermined.


a number of studies have failed to support this link (Park, 1990; Wittebaum & Stasser, 1996). Defective decision making can occur in newly formed groups, where cohesion is low, as group members lack the security in their roles and status to challenge one another (Leana, 1985). On the other hand, more cohesive groups should develop norms that allow more open discussion. Developing norms that promote an open and constructive environment for group discussion was associated with high performing teams, whose members were not afraid to express ideas and opinions (Jehn, 1995). Manz and Neck (1995) suggested
Chapter eight: Managing teams for safe performance

Summary Text 8.15 Means to Reduce Effects of Groupthink and Poor Group Decision Making

- Build critical evaluation into the group discussion so that it is legitimate to disagree or be skeptical
- Encourage people to air doubts and uncertainties
- Leader tolerates criticisms of his/her judgments
- Leader avoids stating his/her preferences and expectations with regard to outcomes at the start of discussion
- Conclusions only arrived at after consideration of an adequate number of alternative courses of action (e.g., via brainstorming)
- Test decisions against external, impartial parties
- Use external expertise in decision making
- Ensure heterogeneity among members (i.e., individual differences)

A rational approach to decision making that could help to avoid groupthink, including the following criteria:

- Encouraging divergent views
- Open expression of concern/ideas
- Awareness of limitations/threats
- Recognizing members’ uniqueness
- Recognizing views outside the group
- Discussing collective doubts
- Using nonstereotypical views
- Recognizing ethical and moral implications

Summary Text 8.15 provides further guidance in reducing groupthink.

8.7 Managing effective work teams

Referring to evidence that increased team working can lead to productivity increases within organizations, Hackman (1994) warned that building effective teams is not easy and that it may be possible to obtain similar improvements in other ways. He also cautioned that using teams is not an easy solution and that if carried to its logical conclusion, could represent a revolutionary threat to the established management order. As noted previously, although there is evidence that using teams, in particular those that are self-managing, will benefit safety (Trist et al., 1963, 1977; Walton, 1972; Goodman, 1979; Pearson, 1992; Hechanova-Alampay & Beehr, 2002; Roy, 2003), potential threats to developing a positive team safety climate need to be managed carefully. Hackman (1994) identified five common mistakes made by organizations in establishing teams, with the expectation that performance will thereby be enhanced. These are reviewed below, highlighting safety implications.

8.7.1 Managing teams as individuals

A performing unit may be called a team but is managed as a set of individuals — for example, in respect of work allocation, reward, selection, and appraisal. It is important that group processes operate effectively within teams — that is, that team members work interdependently
Specify ends?  
<table>
<thead>
<tr>
<th>Yes</th>
<th>Engaged, goal-directed activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Anarchy</td>
</tr>
</tbody>
</table>

Specify means?  
<table>
<thead>
<tr>
<th>Yes</th>
<th>Turn-off (worst state)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Wasted human resources</td>
</tr>
</tbody>
</table>

**Figure 8.1** Specifying ends and means for group activity. (After Hackman, 1994.)

to develop strong group norms and group cohesion. Managing a unit as a set of individuals will serve to undermine group characteristics that lead to enhanced performance. Effective group processes create a team climate in which there is a sense of belonging that allows members to speak up, suggest alternative ways of working and admit to mistakes (Edmondson, 1999), as well as enabling development of safety citizenship behaviors, such as approaching coworkers engaged in unsafe acts (Hofmann & Stetzer, 1996; Hofmann et al., 2003). Team leaders need to facilitate team functioning by encouraging members to speak up, creating opportunities for learning and promoting openness in communication (Edmondson, 2003).

### 8.7.2 Balancing authority and democracy

Extremes of both authority and democracy are inimical to team effectiveness. Specifically, it is important to specify a team’s ends or objectives but also to allow the team to determine the means for achieving their objectives (see Figure 8.1). This shows that specifying neither the means nor the ends (complete democracy) can result in an anarchic state in which the team has no *raison d’être*. However, specifying both means and ends (extreme authority) is also a poor team management strategy because the team has no autonomy or opportunity to display creativity in achieving its objectives, thereby representing a waste of human resources. However, worse still is to prescribe the means (e.g., parameters and mode of operation) but not to give the group any indication of its ultimate objective. This is liable to leave the group frustrated and de-motivated. The best option is to provide a group with its objective and leave the members to determine how to achieve it. This is most likely to result in an active search for solutions that involve group members in enjoyable and effective problem solving. Many outward bound team-building exercises are designed on this principle. The irony of such exercises is that while they are designed to develop teamwork, frequently they are used to identify individuals for development or promotion within an organization, for which there may be no evidence of their validity.

In terms of safety, feelings of empowerment are particularly important in determining the success of autonomous teams — those with greater empowerment engaged in fewer unsafe behaviors and had fewer injuries (Hechanova-Alampay & Beehr, 2002). The basic principle to apply in overcoming groupthink is to ensure heterogeneity of inputs in order to break the group norm of conformity. A number of approaches are possible — as illustrated in Summary Text 8.15. Other criteria to be aware of include, maintaining group member interrelations and ability to solve future problems, as well as using groups to improve member motivation.

### 8.7.3 Teams and organizational structures

If teams have been developed then it is a mistake to leave all other organizational structures unchanged. Reorganization is required so that teams are able to work effectively, which
could entail dismantling some traditional organizational structures. However, it should be acknowledged that team members can reliably be left to work things out for themselves and that the organization’s role should be to provide an enabling structure. The case study described in Summary Text 8.3 is an excellent illustration of this principle in operation.

8.7.4 Teams and organizational support

It is a common failing that once formed, teams are left unsupported. What is required are rewards for the team not for individuals, adequate material resources, a system to provide relevant information to the team, and a supportive educational program.

8.7.5 Teams and training

Without contrary evidence it cannot be assumed that people are eager to work in teams and that they are already skilled in doing so. Individuals with a team orientation will perform more effectively in team-based situations than in those lacking a team orientation. However, evidence suggests that team training can be successful in developing teamworking skills (Eby & Dobbins, 1997). It should not, therefore, be assumed that team orientation is a personality trait that is not amenable to change and development.

Hackman (1994) concluded that the following conditions outlined here are required for effective teamwork:

- Well-designed workgroup, in terms of task, composition, and norms of conduct
- Bounded authority — specify ends but not means
- Clear, engaging direction to provide motivation
- Supportive organizational context that provides rewards, resources, and education
- Expert coaching

It is clear that teamwork is a not a ready solution to problems of maintaining and improving safety at work. Many disasters have occurred due to failures of teamwork, such as miscommunication between the flight deck and the rest of the crew (e.g., Kegworth air disaster, see Summary Text 4.4) and groupthink in decision-making bodies (e.g., Challenger shuttle disaster — see Moorhead et al., 1991). However, evidence suggests that well-designed and well-managed teams contribute positively to organizational safety. One key variable to emerge, despite the paucity of research in this area, is the degree of autonomy or empowerment associated with teams. Some evidence indicates that introducing teams without an associated increase in team-members’ autonomy, such as lean production teams, can lead to increased workload, with negative implications for safety performance (Landsbergsis et al., 1999).

8.8 Conclusions

The study of group dynamics has developed from an essentially mechanistic approach, which considered group members as players of a generally interchangeable or homogeneous nature, to a more sophisticated psychological approach, which regards group members’ personalities as well as tasks that the group (or team) performs as key variables. As groups serve a variety of functions and provide benefits both for individuals and for organizations, it is not surprising that conflicts arise in executing or appreciating these functions and benefits. For example, an individual seeking to use a group to support his or her own objectives and attitudes could be disappointed in a group designed to increase organizational commitment and involvement. While cohesion is generally regarded as a positive
feature of group functioning, in combination with inappropriate norms (e.g., opposed to safety) it can become a negative feature.

Group discussion is held to have a number of benefits for group functioning and for individual member satisfaction. However, for some types of problems, suitably able and qualified individuals acting alone may make better decisions. In any case, it is important to select the right type of group for the task to be undertaken. While there is strong pressure to conform to group norms, there are always likely to be those (deviants) who can resist group pressure. This may be a positive asset if nonconformity brings new approaches to tasks or leads to identifying risks that others have overlooked (e.g., as in a HAZOP [hazard and operability study] exercise). However, it is unlikely to be acceptable when group norms are positively related to safety.

Groups may not follow an ideal route in making decisions, falling prey to such dysfunctional outcomes as the cycle of decision failure and groupthink, either of which could produce disastrous results, particularly in cases where decisions involve high risks. To overcome these types of failures and to increase the effectiveness of group decisions, it is important to build in procedural audits of the quality of decision making and to ensure heterogeneity of personal styles and roles within a group. Various studies suggest that in making decisions of various kinds, groups tend to see responsibility for decision outcomes to be shared among group members. This may result in groups taking riskier decisions than individuals acting alone. Some decisions are best made by individuals, perhaps in consultation with others, while in other cases groups offer a superior decision-making forum. Allen and Hecht (2004b) pointed out the need for organizations to determine which tasks are better undertaken by teams and which by individuals — much as in the allocation of function discussed in Chapter 4. In most cases it should be possible to adopt a logical approach in deciding whether to use a group or one or more appropriate individuals to make a given decision.

From an evolutionary perspective, cooperative kinship and wider community groups provided security for our ancestors, thereby reducing risks from predators and competing groups as members could look out for one another’s interests. However, a potential downside of group membership is that members might falsely believe that others were looking out for them — an early example of social loafing. Such a dichotomized model might underlie several of the phenomena described in this chapter, including polarization in group decision making, groupthink, and other failures in decision making, as well as differences between group and individual-level findings on OHS issues. The strong evolutionary imperative to bind with recognized primary group members, which predates larger organizational forms, might also account for the threat from autonomous work groups (self-managed teams) to organizational hierarchies.

While there has been some debate concerning the effectiveness of teams (Allen & Hecht, 2004a, 2004b; Cordery, 2004; Paulaus & Van der Zee, 2004; West et al., 2004), when well managed, evidence suggests that teams have many positive benefits for organizational safety. Team effectiveness requires a variety of conditions to be met. Thus, teams need to be well designed in terms of their task, composition, and norms. They should also have bounded authority so that objectives are specified, but not the detailed means to achieve them, allowing team members a degree of autonomy or empowerment. Teams should be motivated through having a clear, engaging direction. There should be a supportive organizational context in terms of rewards, resources, and education, as well as expert coaching available.

While there are various ways of assessing group performance, it is generally accepted that there are two broad areas of group functioning. The task area deals with substantive topics, and the socio-emotional area is relevant to procedures and member interrelations. Both are important and can be assessed in various ways: for example, sociometry (for
examining member interrelations), beating the competition (for determining task effectiveness), and interaction process analysis (to evaluate interactions across both areas). One problem associated with conducting quantitative research on teams is that many studies are based on small samples. An exception is Simard and Marchand (1995, 1997), which included over 1000 work groups. Small samples lead to reduced statistical power, making it difficult to draw reliable conclusions. It is also rare to find studies examining the impact of group processes on individual-level variables, such as behavior, using techniques such as multilevel analysis — for example, hierarchical linear modeling (Bryk & Raudenbush, 1989). While this type of analysis has been used in management studies to allow examination of contextual variables on individual behavior (Hofmann et al., 1993), its use in safety research has been limited (a rare example is Hofmann & Stetzer, 1996). Theoretical and empirical work to date suggests a number of individual-level behaviors that are likely to be affected by group-level safety climate, for example, rule violations, incident and injury reporting, and safety participation. However, little evidence currently exists to discuss these relationships further.
chapter nine

Leading and supervising for safe performance

This chapter is concerned with the influence of leadership on safety performance. Supervisors’ and managers’ leadership style can significantly affect subordinates’ attitudes and behavior, and is also important in determining safety climate. The chapter begins by reviewing the concept of leadership and leadership theories; it then discusses the impact of leadership on safety performance, failures of leadership, and managing leadership roles to reduce risk and improve organizational safety.

9.1 Introduction

Whilst early investigations into injury causation focused on individual and technical antecedents, more recent approaches have highlighted the role played by those higher in the organizational hierarchy, such as managers, board members, designers, and others (Reason, 1997). The shift from explanations limited by the injury time frame allowed for a range of activities undertaken by supervisory and managerial staff to be included. This could involve several agents not present when an injury occurs, but who nonetheless contributed to its occurrence. Reason (1993) suggested that a majority of organizational accidents, “have their origins within the managerial and organizational spheres” (p. 8). Major disaster inquiries increasingly confirm this attribution (e.g., McInerney, 2005), and underline moves in a number of jurisdictions to introduce corporate manslaughter provisions that can allocate blame for large-scale incidents involving fatalities at high levels within an organization. Examples of major disasters in which managerial and organizational failures were highlighted include the Zeebrugge ferry disaster in 1987, in which the passenger ferry The Herald of Free Enterprise left port with its bow doors open, leading to its capsize and to 188 deaths (Department of Transport, 1987) and the Southall train crash in 1997, which left seven people dead (Uff, 2000; Summary Text 9.1). Attempted prosecutions for corporate manslaughter in the British courts failed against the companies responsible, P&O European Ferries and Great Western Trains respectively. The U.K. Government announced draft legislation on corporate manslaughter in 2004 (Queen’s speech, November), which was published in March 2005 (The Home Office, 2005). If this becomes law, it will allow for U.K. companies to be prosecuted, rather than individual directors or executives as the legal situation currently requires.

This chapter looks at the contribution that managers and supervisors can make to injury causation and prevention, and ways that improvements may be made at managerial levels.
Summary Text 9.1 The Southall Rail Crash (1997)

The Southall rail crash, which left seven dead and 176 injured, occurred on September 19, 1997. An Intercity passenger train operated by Great Western Trains was traveling at 110 mph toward London’s Paddington Station. The passenger train passed a signal at danger (signal aspect showing red) and crashed into the side of an empty freight train that was shunting at slow speed across the line. The engine burst into flames and carriages of the train were derailed. Some passengers suffering serious injuries were trapped in the wreckage for hours.

The report into the disaster (conducted by Professor John Uff) revealed that the passenger train was operating at normal speed with a defective automatic warning system (AWS). It was also fitted with sophisticated automatic train protection (ATP) equipment, which would have prevented the accident if it had been operational. However, the ATP was switched off.

Whilst the proximate cause of the accident was attributed to driver error, the report identified a number of failings by the train operator. Amongst 93 recommendations, the report noted the need for Great Western Trains to address the following issues:

- Emphasize the need for staff to use fault-reporting systems
- Increase emphasis on rule-book compliance
- Introduce simulators for driver training
- Enhance senior managers’ involvement in safety management systems, including introducing safety tours
- Develop good practice from research into human behavior and fatigue

Although evidence suggests that leadership plays a key role in promoting safety (Dunbar, 1975; Cohen, 1977; Hofmann et al., 1995), surprisingly little research specifically examines this relationship. This chapter reviews relevant evidence, links it to leadership theories, and explores some implications for improving safety at work. Chapter objectives are as follows:

- Provide an historical perspective on the development of leadership theories
- Describe and explain prominent leadership theories
- Examine implications of leadership theories in relation to safety performance and injury causation
- Explore the relationship between leadership and safety climate
- Describe the concept of trust and discuss its importance to leadership
- Provide an insight into failures of leadership
- Identify ways of improving leadership effectiveness

Kotter (1990) distinguished between a leader (who establishes direction, aligns people, motivates and inspires, and brings about change) and a manager (who controls planning and budgeting, organizing and staffing, and controlling and problem solving). Zaleznik (2004) suggested that whilst managers are seen as fairly passive people-centered operators intent on keeping the show on the road, leaders seem to be more solitary, proactive, intuitive, empathetic, and are attracted to situations of high risk where rewards for success are
great. Whilst leadership and management are distinctive and complementary phenomena, both are necessary for managing complex organizations. Managerial leadership could be viewed as integral to the managerial role, and its significance grows in importance as one climbs the organizational hierarchy.

9.2 Leadership theories

Early leadership models included: trait approaches (e.g., “great man theory”), which focused on identifying personality characteristics associated with good leaders; leadership style approaches (e.g., the Ohio and Michigan State studies in the 1960s), which focused on defining leadership behaviors; and contingency approaches, which considered interactions between leader characteristics and situational factors. “New leadership” theories followed, including charismatic leadership, and the influential transformational–transactional leadership theory. These theories, and some possible implications for safety performance, are discussed below.

9.2.1 Trait theories

Although there is a large literature on both personality and leadership, there is little substantial evidence of a significant relationship between these two concepts. Stogdill (1974) concluded that factors frequently linked with leadership are activity, dominance, self-confidence, achievement drive, and interpersonal skills. A meta-analysis by Lord et al. (1986) found that compared with nonleaders, leaders tended to be more intelligent, extravert, dominant, masculine, conservative, and well adjusted. Kirkpatrick and Locke (1991) suggested that the six traits that leaders possessed when compared with nonleaders were: intelligence, desire to lead, energy and ambition, self-confidence, honesty and integrity, and knowledge (job related). However, whilst these characteristics seem to be commonly possessed by leaders, mere possession of these personality traits and attributes is insufficient to make one a successful leader. Other researchers have focused upon leadership style or behavior.

Many organizations use personality tests to select individuals for managerial or leadership roles that are safety critical. For example, Flin and Slaven (1995) reported that all major airlines use personality tests as part of their selection procedures. However, although organizations may be looking for specific personality traits, their selection criteria can be summarized as a set of competencies (see Summary Text 9.2).

9.2.2 Leadership style

The behavioral style approach distinguished between two distinct styles of leadership — one emphasizing relationships (consideration) and the other emphasizing task (initiating structure) (Fleishman & Harris, 1962). These are as follows:

1. Consideration indicates friendship, mutual trust, respect, and warmth. A leader with a high score on this dimension is likely to be friendly and approachable, with good rapport and two-way communication with subordinates, who is willing to help with personal problems, and thereby adopts a participative and empowering approach to leadership.

2. Initiating structure indicates a concern with defining and organizing roles or relationships within an organization, establishing well-defined forms of organization, channels of communication and ways of getting jobs done, and trying out new ideas and practices. A high score on this dimension characterizes individuals who are
Summary Text 9.2 Competencies for Safety-Critical Jobs

- Leadership ability
- Communication skills
- Delegating
- Team working
- Decision making under stress
- Situation awareness
- Planning and implementing actions
- Remaining calm and managing stress in oneself and others
- Preplanning for emergencies


active in directing group activities through planning, communicating information, scheduling, assigning group members to particular tasks, and expecting workers to meet particular standards of performance and deadlines.

Likert’s (1967) four systems typology of leadership styles, outlined below, was based on distinguishing between autocratic (task-oriented) and democratic (relationship-oriented) leadership:

1. Exploitive authoritative leadership is based on fear and threats. One-way communication flows from leader to subordinates; leader and subordinates are psychologically distant; decision making is centralized.
2. Benevolent authoritative leadership is based on rewards to encourage performance. Upward communication is limited to what the leader wants to hear; subservience to superiors is widespread; although most decision making is centralized, there may be some delegation.
3. Consultative leadership is based on appropriate rewards. Communication may be two-way, but upward communication is cautious and limited; some involvement is sought from subordinates, who can have moderate influence in some decisions.
4. Participative leadership is based on group participation and involvement in setting performance goals and improving work methods and procedures. Communication is two-way and emphasizes developing a network of accurate information. Subordinates and superiors are psychologically close, decision making is decentralized and group decision making is widely spread throughout the organization.

The participative style of leadership has been endorsed in a number of studies. In an early Michigan study of the role of first-line supervisors, it was concluded that supervisors who often checked up on subordinates, gave them detailed and frequent instructions, and generally limited workers’ freedom to do their work in their own way (i.e., a directive or autocratic style) had low productivity records. This result was contrasted with records of high-productivity units, which were characterized by high frequency contact between superior and subordinates, decision making that tended to be pushed down the hierarchy, superiors who were helpful in a constructive way, and good superior–subordinate relationships. This profile is congruent with a participative style. In low-productivity units, on
the other hand, contact between superior and subordinates was low and there was a high
degree of pressure to finish jobs and meet production targets (Likert, 1961). With regard to
the dynamics of participation, Gastil (1994) suggested that a leader should ensure that the
features listed below are given attention:

- Everybody participates in setting objectives and deciding activities
- People are given responsibility
- Demanding but realistic objectives are set with explanations, but without over-
powering people
- The leader is vigilant and active in identifying and solving group-based problems,
  but does not take over

Critics of the participative leadership school (Crozier, 1964; Strauss, 1968) outlined the
following reservations:

- A tendency to place overwhelming emphasis on personal coordination and control
to the detriment of bureaucratic or impersonal control techniques.
- The important role of bargaining and use of power in interpersonal relationships is
overlooked.
- The democratic or participative style is conceived largely in terms of group har-
mony and compatibility between personal goals and organizational goals, but the
importance of organization structure is neglected.
- Although generally people would like to exercise some degree of control over their
own environment, they may fear the participation process because it threatens their
integrity and independence, or they believe that others will control them to some
extent.
- If rewards or benefits resulting from cooperating with others prove inadequate, then
withdrawal from the participative process is likely.
- Participation might lack appeal to those who do not trust each other, who feel intel-
lectually superior to their peers, or who do not have the patience to bother with it
and feel that it consumes too much valuable time.

Stace and Dunphy (2001) argued that the participative style could be inappropriate in some
circumstances. They considered that if difficult to reconcile conflicting views were likely
to surface in a discussion forum then it is highly likely that a participative style would not
be suitable because it would consume too much time. Equally, where a strategic change in
direction is called for in order to ensure organizational survival, it is likely that a particip-
ative style would be inappropriate, whereas a more directive style could be functional. For
example, restructuring of the New South Wales police force was spearheaded by a newly
appointed Police Commissioner charged with stamping out corruption and modernizing
the force — a firm directive style was considered functional in this context, at least in the
initial stages (Stace & Dunphy, 2001). However, even though senior management could
be directive, as in the above situation and in leading change, middle managers and those
beneath them could be more participative in their approach when implementing change.
The last point is likely to be endorsed as functional by Wagner (1994) who, in a reconsider-
ation of research evidence, concluded that overall participation had a small positive effect
on group members’ productivity and job satisfaction.

Despite the reservations discussed above, it appears that worker participation is influ-
ential in enhancing safety at work. Its importance has been highlighted in other chapters —
for example, in relation to the success of behavioral change interventions in Chapter 3,
developing and implementing HRA techniques in Chapter 4, and as a means of reducing occupational stress in Chapter 7. Formal attempts to increase worker participation in safety activities have been introduced by legislation — for example, safety committees and safety representatives (see Chapter 8, for a discussion of safety committee effectiveness). Worker participation is also crucial to developing a positive safety climate (see Chapter 6), as workers need to develop a sense of ownership over safety to motivate their involvement in safety activities and safety-related organizational citizenship behaviors (OCBs). Engagement in specific safety-related activities, such as behavioral safety interventions, or completing safety climate questionnaires, can help to raise safety awareness and motivation. However, as noted in Chapter 3, this can be relatively short lived if not supported by long-term management commitment and fresh initiatives. Evidence supports a positive relationship between safety compliance — for example, following safety rules and regulations conscientiously — and supervisors’ participatory management style (Simard & Marchand, 1997). Mattila et al. (1994) found that construction projects had a better safety record where supervisors engaged in a participative leadership style. However, while recognizing the value of participative management, O’Dea and Flin (2000) reported that 57% of managers in their study preferred a telling/selling approach to subordinates (authoritarian style).

9.2.3 Contingency theories

Contingency theories consider leadership within an organizational context. A number of significant theories are considered within this category, of which some of the most important are described below.

9.2.3.1 Worker maturity

This model (Hersey & Blanchard, 1982) extended the relationship/task dimensions of leadership to form four styles (tell, sell, participation, and delegation), which must be matched to subordinates’ maturity. Maturity is considered in the context of a particular task and consists of two parts: job maturity — relating to technical knowledge and task-relevant skills, and psychological maturity — relating to feelings of self-confidence and ability and people’s willingness to take responsibility for directing their own behavior. The model is used widely in training programs, but the theory has not undergone significant evaluation to test its validity. Vecchio (1987) concluded that the model’s predictions were most accurate for low-maturity subordinates, but not very accurate for high-maturity subordinates.

9.2.3.2 Least preferred coworker (LPC)

This theory (Fiedler, 1967) attempted to predict how leadership style, leader–member relations, power vested in the leader position, and job or task structure, harmonized to determine a leader’s ability to achieve productive output. Fiedler’s contingency theory of leadership has been subject to considerable criticism (Graen et al., 1971), but much evidence supports at least substantial parts of the theory (Schriesheim et al., 1994).

9.2.3.3 Normative model

This approach (Vroom & Yetton, 1973) outlined different styles of decision making or leadership (e.g., autocratic, consultative) to cope with both individual and group problems from which a leader chooses the most appropriate form for the situation. The model may have greater applicability for leaders than for subordinates. For example, in Field and House’s (1990) study, subordinates disliked the autocratic style even in circumstances where the
Chapter nine: Leading and supervising for safe performance

model indicated this style to be the most appropriate. Another factor to consider is the skill of the leader in putting the chosen decision style into practice (Tjosvold et al., 1986), as even the correct style may be unsuccessful if handled with poor skill.

9.2.3.4 Path–goal theory
In this motivational theory (House & Mitchell, 1974) the leader is more effective if he or she can help subordinates toward their goals. The theory is concerned with explaining the relationship between a leader’s behavior and subordinates’ attitudes and expectations. Evidence suggests that a path–goal leader, who can compensate for weaknesses in subordinates or in work situations, is likely to have a beneficial effect on worker satisfaction and performance, provided that competent subordinates are not over-supervised (Keller, 1989). Overall empirical evidence is supportive, but there is a call for the theory to be refined with the addition of new moderating variables (Wofford & Liska, 1993; Evans, 1996; Schriesheim & Neider, 1996).

There is supporting evidence to substantiate the major tenets of each of the four theories outlined above. However, little contemporary research has been conducted within these frameworks and little written within the safety literature relating to their application. One theory within the same tradition — leader–member exchange (or vertical dyad linkage) theory — has received more attention in relation to safety outcomes, and this is reviewed below.

9.2.4 Relational leadership

9.2.4.1 Leader–member exchange (LMX) theory
This theory, also known as the vertical dyad linkage theory, emphasizes subordinate participation and influence in the decision-making process (Dansereau et al., 1975). An important implication of LMX theory is that leadership can best be understood by focusing on dyads (pairs of relations) made up of leader and member (a vertical relationship) rather than concentrating on leadership style averaged across all members, which assumes that all subordinates are treated in the same way.

The LMX relationship between leader and member develops quickly and remains stable over time, with leaders drawing a distinction between subordinates who are members either of in-groups (characterized by high LMX relationships) or out-groups (characterized by low LMX relationships). Although it is not clear how subordinates are classified into these sub-groups, evidence suggests that leaders consider subordinates to be in-group members where the latter have personal characteristics compatible with those of the leader and are likely to be extravert with a higher level of competence than out-group members (Duchon et al., 1986; Liden et al., 1993). An in-group consists of workers who the leader believes are competent, trustworthy, motivated to work hard, and can accept responsibility. Members of the out-group are thought not to possess these traits. Consequently, the leader feels confident to allocate responsibility for important tasks to members of the in-group, thereby making his or her job easier. In turn, the leader reciprocates by offering support, understanding, and a more personal relationship. As the two parties interact over time, the history of those exchanges builds the relationship. Evidence indicates that in-group members have a higher level of performance and satisfaction than do out-group members (Phillips & Bedeian, 1994). In contrast, the leader is inclined not to bestow favors on out-group members. They are given tasks requiring less ability and responsibility and tend not to benefit from a personal relationship with the leader. In fact a leader’s interactions with out-group members are based on his or her formal authority, rather than respect or friendship. A low LMX relationship is one that exists within the bounds of the employment
contract, such that a worker performs his or her job, but contributes nothing extra (Bauer & Green, 1996).

There is substantial support for this theory of leadership (Graen & Uhl-Bien, 1995; Settoon et al., 1996). In a review of LMX research, Schriesheim et al. (1999) argued that six dimensions are predominant in the LMX research: mutual support, trust, liking, latitude, attention, and loyalty. The relationship between leadership and trust, and safety implications, are discussed below. Whilst high LMX relationships have been associated with numerous benefits, such as improved performance and citizenship behaviors (Settoon et al., 1996), lack of high-quality exchange relationships is associated with negative consequences (not just an absence of positive effects). For example, Townsend et al. (2000) showed that performance and citizenship were positively related to LMX, but that LMX was negatively correlated with retaliation behavior. A high LMX relationship is characterized by mutual trust, respect, and liking. This relationship has an impact not only on subordinates’ behavior, but also on the leader. Mayer et al. (1995) found that trusted leaders engaged in more “risk-taking behaviors” (such as delegation and empowerment), whilst their subordinates demonstrated more OCBs and enhanced performance.

Leader–member exchange relationships are based on social exchange. In low LMX relationships, subordinates will not feel obligated to go beyond the bounds of their employment contract (Bauer & Green, 1996), while in high LMX relationships subordinates repay the leader for a high-quality relationship by engaging in extra-role behaviors (Settoon et al., 1996). In organizations where safety is prioritized, subordinates may engage in citizenship behaviors that promote safety (such as monitoring coworkers’ performance) and participate in safety-related activities (e.g., health and safety initiatives or safety committee service). Evidence supports this link between high LMX relationships and subordinates’ safety citizenship behavior (Hofmann & Morgeson, 1999; Hofmann et al., 2003). Hofmann et al. (2003) demonstrated that subordinates in high LMX relationships expanded their formal role definitions to include safety citizenship behaviors. Hofmann and Morgeson (1999) found that the association between high LMX relationships and fewer injuries was mediated by safety commitment and safety communication — that is, high LMX relationships facilitated greater commitment and more effective communications, which in turn assisted in injury reduction.

9.2.5 Trust and leadership

The topic of trust has been viewed increasingly as worthy of particular study in organizational behavior. This concept underlies many daily interpersonal relationships, including those with spouses, coworkers, and bosses. As we experience the behavior of another person, we may develop confidence over time that we can rely on the other person. In any situation where trust enters the frame, risk and vulnerability are inevitable and there is always the prospect that we could be disappointed or taken advantage of when we freely give important information or promises to another person. Schindler and Thomas (1993) identified the following five key characteristics of trust:

- Integrity — referring to honesty and truthfulness, and probably the most important of the five, as it goes to the very core of character.
- Competence — referring to peoples’ technical knowledge and interpersonal skills to deliver what they maintained they were capable of doing.
- Consistency — referring to predictable performance and sound judgement in handling various situations.
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• Loyalty — reflected when one is confident that a person will not act to one’s disadvantage when pursuing a particular line of action, instead the person will act in a loyal way.
• Openness — reflected when one is transparent in one’s actions.

In the trait approach to leadership (see Section 9.2), personality characteristics, such as honesty and integrity, have been associated with effective leaders. To these could be added trust, as it is an important prerequisite of leading others — it is very difficult to exercise leadership if subordinates don’t trust you. On the other hand, trust will exist if subordinates can safely place themselves in the hands of the leader in the belief that he or she will act in their best interests. Robinson (1996) found that applying techniques such as business process reengineering and downsizing by management adversely affected trust in management. Level of trust in managers has been associated with better organizational performance. For example, Davis et al. (2000) found a significant positive relationship between the level of trust in general managers of restaurants and the performance of their business. In addition, general managers who were perceived as trustworthy were also perceived to be higher in ability, benevolence, and integrity. The key to developing trust in managers is effective communication with workers and competent decision making (Whitener, 1997). Although much research has focused upon supervisor–worker relationships, Whitener (1997) argued that trust at this level could generalize into a deeper and organization-wide sense of trust and respect. McCauley and Kuhnert (1992) found that perceptions of leadership style and effectiveness of HR practices predicted workers’ trust in division heads; similarly, both these variables predicted workers’ trust in their CEO and top management (Costigan et al., 2004). Thus, the relationship between first-line managers and workers is important for fostering trust in senior managers.

Trust is a concept that has been linked to safety in a limited number of research studies. Trust in management underpins workers’ perceptions of managerial commitment to safety and their ability to protect workers’ health and well-being — an important dimension of safety climate (see Chapter 6). Watson et al. (2005) found that steel industry workers’ trust in their supervisor was significantly related to their perceptions of work environment safety. Some evidence suggests that trust in management acts as a mediating variable in the relationship between organizational work practices and safety outcomes. Thus, positive organizational work practices increase workers’ trust in their managers, which influences safety incidents, including near-hits and minor injuries (Zacharatos et al., 2005). Trust emerges as a key aspect of transformational leadership (see Section 9.3.2) as the relationship with the leader is characterized by a high degree of trust and confidence in the leader (Jung & Avolio, 2000). There is also evidence that trust in management mediates the effect of transformational leadership on performance (Pillai et al., 1999; Jung & Avolio, 2000). Thus, whilst influencing the development of a positive safety climate, trust in management seems to play a substantial mediating role between organizational variables (high-performance work practices and transformational leadership style) and safety performance.

To build trusting relationships with followers Robbins et al. (2001) suggested that the leader should subscribe to the following principles:

• Keep people informed about various aspects of their work and the significance to them of broad corporate activities
• Be objective and fair in your dealings with people
• Build a capacity to share your feelings with others
• Tell the truth since integrity is crucial for trust; be consistent in your behavior as mistrust could arise from inconsistency or not knowing what to expect
Foster dependability by keeping to your word and promises; maintain confidences because divulging them could be viewed as untrustworthy

Project confidence in the way one exercises technical and interpersonal skills

9.3 New leadership theories

Leadership theories, which sufficed as explanatory frameworks in the 1960s and 1970s, were abandoned in favor of ’New Leadership’ theory, a concept more in tune with leadership practice in the 1980s turbulent business environment. Bryman (1992) described this perspective as characterized by the following features:

- Importance of emotional reactions of followers in response to the vision
- Focus on upper level managers (not supervisory level)
- Collective processes in motivation (e.g., social identification, social contagion)
- Qualitative research approach (e.g., observation, intensive case studies, interviews)

The following sections consider charismatic leadership (House, 1977) and the later, and highly influential, theory of transformational leadership (Bass, 1985).

9.3.1 Charismatic leadership

House (1977) identified charismatic leadership qualities in an ideal form. Charismatic leaders, through the force of their personalities and interpersonal skills, can articulate an appealing vision linking present with future and are said to have an extraordinary effect on followers or subordinates, without resorting to any formal authority. They have great power and influence, project an attractive set of values and modes of behavior, and it is not difficult for subordinates to want to identify with them and to internalize their values as well as having a high degree of trust and confidence in them. Charismatic leaders, endowed with determination, energy, self-confidence, and ability are capable of making self-sacrifices. They depart from conventionality in the way they express courage and conviction about their vision; they inspire and excite their subordinates with the idea that together, with extra effort, great things can be accomplished, and they do not necessarily have to offer a carrot in the form of extrinsic rewards (Shamir et al., 1993; Kirkpatrick & Locke, 1996). The concept of charismatic leadership (House, 1977) brings together the influence of leader traits (high self-confidence, strong beliefs in own views, and need for power), leader behaviors (setting an example, high expectations, motivating, and impression management), and conditions (stress and crisis point). Conger and Kanungo (1987) adapted this theory to reflect the idea that charismatic leadership involves an attribution process, whereby charisma is attributed to a leader where certain behaviors (e.g., vision, self-confidence, and emotion appeal) are observed by followers.

9.3.2 Transformational leadership

The best-known new leadership theory is that of transformational leadership (Bass, 1985). In this process, leaders and followers transform each other to achieve high levels of effort and performance. Transformational leadership has the following four components:

- Individualized consideration — the leader shows interest in subordinates’ personal and professional development, acts as mentor or coach, and listens to followers’ needs and concerns.
• Intellectual stimulation — the leader challenges assumptions, takes risks, and solicits followers' ideas; stimulates and encourages subordinates to be creative and innovative.
• Inspirational motivation — the leader inspires others toward goals and provides meaning, optimism, and enthusiasm; articulates a vision that is appealing and inspiring to others.
• Idealized influence — the leader inspires confidence and is perceived as charismatic; behaves in admirable ways that cause the followers to identify with the leader.

Traditional concepts of leadership are often based on exchanging rewards (e.g., pay, status) for work effort or performance, known as transactional theories. The three aspects of transactional leadership described by Bass (1985) are as follows:

• Contingent reward — exchanges reward for effort or performance
• Management by exception-active (MBE-active) — anticipating problems and taking corrective action by actively monitoring followers' behavior
• Management by exception-passive (MBE-passive) — spotting and correcting followers' mistakes as problems arise

The final form of leadership identified by Bass (1985) is laissez-faire, where the leader is not involved in the followers' work, but is absent, disorganized, or indifferent. It has been argued that this actually represents a form of nonleadership and should therefore be classed neither as transformational nor transactional leadership (Bass, 1998; Avolio, 1999). Bass (1997, 1998) provided much empirical support for the effectiveness of transformational leadership across a range of organizational and individual outcomes, including productivity, job satisfaction, and commitment (Bass, 1998) in a range of organizations (military, industrial, health care, and voluntary sectors) (Bass, 1997). Meta-analyses have provided strong support for transformational leadership (Lowe et al., 1996; Judge & Piccolo, 2004). Bryman (1992) reported evidence suggesting that idealized influence and inspirational motivation were most predictive of satisfaction, effectiveness, and extra effort. Judge and Piccolo (2004) found that contingent reward was almost as effective as transformational leadership (0.39 vs. 0.44), particularly in business organizations, and that MBE-active was also a significant predictor, to a lesser extent, of leader effectiveness. Parry (2002) found that a better psychometric fit for leadership data was between transformational and separate active and passive management categories — with laissez-faire one component of passive management. Laissez-faire leadership has emerged as highly undesirable, with MBE-passive also producing significant negative results against all criteria (Judge & Piccolo, 2004). Hunt (1999) highlighted the following problems associated with much research regarding transformational leadership:

• Mostly survey research, with most studies using the Multifactor Leadership Questionnaire (MLQ) developed by Bass
• Cross-sectional design, which fails to consider effects over time
• Theories characterized by two-factor approach, resulting in little consideration of over-arching factors (Yukl, 1999)
• Predominantly U.S.-based samples

A U.K.-based study (Alimo-Metcalfe & Alban-Metcalfe, 2001) examined perceptions of leadership behaviors in two public sector organizations. A nine-factor model was produced, reflecting elements of both transactional and transformational leadership behaviors (see Summary Text 9.3). The study highlighted a U.K. emphasis on genuine concern for others
Summary Text 9.3  A Nine-Factor Model of Leadership

- Genuine concern for others
- Political sensitivity and skills
- Decisiveness, determination, self-confidence
- Integrity, trustworthy, honest, and open
- Empowers, develops potential
- Inspirational networker and promoter
- Accessible, approachable
- Clarifies boundaries, involves others in decisions
- Encourages critical and strategic thinking


(empowering, valuing, supporting and developing), whilst the U.S. concept of followership is largely absent. Bass (1999) suggested that the best leaders are both transformational and transactional. Indeed, Judge and Piccolo (2004) found support for an augmentation effect — that is, that a foundation of transactional leadership could be amplified by using transformational leadership in order to motivate followers beyond expectations. For example, fulfilling transactional agreements will build trust in followers, which serves as a foundation for transformational effects (Bass, 1998).

Yukl (1998) suggested that transformational leadership achieved its effect through two processes, whereby followers identify with the leader (personal identification) and with the work group (social identification). High performance in followers is achieved through increased ability and motivation. Empowering behaviors, such as delegating responsibility, aid performance by encouraging followers to think for themselves and become more creative (Dvir et al., 2002). The concept of empowerment is discussed later (Section 9.3.5; see also discussion in relation to teams, Section 8.4.1.6). Kark et al. (2003) argued that positive effects of transformational leadership — enhanced self-efficacy collective efficacy and organization-based self-esteem — which are all indicators of empowerment, result from social identification with the work group, whilst negative effects — follower dependence on the leader — are mediated by personal identification with the leader. Negative effects of transformational leadership are discussed in Section 9.5.

Transformational leadership has been associated with lower injury rates (Barling et al., 2000, 2002; Yule, 2002; Zohar, 2002b). The relationship between the four dimensions of transformational leadership and safety outcomes are discussed below.

9.3.2.1 Individualized consideration

Yule (2002) found that this element of transformational leadership style, where the leader shows an interest in subordinates’ personal and professional development and listens to their needs and concerns, was significantly associated with lower injury rates. In relation to safety, leaders would take an active interest in subordinates’ physical and psychological well-being, and be receptive to suggestions and safety concerns. Guest et al. (1994) found that work groups with better safety records had supervisors who demonstrated concern for their subordinates by making workers feel valued, keeping them well informed, and treating them fairly. Lack of social support from supervisors has been associated with occupational injuries (Sherry, 1991; Iverson & Erwin, 1997; Hemingway & Smith, 1999).
As discussed in Chapter 7, lack of social support may be a source of strain (stressor) for workers, or may act as a moderator (buffer) in the stress–strain relationship (Schaubroeck & Fink, 1998). There is also evidence that social support (including supervisory support) has an indirect effect on injuries, mediated by safe behavior (Oliver et al., 2002). Tomás et al. (1999) reported significant positive relationships between workers’ safe behavior and supervisory response. The role of supportive supervision in shaping workers’ behavior is also reflected in longitudinal research on safe working (Parker et al., 2001). Thompson et al. (1998) found a significant relationship between supervisor support for safety and safety compliance.

In a longitudinal study Parker et al. (2001) found that supportive supervision had a positive lagged effect on safe working, showing that having supportive, coaching-oriented team leaders resulted in safer working that could be measured over an 18-month period. This study provided evidence that experiencing this style of leadership has a positive effect on future behavior. It emerged as a particularly strong relationship, which remained significant when other work characteristics and background factors were included in the analysis, emphasizing the importance to safety of this type of leadership behavior. Another finding from this study was that the influence of supportive supervisory style was a direct effect, not mediated by organizational commitment. Zohar (2002b) argued that supervisory response to safety is an interactive function of concern for members’ welfare (individualized consideration) and safety priorities assigned by senior management, so that a supportive management style would have less effect in promoting worker safety where safety is given a low priority. Workers’ safety behavior was strongly influenced by supervisory practices (such as discussing safety issues with subordinates), which are more likely when a supervisor is concerned for subordinates’ welfare. Another possible mechanism linking individualized consideration with improved safety performance is via its effect on communications, where supervisors are more willing to discuss safety issues with subordinates (Hofmann & Morgeson, 1999; Parker et al., 2001).

### 9.3.2.2 Intellectual stimulation

Of the different aspects of transformational leadership, Yule (2002) found that intellectual stimulation had the strongest relationship with lower injury rates. This dimension of leadership style reflects a leader’s ability to challenge existing assumptions and encourage subordinates to think creatively and to be innovative. Barling et al. (2002) suggested that this leadership style encouraged workers to address safety issues and to share information concerning safety risks.

Intellectual stimulation may help to counter some dysfunctional aspects of groups discussed in Chapter 8. For example, teams that develop strongly held norms concerning safety could be in danger of developing highly routinized behavior that is subject to little scrutiny. Having a team leader whose leadership style is characterized by intellectual stimulation could help team members to question their assumptions and challenge them to develop novel solutions. This could enhance the team’s capacity for long-term learning and their performance in terms of safety (and other performance criteria). Effective learning from injuries is enhanced within teams characterized by open communications (Hofmann & Stetzer, 1998). This leadership style may aid learning by stimulating team members to critically examine weaknesses that lead to injuries. Intellectual stimulation may also facilitate effective group decision-making processes by encouraging team members to examine all possibilities, actively seek contrary evidence, and solicit expert opinion thereby helping to avoid groupthink effects (see Chapter 8). However, little research is directly relevant to this aspect of transformational leadership, so mechanisms by which intellectual stimulation influences injury involvement are largely unknown.
9.3.2.3 Inspirational motivation
A leader employing this aspect of transformational leadership articulates the organizational vision and inspires subordinates toward organizational goals through his or her optimism and enthusiasm. In relation to safety, Barling et al. (2002) suggested that inspirational motivation has a positive effect by challenging team members to go beyond individual needs for the collective good — for example, engaging in OCB and safety-related activities, by convincing their followers that high levels of safety are attainable. However, Yule (2002) found no evidence of a relationship between inspirational motivation and injuries.

Inspirational motivation may be related to performance through such concepts as group potency — that is, a group’s perception of its likely success and its ability to meet challenges (see Chapter 8). Gevers et al. (2001) demonstrated that groups with high potency responded positively in the face of time pressure, by increasing effort to meet deadlines. Tesluk and Quigley (2003) suggested a similar concept in relation to safety called collective efficacy (the group’s belief in its ability to work safely). It seems likely that inspirational motivation would enhance collective efficacy (or group potency) by encouraging team members to increase effort to maintain safety levels in the face of increasing operational demands and time pressure.

9.3.2.4 Idealized influence
Idealized influence affects worker performance through identification with the superior as role model and moral leader. Although Yule (2002) found no significant effect of idealized influence, Barling et al. (2002) argued that leaders influenced their subordinates to perceive safety as a social responsibility by expressing their personal commitment to maintaining safety. Identification with the leader encourages subordinates to prioritize safety goals, rather than compromising safety to meet production demands, as this is the right thing to do.

This aspect of transformational leadership may play an important role in shaping safety climate by strengthening subordinates’ perceptions of management commitment to safety. It would also act to counter some of the disadvantages of autonomous work groups identified by Roy (2003) (see Chapter 8). In the case of such safety responsibilities as identifying failures and developing corrective measures, there is a danger that managers will be perceived as losing commitment to safety if they assume that work teams are undertaking these responsibilities. Where leaders continue to demonstrate idealized influence in relation to their personal commitment to safety standards, this should help to maintain positive team safety climate. It is also likely to aid development of appropriate group norms that embody safety as the top priority. Where team members identify with the leader, his or her personal commitment to safety will be translated into group norms that are accepted within the team.

9.3.2.5 Contingent reward
Although not a dimension of transformational leadership, contingent reward is often considered alongside the four components discussed above as it correlates strongly with these and has been shown to have positive associations with performance outcomes (Judge & Piccolo, 2004). However, evidence relating to this style of leadership is mixed; contingent reward has been associated with reduced minor injury rates, in a relationship fully mediated by safety climate (Zohar, 2002b), but also with higher, rather than lower, injury rates (Yule, 2002).

Judge and Piccolo’s (2004) meta-analysis showed that whilst transformational leadership is associated with follower satisfaction and motivation, contingent reward had stronger
relationships with performance criteria. However, whilst transformational leadership generalized across settings, the context affected contingent reward leadership, such that its validity was much stronger in business settings. The authors suggested that this finding related to resource availability, in that leaders have greater access to tangible resources to reward business professionals for their efforts. In other situations, where leaders have access to fewer resources, they may be less able to fulfill their part of the exchange, making contingent reward leadership less effective. As much safety research focuses upon industries where a high level of tangible resources would not be expected (e.g., public sector, manufacturing, construction, transport, and offshore oil and gas), this might account for negative relationships found between contingent reward and injuries. This would suggest that the contingent reward style of leadership would be less effective in promoting safety, compared with other performance criteria. In addition, as safety goals may come into conflict with other performance outcomes (related to production), rewards associated with production — for example, performance bonuses, may override rewards associated with safe performance, as leaders prioritize production goals above safety goals, thereby making some outcomes more desirable than others. Zohar (2002b) found supporting evidence by demonstrating that contingent reward was effective in promoting a positive safety climate only when safety was assigned as a high priority (but not when it was assigned a low priority), as supervisors view safety as a legitimate performance goal.

9.3.2.6 Management-by-exception and laissez-faire leadership

Other forms of transactional leadership described by Bass (1985) vary from small positive effects (MBE-active) to substantial negative effects (MBE-passive, laissez-faire) on leader effectiveness and performance criteria (Judge & Piccolo, 2004). These findings indicate that only MBE-active — where leaders monitor subordinates’ behavior, anticipate problems, and take corrective actions, is likely to have a positive association with safety performance. Passive and inactive leadership would be expected to have strong negative relationships with safety criteria. As in the general literature on leadership, little attention has been paid to these forms of leadership, and their implications for safety performance. However, a number of prominent disasters have illustrated the effects of poor management; for example, the public enquiry report on the Piper Alpha disaster (Department of Energy, 1990), which occurred in 1988 and claimed the lives of 167 people, criticized the performance of the offshore installation managers (OIMs) involved at the time of the disaster. The report noted that offshore oil companies could do more to enable OIMs to act proactively in crisis situations.

Judge and Piccolo (2004) found some evidence to support the augmentation hypothesis, in which transformational leadership augments effects of transactional practices. Zohar and Luria (2003) drew on the augmentation hypothesis to argue that a contingency model of safety leadership can be applied, in which transformational and transactional leadership styles are complementary, where the practices used will depend on the situation — see earlier section on contingency theories, Section 9.2.3. The key situational variable in this model is degree of routinization — that is, rule formalization (number and specificity of rules and procedures) and activity routinization (degree of variation in problem types and difficulty in problem solving). Where routinization is high, the model suggests that transactional leadership would be most appropriate, whereas when routinization is low, transformational leadership is most suitable (see Figure 9.1). Using inappropriate forms of leadership for the situation will result in a misfit, of which the two types are as follows:

- Knowledge-based misfit — occurs where a transactional leader is managing a work group whose tasks are nonroutine and where existing rules and procedures may fail to adequately address work complexity. Effective performance is based on
developing a realistic mental model of the system and developing successful improvisations, knowing when to apply rules, given an accurate assessment of the hazards prevailing at the time (see Chapter 4 on rule-based behavior).

- Rule-based misfit — occurs where a transformational leader is managing a work group whose tasks are routine and rules are formalized. Effective performance is based on applying appropriate rules and avoiding rule violations.

It is easy to see how knowledge-based misfits could occur as a transactional leadership style would fail to encourage the creativity required to develop solutions to novel problems or to support emergence of realistic mental models required to enhance safety performance. However, it is conceivable that a transactional leader of an autonomous work group could fare almost as well as a transformational leader, by using contingent rewards or MBE-active techniques to motivate workers toward goals and allowing latitude in the means to reach those goals. Zohar and Luria (2003) argued that rule-based misfits could result in reduced safety performance as transformational leaders would encourage innovation and safety participation where only compliance is required. Where goals are pragmatic, it has been noted that charismatic leadership could be dysfunctional (House et al., 1991). However, whilst it is certainly possible that unsafe acts may result from attempting to improvise solutions where existing rules represent the most appropriate ways of working, other aspects of transformational leadership, such as individualized consideration, would be effective, even in highly routinized situations.

There is evidence that supportive supervision, where leaders demonstrate concern for subordinates’ welfare and listen to safety suggestions, is related to improved safety compliance (Thompson et al., 1998), as supervisors are perceived to be fair and trustworthy. A further example is from Guest et al. (1994) who investigated gangs of railway track maintenance workers performing routine maintenance work, following highly formalized rules and procedures. This study found that supervisors who made workers feel valued and treated them fairly managed groups with a better safety record. This example illustrates how transformational leadership can lead to improved performance, even in a highly routinized environment. Therefore, whilst this model is informative, it probably oversimplifies the relationship between leadership style and safety outcomes, with transformational leadership and safety participation on one hand and transactional leadership and compliance on the other. Some forms of transactional leadership can be effective, even in low routinized situations, while transformational leadership predicts both safety compliance and safety participation (Williams et al., 2000), particularly individualized consideration (Thompson et al., 1998).

### 9.3.3 Safety climate and leadership

Studies have highlighted the importance of safety climate to leadership and safety. As noted in Chapter 6, a key dimension of safety climate is perceptions of managers’ commitment
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to safety in terms of their attitudes and their actions. For example, Dedobbeleer and Béland (1991) found that the following worker perceptions of the factors were indicative of management commitment to safety:

- Management attitude toward safety practices
- Management attitude toward workers’ safety
- Actions taken by supervisors to enforce safety
- Management safety activities — including safety instructions and availability of proper equipment

Despite their importance in shaping perceptions of safety climate, and in turn worker behavior, little research focuses on managers’ attitudes toward risk and safety — as opposed to many studies focusing on worker attitudes (see Chapter 6). Rundmo and Hale (2003) examined safety attitudes of 213 senior managers, showing that they were strongly related to the managers’ behavioral intentions and self-reported behaviors in relation to safety activities. The most powerful attitude was management commitment and involvement in safety work, which significantly predicted managers’ behavioral intentions in terms of motivation and monitoring (time that managers reported spending on safety communication and motivating workers), and to a lesser extent, procedures and safety regulations (time that managers spent on improving safety measures). Thus, the key attitude to encourage in managers is with respect to commitment toward, and involvement in, safety work.

Managers’ leadership style is likely to affect how they represent their attitudes and how subordinates interpret their actions. Thus, it has been argued that leadership style is an antecedent to perceived safety climate, which in turn predicts injuries (Barling et al., 2002; Zohar, 2003). Barling et al. (2002) found that the relationship between transformational leadership and occupational injuries was fully mediated by safety climate — there was no significant direct relationship between leadership and injuries. Zohar (2002b) found that transformational leadership and contingent reward were both related to minor injuries, where the relationship was fully mediated by safety climate. This relationship was moderated by externally assigned safety priorities, such that transformational leaders generated a positive safety climate, even when safety was assigned a low priority. Contingent reward was only effective in generating a positive safety climate when safety was assigned a high priority. MBE leadership resulted in a positive safety climate under high assigned priority but poor safety climate under low assigned priority. These results suggest that transformational leaders can promote a positive safety climate — leading to fewer occupational injuries, regardless of the assigned safety priority, whereas contingent reward and MBE leadership require safety to be assigned a high priority in order to have a positive effect on safety climate.

Transformational leadership is essentially a group-level variable as transformational leaders treat all team members equally (although not all empirical work measures it at this level — e.g., Barling et al., 2002). However, LMX leadership is characterized by its individualized treatment of each subordinate. Hofmann et al. (2003) argued that safety climate acts as a moderator in the relationship between LMX leadership and safety behavior — that is, high LMX relationships only lead to increased engagement in safety citizenship behaviors when safety climate is positive. In this case, safety is perceived as having high priority and so safety-related behavior is seen as a legitimate means of reciprocating a high quality relationship with the leader. This hypothesis was confirmed by their analysis, which showed a strong positive association between LMX and safety citizenship role definitions in work groups with a positive safety climate, but much weaker and nonsignificant relationships in those exhibiting poorer safety climates. This study demonstrated that high LMX
relationships only have beneficial effects for safety in positive safety climates, indicating that individuals with a high LMX relationship with their supervisor, who work in groups characterized by a positive safety climate, will be more likely to engage in safety citizenship behaviors. It follows that a prerequisite for any safety benefits from high LMX relationships is working in a team that has a positive safety climate.

Much of the research reviewed in previous sections has examined supervisors’ leadership style, with little attention focused on senior managers. Thus, caution must be exercised when extending results highlighted above from first-line managers to those higher in organizational hierarchies. Thompson et al. (1998) examined supervisor support for safety separately from management support; whilst both were important variables that were significantly related to safety behavior, each played a slightly different role. Supervisor support was more closely related to safety compliance, whilst management support was more strongly associated with safety conditions. Clarke (1999) showed that supervisors’ and managers’ safety attitudes can differ significantly, and moreover, that both levels are viewed as significantly different from a workers’ perspective, suggesting that such perceptual differences may lead to communication difficulties. Yule (2002) found that larger differences between leaders’ views of their own leadership style and those of their subordinates were significantly associated with higher injury rates. Thus, perceptual differences may also be linked with injury occurrence.

9.3.4 Substitutes for leadership

According to some authors (Kerr & Jermier, 1978; Podsakoff et al., 1996), situations arise in which there are sufficient factors independent of leadership that support subordinates to the extent that they do not have to rely on a leader for guidance — for example, ability, training, and previous experience. These factors could account for effective performance even with an unsatisfactory group leader. In effect, subordinates require little supervision. Kerr and Jermier (1978) suggested that effective group performance depended on factors other than leadership and therefore leadership should be recognized as merely another independent variable among many that influence worker satisfaction and performance. Williams et al. (1988) and Yukl (1998) provided support for this theory.

Leadership substitutes include subordinates’ abilities and skills, as well as intrinsically satisfying tasks, explicit formalized goals, rigid rules and procedures, cohesive groups, and knowledgeable officials, other than the leader, whom subordinates can consult. For example, where a task is interesting or satisfying, subordinates may be motivated by the work itself, thereby negating the need for supervision. Where tasks are simple or repetitive, or feedback on progress is on hand, it is unnecessary for leaders to provide advice or feedback. Likewise, little direction is needed from a leader when goals or objectives, rules, and procedures are clearly stated and accepted. With regard to group cohesiveness, a work group comprising a close-knit team of competent individuals capable of taking initiatives without direction (e.g., an emergency services team) creates less need for intervention by a leader. In contrast, a leadership neutralizer stops a leader from taking action in some way. For example, the leader’s position may not be endowed with sufficient power, or the leader does not have adequate organizational rewards to dispense, or there may be physical distance between leader and subordinates. Vecchio (2003) noted that this theory helps to explain mixed results from leadership studies, as many fail to recognize the effect of neutralizers and substitutes, and so may produce nonsignificant results.

In relation to safety, evidence largely supports positive effects of autonomous work teams (see Chapter 8) in which leadership functions have been delegated to the team. However, it was noted in Chapter 8 that these teams are not without their problems. For example, Roy (2003) noted increased safety motivation and ownership of safety in
these teams, but that there can also be increased pressure within teams in terms of resolving production–safety conflicts. One danger is that managers and supervisors withdraw attention from these teams and are then perceived as lacking commitment to safety — a key dimension of a positive safety climate; thus it is important that safety leadership is maintained. This point is supported by Hofmann and Morgeson (2004), who suggested that leadership is crucial and that leaders must develop an organizational climate where proper consideration of the safety implications of decisions are rewarded. Although earlier evidence noted positive effects from supervisors who set safety expectations, monitor, and provide appropriate rewards, this must be weighed against the need for autonomy and empowerment, in that greater empowerment is associated with safety benefits (see Section 9.3.5).

9.3.5 Empowerment

Most definitions of empowerment focus on the superior–subordinate relationship in which power (i.e., decision-making authority) is delegated to workers. This power is internalized by subordinates and returned to the organization in the form of enhanced performance. Although some theories have emphasized management practices that lead to empowerment, others have focused on empowerment as a psychological construct (Manz & Sims, 1980; Conger & Kanungo, 1988; Thomas & Velthouse, 1990; Spreitzer, 1995; Walsh et al., 1998; see Summary Text 9.4). Lean production, where operations are conducted by teams, with maximum redistribution of tasks and responsibilities to the workforce, is accompanied by increased team empowerment (Taira, 1996). Although not usually employed as a safety initiative, empowerment has been related to improved organizational effectiveness and productivity (Hardy & Leiba-O’Sullivan, 1998). Through empowerment workers acquire greater responsibilities and more control over their work — factors associated with better psychological and physical health (see Chapter 7). As noted in Chapter 8, research evidence largely supports a positive link between self-managed teams and improved safety outcomes. Hechanova-Alampay and Beehr (2002) found that degree of empowerment in self-managed teams was significantly related to both unsafe behaviors and team member injuries, such that teams that were rated as more empowered (by an independent panel of assessors) engaged in fewer unsafe behaviors and experienced fewer injuries. Span of control was also a significant factor, indicating that work group size affects safety benefits, as leaders cannot cope with empowering larger work teams.

9.4 Leadership failures

Much research focuses on successful leadership and the traits, behavior, and context within which it occurs. However, less attention is given to bad leadership (despite there being so much of it around)! Studies conducted by Lombardo and colleagues identified factors that were associated with failed leadership. For example, using an eight-dimensional inventory, which included organizational savvy, honor, sensitivity, and ability to direct and motivate subordinates, Lombardo et al. (1988) distinguished successful senior managers from those who had derailed (been fired or demoted). Results from bosses’ ratings of 86 successful senior male managers on the eight dimensions were significantly higher than those of 83 who had derailed. These can be summarized in the following points:

- Poor interpersonal skills — for example, abrasive, cold, aloof, arrogant, intimidating, insensitive
- Overambitious — for example, betraying trust, failing to follow through
Summary Text 9.4 Summary of Leadership Theories Alluding to Empowerment

Conger and Kanungo (1988)

Psychological empowerment = self-efficacy

Leadership practices (e.g., setting goals, feedback systems), job enrichment (e.g., increasing autonomy and decision making), and competency-based rewards lead to increased feelings of self-efficacy, which increases motivation (and performance).

Spreitzer (1995); Thomas and Velthouse (1990)

Psychological empowerment = intrinsic motivation

A participative climate (e.g., role clarity, access to information, sociopolitical support) facilitates empowerment, which comprises the four dimensions outlined as follows:

- Meaning — fit between one’s work and one’s personal beliefs and values
- Competence — belief in one’s capability to perform activities with skill (self-efficacy)
- Self-determination — sense of initiating and regulating one’s actions (autonomy)
- Impact — degree of influence over work outcomes

Manz and Sims (1980)

Psychological empowerment = self-leadership

Self-management acts as a source of task structure and direction; it involves covert behavior modification. Managers can encourage development of empowerment behaviors through modeling.

Walsh et al. (1998)

Psychological empowerment = self-knowledge

The relational approach to empowerment emphasizes the quality of the relationship between members of the empowered group. Empowerment is defined in terms of connections between people (communicate empathy, express vulnerability, and help others to develop). Problems are associated with the following factors:

- Power — moving away from power over others toward shared power
- Disconnection — empowerment is not developed equally throughout the group (so that some people feel disconnected)
- Conflict — expressing and discussing conflicts openly
• Inability to be strategic — for example, focusing on the how rather than the what, conflict with upper management
• Overmanaging — for example, inability to delegate, constant monitoring or meddling, inability to build a team

Other studies identified personality characteristics associated with failed leadership (Tyson et al., 1986; Brindle, 1992; Hogan & Hogan, 2001). These included: imaginative, bold, forthright, uninhibited, unconventional, innovative and independent — characteristics that have also been reflected in personalities of successful leaders. However, Hogan and Hogan (2001) argued that managerial incompetence is linked with dysfunctional personality characteristics such that a failed leader may be uninhibited and forthright, but also display a tendency to blow up (e.g., respond with anger to problems, behave in a mercurial and abusive fashion), to show off (e.g., imaginative, eccentric, self-confident, colorful), or conform under pressure (e.g., controlling, reactive, adhere rigidly to established procedures).

9.5 Leadership ethics

Early theorists identified leadership as having a component of morality. However, more recently, the moral or ethical component of management has largely been abandoned, with managers seeing their primary (or only) obligation to be that of ensuring organizational productivity (Cohen, 1995). Emphasis has generally been on positive outcomes of transformational leadership — for example, Burns (1978) suggested that transformational leadership raises both leaders and followers to, “higher levels of motivation and morality” (p. 20). Transformational leadership encourages workforce empowerment, through developing self-efficacy (belief in oneself), collective efficacy (belief in the team), and organization-based self-esteem (value attached to being an organizational member) — Figure 9.2 outlines ethical concerns of transactional and transformational leadership. However, there is a dark side in terms of the potential for charismatic leaders to deceive and exploit their followers (Bass & Steidlmeier, 1999), if followers come to view the leader as exceptional and develop dependence on the leader for guidance and inspiration (Yukl, 1998). Conger and Kanungo (1998) identified the negative characteristics of charismatic leaders as follows:

- Narcissism
- Authoritarianism
- Machiavellianism
- Flawed vision
- Need for power coupled with lack of activity
- Promotion of dependency among followers
- Personal identification
- Lack of internalization of values and beliefs

Kark et al. (2003) argued that whilst social identification with the work group leads to empowerment, personal identification with the leader leads to dependence. Their study indicated that transformational leadership style predicted both empowerment and dependence, but that it was related more strongly to personal identification than to social identification, indicating that this is the primary mechanism through which a transformational leader exerts influence. These results suggested that charismatic leadership is potentially more damaging, as leaders may promote dependence without empowerment.
Human safety and risk management

**Transactional leadership**

<table>
<thead>
<tr>
<th><strong>Ethical concern</strong></th>
<th><strong>Task</strong></th>
<th>Whether what is being done and the means employed to achieve it are morally legitimate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reward system</strong></td>
<td></td>
<td>Whether sanctions or incentives impair effective freedom and respect conscience</td>
</tr>
<tr>
<td><strong>Intentions</strong></td>
<td></td>
<td>Truth telling</td>
</tr>
<tr>
<td><strong>Trust</strong></td>
<td></td>
<td>Promise keeping</td>
</tr>
<tr>
<td><strong>Consequences</strong></td>
<td></td>
<td>Whether legitimate moral standing and interests of all those affected are respected</td>
</tr>
<tr>
<td><strong>Due process</strong></td>
<td></td>
<td>Impartial process of settling conflicts and claims</td>
</tr>
</tbody>
</table>

**Transformational leadership**

<table>
<thead>
<tr>
<th><strong>Ethical concern</strong></th>
<th><strong>Idealized influence</strong></th>
<th>Whether puffery and egoism by leader predominate and whether leader is manipulative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inspirational motivation</strong></td>
<td></td>
<td>Whether leader provides true empowerment and self-actualization for followers</td>
</tr>
<tr>
<td><strong>Intellectual stimulation</strong></td>
<td></td>
<td>Whether leader’s program is open to dynamic transcendence or is closed propaganda and a line to follow</td>
</tr>
<tr>
<td><strong>Individualized consideration</strong></td>
<td></td>
<td>Whether followers are treated as ends or means; whether their unique dignity and interests are respected</td>
</tr>
</tbody>
</table>

**Figure 9.2** Ethical concerns of transactional and transformational leadership.

It seems that transformational leaders may have both positive and negative effects on followers.

Bass and Steidlmeier (1999) suggested that the ethics of leadership depended upon the following three factors:

- Leader’s moral character
- Ethical legitimacy of values embedded in the leader’s vision
- Morality of the processes of social ethical choice and action that leaders and followers engage in and collectively pursue

Howell and Avolio (1992) argued that only socialized leaders, concerned for the common good, could truly be transformational leaders. Personalized leaders, who are primarily concerned with their own self-interests, could not truly be transformational leaders. Bass and Steidlmeier (1999) distinguished between authentic transformational leadership and pseudo-transformational leadership. Authentic leaders are concerned with “the good that can be achieved for the group, organization or society for which they are responsible” (p. 188) — that is, the values from which they act are altruistic. Price (2003) identified a number of ways in which leaders may be “inauthentic” by examining the congruence of their behavior with their values (see Figure 9.3). However, there are also ethical concerns with authentic transformational leadership, the primary one being that, “authenticity entails commitment
Figure 9.3 Leadership dimensions, behaviors, and values. (After Bass & Steidlmeier, 1999.)

to a type of good that too easily overrides the authority of generally applicable moral requirements” (Price, 2003, p. 75). Ethical failures of leadership can occur when leaders overestimate the importance of their altruistic values and make moral exceptions of themselves. Where followers accept these justifications (due to their acceptance of the leader’s values) ethical risks of authentic leadership are increased. The interests of the group can become paramount, sometimes to the exclusion of external interests. For example, a leader may prioritize the safety of his or her work group over safety considerations of other groups, such as customers or a wider public.

9.6 Conclusions

Much research emphasizes the importance of management’s role in organizational safety. As managers’ safety attitudes are important in shaping an organization’s safety culture (see Chapter 11) it is essential that senior managers are genuinely committed to improving safety and have sufficient competence to implement this commitment in policies and practice. This chapter has also illustrated how managers’ leadership style exerts significant effects on subordinates’ perceptions, attitudes, and behavior, which impacts on safety climate.

Even the most rudimentary leadership style at first-line level can have positive effects for safety if it begins to establish trust between supervisors and workers, for example, involving keeping promises, telling the truth, treating workers fairly, and engaging in clear and unambiguous communication. Key to developing workers’ trust in managers is effective communication and competent decision making; if this kind of relationship can be fostered at local level, then trust can be transmitted throughout an organization (Whitener, 1997). Trust in senior managers and their safety policies can be developed through positive relationships between workforce and first-line managers. Whilst transactional leadership style can lay the foundations for this trust, more transformational aspects of leadership style lead to positive safety outcomes. This chapter has shown that whilst various leadership styles can positively impact upon safety, only transformational leaders are likely to be able to promote a positive safety climate (leading to fewer occupational injuries) regardless of assigned safety priorities, whereas contingent reward and MBE leadership require safety to be assigned a high priority in order to positively affect safety climate. Many aspects of transformational leadership style aid effective group functioning, for example, developing novel solutions to problems, engaging in safety OCBs, and striving for a high level of safety performance. However, whilst leadership interventions might
profitably focus upon developing practices that characterize a transformational style, there is also a need to emphasize elimination of passive and inactive leadership practices that have deleterious effects on safety.

Clarke (1999) demonstrated that both managers and workers could underestimate the importance of safety to the other group; greater information sharing can help to reduce such perceptual differences and foster workers’ trust in management. Similarly, Flin (2003) argued that it is not always the case that senior managers lack commitment to safety, but that sometimes the workforce do not recognize that commitment. Thus, it may be necessary to focus upon improving the communication of this commitment throughout an organization. Flin (2003) described upward appraisal as a tool for identifying communication failures, where one senior manager, and managers at the next level down, participated in an exercise that included a workshop to discuss results, which led to successful behavioral changes for middle level managers. Management training can also have positive benefits. For example, Stokols et al. (2001) examined effects of a management training program (involving role-playing exercises and time for group discussion among participants from several companies) in 48 small and medium enterprises (SMEs) (compared with 46 control companies). The authors found that, compared with controls, there were significantly higher levels of corporate regulatory compliance over the following 12 months. However, due to lack of reliable injury data, no relationship could be demonstrated with safety outcomes.

Workers’ perceptions of managers’ commitment to safety is a major determinant of safety climate. These perceptions are affected by leadership style, effectiveness of organizational work practices and safety systems (see Chapter 10), and the quality of communication between managers and workforce. As little research has examined the mechanisms by which senior managers influence corporate safety performance, this is an area requiring significantly more research attention.
chapter ten

Managing human risks

This chapter provides a context for managing features of human behavior discussed in earlier chapters. A broad framework is provided in the form of a risk management approach. It is argued that risks should be managed as part of a strategic, human resources management (HRM) perspective. Work practices associated with occupational health and safety (OHS) are reviewed including, selective hiring, communication and information sharing, reward systems, and training. A risk management approach is presented that includes a range of techniques, such as risk assessment, safety audit, and safety interventions.

10.1 Introduction

It is frequently stated that management should manage OHS risks with the effectiveness and commitment with which they manage other functions. For example, the Health and Safety Executive (HSE, 1991) considered that safety management is part of sound management. It could be argued that such risks, which imply a threat to life as well as to productivity and profitability, should be managed better than other functions. This chapter overviews selected components of managing OHS that can be incorporated within risk management, a topic that encompasses broad principles and criteria (Bamber, 1994). In selecting topics for inclusion in this chapter, we have considered the book’s primary orientation toward managing human rather than technical aspects of risk as well as featuring emergent aspects of managing such risks. Managing human risks is one component of managing all risks, for which an integrated strategy is required. The Confederation of British Industry (CBI, 1993) noted that having completed a risk assessment, management should allocate resources and responsibilities, set priorities and deadlines, ensure quality, allocate resources for controls, and institute auditing procedures. These steps are the province of HRM. Hence there is a need to consider HRM as a critical aspect of risk management. The objectives of this chapter are as follows:

- Outline the risk management process
- Review different approaches to safety management, including safety management systems (SMSs) and safety audits
- Explain the role of HRM in relation to OHS
- Identify human resource (HR) practices that are related to safety outcomes
- Present an integrated approach to managing human risks
- Discuss types of safety interventions available for controlling risks and how to implement them successfully
10.2  A risk management approach

The different approaches to risk reviewed in Chapter 2 illustrate the multifaceted nature of risk and emphasize the need to take a multidisciplinary approach to understanding and managing risk. A risk management approach needs to be sufficiently broad based to encompass individual differences and the sociopolitical environment, as well as including more traditional components, such as technical and economic approaches to risk assessment and evaluation.

10.2.1  Risk assessment

The essence of risk management is: first, identify risks (measure in some way); second, assess potential seriousness (how important in the light of other factors); third, seek to influence associated outcomes (do something about it); and finally, monitor the effectiveness of interventions (see Summary Text 10.1). Examples of technical/economic approaches to risk management, principally used for physical hazards, are discussed in Chapter 2.

In the United Kingdom the general legal basis for risk assessment rests in Regulation 3 of the Management of Health and Safety at Work Regulations 1992, which requires systematic examination of hazards and the potential for the risks arising to cause harm. In Australia, each state serves as its own jurisdiction for OHS issues, and has similar legislation requiring risk assessment and risk management. Jointly with New Zealand, Australia also has a national risk management standard (AS/NZS 4360). Other regulations also require risk assessments in specific areas. The CBI (1993) defined risk assessment as an evaluation of the chance that harm will occur and considered that risk control principles should link to both quality issues and to safety culture (see Chapter 11). Risk assessment is viewed as comprising the first two stages of the risk management process: hazard identification and risk evaluation or measurement. Types of risk assessment include: assessments of large-scale complex hazard sites, as in process industries, requiring quantitative risk assessment (e.g., involving fault trees, event trees, probabilistic risk assessment [PRA], failure modes and effects analysis [FMEA], hazard and operability study [HAZOPs]) (Raafat, 1990); those required under specific legislation (e.g., for hazardous substances under the COSHH Regulations 1988); general assessments of the complete range of workplace risks, as required under the Management of Health and Safety at Work Regulations 1992; and risk assessments specific to a workplace or work process (including human factors risk assessments, such as HRA, described in Chapter 4). As noted in Chapter 2, a purely technical or economic approach to risk management has a number of limitations, primarily that the social nature of risk is ignored.

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Summary Text 10.1  The Basic Risk Management Process

The risk management process involves the core features outlined below:

- Identifying hazards (what are they? how many?)
- Evaluating risk (how much danger? how soon? how often? who is exposed?)
- Controlling risk (what methods? to what benefit?)
- Monitoring controls (how do they stand up? what changes are needed?)
10.2.2 Safety management systems

One means for managing or controlling risks identified as part of the risk assessment process, is to establish a safety management system (SMS), where safety management relates to the practices, roles, and functions associated with remaining safe (Kirwan, 1998). Wright (1994) considered the SMS to be the, “means by which the organization controls risk through the management process.” The Health and Safety Commission (1993b) considered that the SMS refers collectively to, “those elements in the management system which are particularly concerned with health and safety performance and legal compliance, as well as with loss control” (p. 101). The United Kingdom’s original 1996 SMS guidelines were updated in 2005 (BSI, 2005), while a certification standard has also been produced (BSI, 1999). The International Labour Organization has also produced guidelines on OHS management systems (ILO, 2001). The importance of an adequate SMS to effective organizational functioning on safety has been recognized in reports of disasters such as those at Clapham Junction (GB: Department of Transport, 1989) and Piper Alpha (GB: Department of Energy, 1990).

Wright (1994) identified three distinct approaches to the SMS: the first is based upon a traditional systems approach (as exemplified by HSE, 1991); the second focuses upon the concept of safety culture and attitudes (see Chapter 11), as described, for example, in Hale et al. (1991) and Pidgeon et al. (1991); the third approach is based upon best practice, typified by safety auditing and developed from practices in the petrochemical and other process industries. The HSE (1991) approach to safety management contains the following six elements:

1. Policy
2. Organizing
3. Planning and implementing
4. Measuring performance
5. Reviewing performance
6. Auditing

Processes such as worker involvement, continuous improvement, and resource provision and risk control, support these elements, while interconnections between them include feedback loops.

A systems approach to safety is described by Waring (1989, 1991), where a system comprises the following elements:

- Structural elements — relatively enduring system components such as key posts, reporting relationships, safety documentation, committees, and other groups.
- Processes — tend to be more changing aspects, including action, decision making, problem solving, information provision, and communication.
- Interconnections — between system elements and processes include feedback loops and provide a framework for the system.
- External influences — include government, legislation, the economy, state of technology, rate of change, and public opinion.
- Subsystems — may be found in more complex systems, perhaps nested like Russian Matreshka dolls. Examples of subsystems include: control (decision making, policy, strategic planning), monitoring (systematic checking of safety performance), executive (operational subsystems, e.g., maintenance, production), and communication (transmission via one or more channels).
Waring (1991, 1995) argued that the conditions necessary for an effective SMS are both functional (involving management control, monitoring, executive and communications subsystems) and human (involving leadership, political and safety culture subsystems). Thus, political will and top management commitment need to be reinforced with a common set of safety beliefs, values, and behaviors from all those within the organization comprising the safety culture (see Chapter 11). The auditing approach, based upon expert opinion, is more a set of practices than a system of management and relates elements of an audit to such management functions as planning, organizing, implementing and controlling, as well as accountability. All three approaches bring together human and managerial aspects of risk and emphasize such features as the importance of top management commitment, setting clear safety objectives, and communicating required information adequately. However, an integrated SMS approach poses many challenges (see Wright, 1994; Waring, 1995, for a discussion).

10.2.2.1 Measuring performance
Drucker’s maxim “what gets measured, gets done” is a reminder of the importance of measuring performance if useful safety objectives are to be achieved. It could be added that what gets done should be measured as a basis for further action. A wide range of measures might be used to gauge management performance in health and safety (see Summary Text 10.2). Given this variety, five important issues to be addressed when deciding upon the measures to employ are described in Summary Text 10.3.

A distinction can be made between proactive and reactive monitoring, as well as between different types of proactive monitoring. The essential difference is that reactive monitoring is concerned with reacting to events — for example, injuries and dangerous

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**Summary Text 10.2 Illustrative Measures of Health and Safety Performance**

<table>
<thead>
<tr>
<th>Objective quantitative</th>
<th>Subjective quantitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibrated instrument measures (e.g., noise)</td>
<td>Attitude surveys</td>
</tr>
<tr>
<td>Hazard analysis using formal system</td>
<td>Prosecutions and notices served</td>
</tr>
<tr>
<td>Verified quantified audit</td>
<td>Unverified quantified audit</td>
</tr>
<tr>
<td>Behavior sampling</td>
<td>Motivation surveys</td>
</tr>
<tr>
<td>Verified injury/disease/damage rates</td>
<td>Unverified injury/disease/damage rates</td>
</tr>
<tr>
<td>Structured interviews/surveys</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective qualitative</th>
<th>Subjective qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workplace inspections</td>
<td>Ad hoc observations</td>
</tr>
<tr>
<td>Health and safety adviser employed?</td>
<td>Status of health and safety adviser</td>
</tr>
<tr>
<td>Injury investigations</td>
<td>Ad hoc safety tours</td>
</tr>
<tr>
<td>Documentary analysis</td>
<td>Health and safety consultation</td>
</tr>
<tr>
<td>Extent of OHS training</td>
<td>OHS training effectiveness</td>
</tr>
<tr>
<td>Diary monitoring</td>
<td>Unverified expert judgment</td>
</tr>
<tr>
<td></td>
<td>In-depth interviews and focus groups</td>
</tr>
</tbody>
</table>
Summary Text 10.3 Issues to be Addressed in Measuring Management Performance

Reliability — this describes the extent to which a measure will give the same result on successive occasions of use. This assumes that what is being measured stays the same. For example, a measure of housekeeping in a workplace (e.g., an observation checklist) might be reliable even though it gave different results each time. This could be because the housekeeping was changing over time. One way of establishing the reliability of an instrument is to get different people to use it at the same time (called interrater reliability). For example, two independent assessors complete the same safety audit checklist in the same workplace. If they obtain the same, or almost the same result, then the chances are that this is a reliable checklist (for this particular workplace). If their respective results differ widely then it is unlikely that this is a reliable measure. Unreliable measures will remain subjective, even though the results may be quantifiable. The results may still be important, however. For example, if the two people completing an audit checklist are the plant manager and the safety representative and they get widely differing results (it has happened!), then this is an important indication that someone’s perceptions (perhaps those of both parties) are partly wrong. This finding may lead to vital changes in health and safety provision — both technical and organizational aspects.

Validity — this refers to whether the indicator being used really is a good measure of what is being measured. For example, asking whether injury data are a valid measure of management performance in health and safety is really just asking whether they are a good (in the sense of adequate or satisfactory) measure. Similarly, we may ask whether safety audits are a valid way of measuring health and safety performance. To answer this question, it is necessary to know what our ultimate objective is. Our objective is sometimes called a criterion measure — because it is the criterion against which something is assessed. Generally, for health and safety, the criterion (or ultimate objective) is a significant reduction in reported instances of injuries or ill health. Thus, to establish the validity of safety auditing as a performance measure, we might correlate (i.e., establish whether there is an association between) safety audit scores over a period of time — which could be several years — with injury rates (or with whatever criterion or outcome measure we selected). A high correlation (say in the order of 0.7 or above) would indicate a reasonably valid measure, while a low correlation (say less than 0.2) would suggest that our indicator (the audit scores) was not very valid (in the example of correlating audit score with injury rates, a negative correlation would be expected). A criterion that is used as an objective — for example, reducing reports of injuries or ill health, cannot also be used as an indicator. This is because they are one and the same measure and are thus not independent. This is simply a matter of logic. Thus, logically, if we use injury or disease data as a measure, we need to set some other criterion or objective that we are using injury rates as an indicator of. This might be difficult, although we might suggest, for example, that production quality, profitability through cost reduction, efficiency, and effectiveness, or managerial excellence would be candidates.

Triangulation — this term originates from the geographical sciences when it is usually used to denote the practice of taking a minimum of two different measures to gauge the true height of a point above sea level. This practice has
been taken up by a number of other disciplines and translates into the principle of not relying upon a single measure to assess something but rather to use a combination of measures (or methods or data) to evaluate, for example, the effectiveness of a management practice. Thus, if management’s health and safety performance is being evaluated, it will be necessary to use a number of different measures in order to gain a good (i.e., a valid) assessment of that performance. In practical terms, this might mean using at least one measure from each of the cells of the matrix shown in Summary Text 10.2. This would provide a much better overall assessment of management performance than relying upon any single measure.

**Accuracy and completeness** — these are relatively straightforward principles — namely, whatever measures (whether as indicators or criterion measures) are used should be accurate and complete. Measures that are inaccurate or incomplete can be neither valid nor reliable (although accuracy and completeness alone, of course, are not enough). Thus, the accuracy and completeness of all data should be systematically checked.

**Measurement scales** — there are three basic types of scales that may be used when anything is measured. First, nominal (or categorical) scales simply measure qualitative differences between things. For example, Company A has carried out a risk assessment while Company B has not. That is a qualitative difference — which could also be a valid measure of safety performance. Second, ordinal (or rank-order) scales can be used to determine the ranking of different items. For example, three plants in a company carry out safety audits. Plant A achieves a score of 66%, Plant B has a score of 50%, while Plant C ends up with 33%. These data, assuming they are verified, tell us that Plant A is better than Plant B, which in turn is better than Plant C. However, they do not tell us how much better Plant B is than Plant C or how much better Plant A is than Plant B. Thus, for example just because Plant A’s score is twice that of Plant C, we cannot validly draw the conclusion that Plant A’s health and safety performance is twice as good as that of Plant C (only that it certainly is better, given that the measure is valid). The key is how the instrument is scaled or calibrated. Thus, for example, it may be relatively easy to achieve a score of 50% on this audit and with a little bit of effort, Plant C could bring itself up to Plant B’s level. However thereafter it may become increasingly difficult to achieve higher scores so that 66% is really quite good. The point is that from the scores alone we have no way of knowing and thus can only draw the conclusion that the rank order is correct, but we cannot talk about the relative difference between the three plants in terms of a ratio. It is therefore important not to rely exclusively upon numerical data when making comparisons between workplace audit scores, but also to consider, for example, historical data and information about management and safety culture. Finally, interval (or ratio if there is a zero start point) scales do enable us to state how much of a difference there is between two things. This is because an interval scale is calibrated so that a difference of one point means the same irrespective of where we are on the scale. For example, because injury rates (frequency or incidence) are calculated on the basis of a ratio (per hours worked or people employed) then we know that an increase from 0 to 1 represents the same interval as an increase from 1 to 2 or from 99 to 100. However, interval scales will not be widely found in measures of management performance in health and safety. This is because for the most part we are measuring things that cannot be quantified to the degree necessary to construct an interval scale. Thus, for the most part, measures in this area will be qualitative — nominal or, at best, ordinal.
occurrences, while proactive monitoring attempts to institute practices to prevent or mitigate the worst consequences of those events. Sometimes, reactive data are known as outcome data (what management reacts to) while audit results provide an example of data for proactive monitoring (gathered by management as a prevention tool). It is essential to collect outcome data because these (i.e., the events) are what safety and risk professionals are trying to prevent. In other words, these are our criterion measures; our objective is to minimize such sources of loss to an organization. Therefore, they must be measured as criteria for long-term success. As far as possible, outcome data should be quantified, for example, expressed as numbers or rates so that they can be compared over time. It should also be possible to translate these losses into monetary terms, which can act as a powerful motivator for senior management. Such an exercise also makes it possible to balance the costs of losses that are occurring with expenditure on measures designed to control the losses. However, it is not sufficient to monitor only reactive data, proactive measures are also needed. One method of measuring safety performance in relation to the management system, safety auditing, is reviewed in Section 10.2.2.2.

10.2.2.2 Safety auditing

The HSE (1991) considered (safety) auditing to be a crucial part of the feedback process in safety management systems, defining it as, “the structured process of collecting independent information on the efficiency, effectiveness and reliability of the total safety management system and drawing up plans for corrective action.” Six types of safety audit are outlined below:

1. Safety audits on specific topics, for example, human factors, hazardous substances, or the environment.
2. Plant technical audits involve an in-depth review of all plant and processes carried out by specialist staff, for example, on a 5-yearly basis.
3. Site technical audits cover all work of a specified type at predetermined intervals and involve both local and specialist staff.
4. Compliance audits (or verification audits) are designed to establish whether the range of relevant health and safety legal requirements have been complied with by the organization. Verification is concerned with whether the SMS is doing what it is claimed to do in its extent and quality and whether this is adequate as operated.
5. Validation audits are concerned with the scope of an audit and with its design, focusing upon such matters as whether the right kinds of subsystem and components are being adopted, whether the right kinds of monitoring are being done, and whether appropriate subsystems are in place.
6. Management safety audits (or area safety audits), combine validation and verification audits, are typically carried out annually, cover general safety matters, and involve local staff and perhaps also specialist auditing staff. A management safety audit could be carried out at both strategic and operational levels. This is the type of audit referred to in this chapter.

The essential rationale for auditing OHS is that management is able to measure effort and to express this in a way that can be commented upon and evaluated. It also makes possible comparison of results over time, systematic review of risks and ensures that (external) legal and (internal) organizational policy requirements are being met. A safety audit also performs the functions and features outlined in Summary Text 10.4. There is no model audit; rather each audit should be unique and derived from an organization’s strategic safety and risk management needs. The process of developing an audit or conducting it for the
first time can play a vital part in hazard identification. Once validated, audit items are weighted, answered, and scored and the resultant figures provide a risk assessment. Successive completions of an audit provide a means of monitoring management performance in health and safety over time. The safety audit is an expression of opinion on the validity and reliability of the effectiveness of the SMS or particular aspects of it. Summary Text 10.5 outlines key principles of safety auditing.

When considering the audit in action, a number of issues need to be addressed. The first is the extent to which a safety audit is seen to be something that is imposed on one party (e.g., a line manager) by another party (e.g., an accredited safety auditor). An alternative perspective is that people whose performance is being audited collectively should be involved in the auditing process. This is in keeping with the spirit of self-regulation and is

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**Summary Text 10.4 Functions and Features of a Safety Audit**

- An all-embracing approach that can give both a single quantified or qualitative measure of management performance in the principal area and a disaggregated view of performance in selected areas
- A proxy measure of risk in an organization that is proactive rather than reactive (as in the case of injury or ill-health data); looks to make changes where required and provides guidance for doing so
- Should be tailored to the requirements (e.g., particular hazards and risks) of each organization
- Provides an overview of the range of issues requiring attention, thereby providing a strategic perspective
- Can provide guidance not only on what has to be done but also on why (e.g., legal or efficiency requirements) and how to achieve it
- Enables senior management to be assured of compliance
- Offers local management the means to promote compliance
- Provides for a longitudinal approach to health and safety
- A flexible approach to managing health and safety

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**Summary Text 10.5 Principles of Safety Auditing**

- Seek to be positive rather than being preoccupied with fault finding
- Identify deviations from agreed standards
- Facilitate analysis of events that lead to those deviations
- Highlight good practices
- Be professional, impartial, and objective
- Integrate auditing into safety and risk management systems
- Assess each management function or area as objectively and accurately as possible
- Provide a measure of the state of health and safety risks
- Indicate strengths and weaknesses in key areas
- Provide clear guidelines for improvements
- Be a means for monitoring in health and safety improvements
far more likely to result in ownership of the auditing process by those whose performance is the focus of the audit. In particular, it is important that those introducing safety auditing bring line management with them and encourage managers to consider safety auditing as a learning opportunity. Whether they are from inside or outside the organization, safety auditors need to be independent. There is value in bringing a fresh pair of eyes to the auditing process as this assists in the objectivity of auditing. Effective involvement and participation of managers and other parties is essential in order to maximize the impact of an audit. As both independence and involvement are essential aspects of safety auditing, management skill is required to achieve a successful coalition of these criteria. Having agreed the principle of safety auditing within an organization, the issue of persuading various parties of its value needs to be considered as part of the process of winning hearts and minds (see Summary Text 10.6).

It is important to be able to evaluate the effectiveness of a safety audit. In the short term, this can be done by verifying audit scores. In the long term, scores should be assessed against an independent measure, such as injuries or other losses. The ultimate test of a safety audit is whether its use is associated with and can be demonstrated to have influenced declining rates of injuries, diseases, and other losses. This may be difficult because when the management of an organization decides to introduce safety auditing they usually also make other changes and it is likely that a combination of factors affects injuries and other losses. For example, a positive safety culture may be required for the introduction of a safety auditing system. The safety audit process is then likely to enhance the safety culture. Both, together, may then work to reduce injury and absence rates and so on. This accords with the philosophy that safety auditing is only one component of a comprehensive SMS.

10.2.3 Human resource management (HRM)

Of the HRM-performance link, Guest et al.’s (2003) mixed results from their study of 366 U.K. companies found no clear causal connection between HR practices and productivity, although they did discern a link between HR practices, company profit, and lower staff turnover. However, in a study of Taiwanese high-tech firms, Chang and Chen (2002) found significant effects on worker productivity from HR practices, such as training and development, teamwork, benefits, human resource planning, and performance appraisal. Bartel’s (2004) study of U.S. banks showed a strong relationship between the incentives dimension of high performance workplace systems (HPWS) (performance evaluation, feedback, and recognition) and branch performance. In Laursen and Floss’s (2003) study of 1900 Danish firms, innovation was linked with seven out of nine HR practices. However, as successful innovators in manufacturing took a different approach from successful information and communication technology (ICT) innovators to training, sector differences were suggested. In a study of 50 business units of a large U.S./Canada food service company, Wright et al. (2003) found a link between HR practices and organizational commitment, the latter being partly linked to business unit performance. However, Purcell et al. (2003) cautioned that it is not always certain how different HR practices lead to particular outcomes.

One of the problems of managing safety in organizations has been a tendency to see OHS as separate and isolated from other management activities. Many organizations, particularly small and medium sized enterprises (SMEs), see OHS as an inconvenience at best and as driven by regulatory and legislative compliance. The SMS may be developed due to legislative requirements, but exists as a bolt-on, rather than being integrated within the wider management system. A more sophisticated approach is to recognize the connections between OHS and other aspects of business performance. If a long-term, more strategic view is taken, it can be seen that safety and productivity (or profitability) are compatible objectives, where high performance strategies deliver not only higher productivity outcomes
Summary Text 10.6 Implementing Safety Audits — Some Practical Considerations

For safety and risk professionals, safety auditing could be viewed as a means to achieving the following:

- Compiling a priority list of items requiring attention — a practical and important function.
- Getting line management to think about health and safety issues — relates to the awareness generating function of the safety audit.
- Getting line management to own their health and safety responsibilities — takes the mission a stage further by helping to locate responsibility where it belongs, hopefully leaving the safety and risk professional in an advisory role.

In this latter task, it is important to provide practicable guidance to line managers. Kase and Wiese (1990) highlighted the following items as being required by a safety audit:

- Present both positive and negative findings
- Cite sources of all requirements and indicate current deficits
- Don’t hand over problems for which solutions do not exist
- Always offer solutions, recommendations, or corrective actions
- Where options exist, appeal to a manager’s expertise to derive the optimum corrective action
- Give enough time for evaluation and decision making
- Follow up

For line managers, the following factors described are likely to be among those that will persuade them of the value of safety auditing:

- It allows them to audit themselves rather than to have an audit imposed on them from outside — assuming that a self-regulation route is to be followed.
- It provides for a quantitative assessment of their health and safety performance, thereby allowing them to decide how to prioritize items as a prelude to devising and implementing solutions. While quantification is not essential for assessing risks and in many cases risk assessments and decisions about priorities can be made by informed judgment, a quantified measure is still useful for longer-term monitoring of progress.
- On the first occasion, the results of the safety audit can be confidential to the manager so that he/she has an opportunity to improve health and safety in his or her own area of responsibility.

These benefits have an important common factor: they all increase the degree of control that a manager can exert in respect of health and safety in his or her area of responsibility. Participating in the control process is much more likely to be motivating than having a solution imposed exclusively from without and thus these factors are of crucial importance.
A very important group in any organization is the executive directorate. Arguments that could be used to persuade directors of the benefits of safety auditing include the following:

- Safety auditing offers a way for top management to meet their health and safety responsibilities — for example, by ensuring that all relevant legal and company policy requirements are covered by the audit.
- A way of improving health and safety on plant and premises — auditing can provide an overview of the state of health and safety across the organization as a basis for strategic decision making.
- A way of identifying potential losses — for example, by revealing where costs may be unnecessarily high.
- To highlight deficiencies — for example, in emergency procedures or where audit scores are low.
- As a cost-effective tool — being systematic and thorough can help to make a strong case for auditing.

but also improved safety. One means of integrating OHS into mainstream management is to consider managing safety risks through an HRM perspective. Guest (1987) described HRM as constituting the range of policies that have strategic significance in an organization. It involves a number of areas, including organizational behavior and organizational psychology as well as personnel management and industrial relations. In essence, HRM is a business-oriented approach to managing people, on a par with other resource functions. It can be considered as a systematic, integrated approach, incorporating a set of tools to achieve strategic objectives.

The four basic principles of HRM described below are all consistent with a strategic approach to risk management:

1. Human resource management is strategy driven. It follows from addressing such basic strategic questions as: what business are we in; what do we want to do; what needs to be done and by whom; and what human resources do we need to do it? Strategic HRM is proactive and oriented toward meeting business objectives, such as growth and profitability.
2. Workers (and sometimes customers and suppliers as well) are a strategic resource to achieve competitive advantage — in public sector organizations, this might be excellence, quality, and delivery. Human resources are seen as the single most important agents of the organization, which views them as an investment not as a cost. Thus, management’s objective is to direct human resources to business needs so as to make the best of them, hence concern with performance and its measurement. There is a strong imperative to manage human resources as a business contribution; thus, low labor turnover may be one objective.
3. Human resource management is a line management responsibility, being part of production and other management functions. While personnel policies are a major contributor to corporate objectives, in HRM they are not a specialist function. Thus, different skills are required from those demanded of the traditional industrial relations function — for example, development of commitment as opposed to confrontational tactics. Management’s aim is to foster allegiance to the organization, for example as opposed to a trade union.
4. Human resource management is concerned with integration and control, through which management seek a common purpose or unitary perspective — as opposed to a pluralist view in which different parties hold views that reflect their own positions. Concordance between individual needs and organizational objectives is sought. Workers’ skills and ideas are used as appropriate rather than managerial prerogative being imposed. Positive-sum solutions (in which all parties can gain) rather than zero-sum outcomes (where one party’s gain is another’s loss) to problems are demanded. Management aim to shape corporate culture as a major influence upon excellence, for example, through promoting shared values, an open organizational climate, and appropriate management style. Monitoring of performance and accountability of line management are important in the control function.

A wide range of topics has been subsumed under the HRM banner, including: training and development (e.g., developing competencies through job analysis, task analysis, training needs analysis, and skills audits); motivation, rewards, and performance appraisal; involvement and participation; and, human resource planning (e.g., defining requirements, greater flexibility and analysis techniques such as brainstorming, force field analysis, and organizational climate analysis). All these features figure to some extent in this book, although not all of them have chapters or sections devoted to them. They are reflected more in a general awareness of the significance of changes that have taken place under the HRM banner. The health, safety, and welfare function of HRM is still one that receives considerably less attention than do other aspects highlighted above. Yet, as reviewed in the following sections, there is much scope for including safety and risk matters within an HRM framework. For more detailed discussions of HRM see, for example, Beardwell et al. (2005).

10.3 HR practices associated with occupational health and safety

Despite early safety research emphasizing the importance of technical failures and human error, a number of empirical studies identified organizational and managerial factors that were associated with safe organizations (Keenan et al., 1951; Cohen et al., 1975; Cohen, 1977; Smith et al., 1978). These studies identified the following factors as important:

- Top management personally involved on a routine basis
- Safety is integral and given high priority in meetings
- High status of safety officers
- Emphasis on safety training
- Open communication links between workers and managers
- Environmental control and good housekeeping
- Stable workforce (good industrial relations and personnel procedures)

Reason (1993, 1995) identified eleven categories of organizational failure, including communication failures and inadequate training (see Chapter 4). Although Reason’s organizational factors are based on case study analysis, there is substantial support for these factors in empirical research. In a review of ten studies, Shannon et al. (1997) found that certain organizational factors were consistently related to lower injury rates, based within six categories; those within the ‘Management style and culture’ and ‘Organizational philosophy on occupational health and safety (OHS)’ were most common (see Summary Text 10.7). These factors highlight the importance of safety training and safety audits, alongside management commitment to safety. The authors noted that the majority of significant factors
Summary Text 10.7 Organizational Factors Associated with Low Injury Rates

Management style and culture

- Workforce empowerment
- Encouraged long-term workforce commitment
- Good relations between management and workers

Organizational philosophy on OHS

- Delegate safety activities
- Active role of top management
- Safety audits conducted
- Evaluation of occupational safety hazards
- Unsafe worker behaviors monitored
- Duration of safety training of workers
- Safety training on a regular basis
- Employee health screening


seem to reflect “a genuine concern by management for its workforce,” and that it would be, “unlikely that this can be acquired simply by ‘tinkering’ with policies and practices” (p. 215). Other significant factors included low turnover, seniority of the workforce, good housekeeping, and safety controls on machinery.

Vredenburgh (2002) examined six management practices (management commitment, rewards, communication and feedback, selection, training, and participation) as injury rate predictors. Overall, these management practices significantly predicted hospital injury rates, accounting for approximately 17% of the variation in injuries, with hiring practices the only significant single predictor. However, factor analysis revealed that the items measuring the six management practices did not correspond as the author intended, instead six factor scales were produced; two of these — reactive practices and proactive practices, were significant predictors of injuries. Selection and training was a significant predictor, whilst ‘analysis of near-misses, enforcement of safety procedures’ acted as a suppressor. This suggests that hospitals with low injury rates perform both proactive and reactive management practices, whilst those with high injury rates primarily adopt reactive responses. The author suggested that front-end hiring and training of workers is most effective in reducing injuries — for example, interviewers could use behaviorally based interview techniques to assess potential workers’ safety record.

Mearns et al. (2003) looked at safety management practices — policies for health and safety, organizing for health and safety, management commitment, involvement, health promotion and surveillance, health and safety auditing, and their association with lower injury rates. The three general areas they identified are as follows:

1. Genuine and consistent management commitment to safety — prioritization of safety over production, maintaining a high profile for safety in meetings, personal attendance of managers at safety meetings and in walk-abouts, face-to-face meetings
with workers that feature safety as a topic, and job descriptions that include safety contracts.

2. Communications about safety issues — pervasive channels of formal and informal communication and regular communication between management, supervisors, and workforce.

3. Worker involvement — empowerment, delegation of responsibility for safety, and encouraging commitment to the organization.

The authors found that all safety management practices were associated with lower proportions of individuals reporting injuries and with lower official injury reports. The results also highlighted a relationship between health promotion and lower injury rate (a finding supported by Shannon et al., 1997), indicating that health-related interventions can have a more wide-ranging effect than intended — in this case including injury reduction. Such an effect may be mediated by safety climate improvements (see Chapter 6 and Chapter 11) or through enhanced well-being and general health, leading to greater resistance to stress outcomes, including injuries (see Chapter 7). These studies indicate not only the importance of reactive monitoring of organizational safety by senior managers, but also proactive measures to ensure safety, such as safety training, selective hiring, communication, and worker participation. Vredenburgh (2002) suggested that combining these two approaches to organizational safety is related to lower injury rates. Management practices related to the factors identified by Mearns et al. (2003), such as senior managers attending safety meetings, safety training, and workforce empowerment, were consistently associated with lower injury rates. The importance of managers being seen by their subordinates to display visible commitment to safety was emphasized in the discussion of safety climate in Chapter 6. Many of the practices that embody such commitment are characteristic of a transformational leadership style (see Chapter 9).

There has been a growing emphasis within HRM on high-commitment (Walton, 1985) or high-involvement (Lawler, 1996) management strategies, such as empowerment and worker participation. Using these high-involvement human resource practices has been described as constituting a high performance work system: a single system of work that comprises multiple, mutually reinforcing HR practices (Becker & Huselid, 1998). These HR practices operate through recruitment, selection, development, motivation, and retention of workers who possess a wide range of superior skills, to create a sustainable competitive advantage for the employer (Way, 2002). Pfeffer (1998) identified seven HR practices that form part of a high performance workplace system (HPWS): employment security; selective hiring; extensive training; teams and decentralized decision making; reduced status distinctions; information sharing; and, contingent compensation. Zacharatos et al. (2005) employed measures of these seven HR practices, plus three additional ones drawn from the safety literature: transformational leadership, high quality work, and measurement of variables critical to organizational success, to comprise a HPWS. At an organizational level, the HPWS was found to account for 8% of the variance in lost-time injuries in a sample of 138 manufacturing organizations in Ontario. At an individual level, effects of two mediators were tested: perceived safety climate and trust in management in a separate sample of 189 male workers from two Canadian companies in the petroleum and telecommunications industries. This study demonstrated significant mediation models: perceived safety climate mediated the relationships between HPWS and both personal-safety orientation (comprising measures of safety compliance, safety initiative, and safety knowledge) and safety incidents (self-reported injuries and near-misses); trust in management mediated the effect of HPWS on safety incidents only. The authors suggested that trust in management fails to mediate the effects of HPWS on personal-safety orientation as this factor is context-free, unlike safety climate, which is context-specific. This study also demonstrated
that management strategies that have been shown to have a significant effect on organizational performance (Way, 2002; Patterson et al., 2004) could also have substantial effects on occupational safety.

From reviewing relevant empirical studies on safety management practices, a number of common themes can be identified that summarize factors associated with lowered injury rates (see Summary Text 10.8). Many of these are associated with HP practices identified as part of a HPWS, including: employment security (stable workforce); extensive training (emphasis on safety training); decentralized decision making (empowerment and delegation of safety responsibilities); sharing information (emphasis on communication between managers and workers); and measurement of variables critical to organizational success (safety audits conducted, evaluation of occupational safety hazards, unsafe worker behaviors monitored, and analysis of near-misses). The major category that does not correlate directly with the HPWS is demonstration of senior management commitment to safety.

Of the ten HR practices that lead to enhanced occupational safety (Zacharatos & Barling, 2004; Zacharatos et al., 2005), a number of these have been discussed elsewhere in this book (as indicated below) or form part of this chapter.

- Employment security — effects of job insecurity are discussed as a source of stress in Chapter 7, and in more detail in relation to safety in this chapter.
- Selective hiring — there is little empirical evidence regarding effects of selective hiring, although personality testing is discussed in Chapter 5 and is discussed in the current chapter.
- Extensive training — training has been highlighted in numerous studies as important for ensuring safety and this chapter considers safety training in further detail.
- Self-managed teams and decentralized decision making — autonomous or self-managed teams are considered in Chapter 8, whilst substitutes for leadership and empowerment are discussed in Chapter 9.
- Reduced status distinctions — the role of hierarchical differences is discussed in relation to miscommunication in Chapter 8 and also in this chapter under the communication and information sharing heading.
- Sharing information — considered throughout this book in relation to communication, including Chapter 8 on teams, as well as in Section 10.3.3 in this chapter.
- Compensation contingent on safe performance — discussed in this chapter in relation to reward systems.
- Transformational leadership — considered in some detail in Chapter 9.
- High quality work — see Chapter 7 in relation to stress; the role of autonomy and control is also considered in terms of autonomous team working in Chapter 8; factors influencing work quality may have direct effects on safety, as well as being mediated by stress (see Chapter 11).
- Measurement of variables critical to organizational success — collecting proactive data, not just reactive measures such as injuries, is considered as part of the risk management approach presented in this chapter.

As noted earlier, one factor that could be added to this list is senior management commitment to safety; whilst not an aspect of HRM per se, overt managerial actions, which are perceived by the workforce to reflect management commitment to safety, can be demonstrated through practices such as, attending safety meetings, management by walking about, face-to-face meetings with workers that feature safety as a topic, and job descriptions that include safety contracts. Another consideration is an integrated approach to interventions, which are often operated in a rather piecemeal fashion, despite evidence that
initiatives, such as health promotions and stress interventions, can have positive effects on safety outcomes (see Chapter 7).

10.3.1 Employment security

The modern world of business has seen a significant decline in employment security, both across Europe (International Survey Research, 1995) and North America (McDonough, 2000). As reviewed in Chapter 7, perceptions of job insecurity have been associated with higher levels of stress (Sparks et al., 2001) and with falling levels of worker health and well-being (Borg et al., 2000; Domenighetti et al., 2000). In addition, a lack of employment security

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**Summary Text 10.8 HR Practices Associated with Reduced Injury Rates**

| Senior management commitment to safety | • Top management personally involved on a routine basis; safety is integral and given high priority in meetings |
| • Active role of top management |
| • Prioritization of safety over production; maintaining a high profile for safety in meetings; personal attendance of managers at safety meetings and in walkabouts; face-to-face meetings with employees that feature safety as a topic |
| • Job descriptions that include safety contracts |

| Worker–management communication | • Open communication links between workers and managers |
| • Pervasive formal and informal channels to facilitate regular communication between management, supervisors, and workforce |
| **Employee relations** | • Stable workforce (good industrial relations and personnel procedures) |
| • Good relations between management and workers |

| Workforce involvement in safety | • Empowerment, delegation of responsibility for safety and encouraging commitment to the organization |
| • Workforce empowerment; long-term commitment of workforce encouraged; delegation of safety activities |

| Safety training | • Emphasis on safety training |
| • Duration of safety training of workers; safety training on a regular basis |
| • Selection and training |
| **Safety data** | • Safety audits conducted; evaluation of occupational safety hazards; unsafe worker behaviors monitored |
| • Analysis of near-hits; enforcement of safety procedures |
| **Others** | • Environmental control and good housekeeping |
| • High status of safety officers; employee health screening |
Chapter ten: Managing human risks

is associated with lower organizational commitment (Ashford et al., 1989; Davy et al., 1991), in line with including employment security as a characteristic of HPWS. Perceptions of job security have an indirect effect on safety motivation — via the impact that a lack of job security has in terms of increasing job dissatisfaction (Probst & Brubaker, 2001). Thus, as workers perceive that their jobs are under threat they become increasingly disillusioned and demotivated and the influence on safety motivation has direct effects on both safety compliance and workplace injuries. Probst (2004a) found that workers who felt that their jobs were under threat displayed higher levels of productivity, whilst also violating safety policies to a greater extent. It appears, therefore, that in these circumstances workers choose to trade-off safety compliance for increased quantity of production — although production quality also declines.

This evidence is consistent with earlier work that emphasized the importance of a stable workforce and good worker relations (Keenan et al., 1951; Cohen et al., 1975; Cohen, 1977; Smith et al., 1978). However, much of this evidence derives from a time when organizations tended to have a large core staff of permanent workers; in a contemporary business context, it is difficult for organizations to continue to offer the same certainty of long-term employment. Indeed many organizations have downsized to reduce their permanent staff in favor of increased subcontracting of peripheral activities and regular use of temporary agency staff, in order to become more flexible and responsive in a rapidly changing market (Guest et al., 1996). Increasing numbers of workers are employed in nontraditional work arrangements, particularly on short-term, temporary, or fixed-term contracts, as contingent workers (Sparrow & Marchington, 1998). McLean Parks et al. (1998) defined a contingent worker as one who, “does not have either an implicit or explicit understanding that employment will be continuous or ongoing, assuming satisfactory performance by both the individual and the organization” (p. 701). There are implications for safety, as the temporary nature of contingent work, with little organizational tenure and limited opportunities to develop relationships based on trust (Beard & Edwards, 1995), does not provide a basis for the employment security that characterizes HPWS.

Nontraditional workers, including contract and contingent workers tend to be overrepresented in injury statistics. As contract workers tend to be younger, less experienced, and subject to lower levels of safety training, compared with core workers, they are at increased injury risk through unfamiliarity with the workplace and with the host organization’s practices and procedures (Rousseau & Libuser, 1997). Contract workers also differ in their safety attitudes; for example, contractors working on offshore oil platforms in the North Sea were found to feel less safe in terms of occupational hazards (Mearns et al., 1998), but to have a greater appreciation of their personal involvement in safety (Alexander et al., 1994) compared with permanent operators. This is also reflected in research conducted in the U.S. petrochemical industry where contract workers, and those with low job control, were found to be more worried about chemical exposures and explosions than were direct-hire workers (Baugher & Roberts, 1999). Similarly, contingent workers tend to hold more negative safety attitudes and engage in fewer organizational citizenship behaviors (Kidder, 1999) compared with permanently employed coworkers. Geller et al. (1996) found that the propensity to actively care about safety was significantly predicted by a number of variables, including personal control and group cohesion: workers who felt more empowered and had a greater sense of belonging within the group were more likely to engage in safety behaviors. Feelings of empowerment and personal control are unlikely to be associated with contingent employment, where workers typically have little control over many aspects of their work (Beard & Edwards, 1995).

To some extent, whilst employment security is related to HPWS and occupational safety, it may not be a long-term solution to managing injury risk. Given the changing nature of modern workforces, in which nontraditional workers are typically represented,
it is not possible to reinstate the promise of long-term employment prospects. Rather, other ways of managing risk must be identified. Downey (1995) suggested that injury risk for contract workers can be reduced by: ensuring that these workers attend the same orientation programs on hazards, safety training, and procedures (if not, the contractor’s safety system should be monitored); reviewing all safety rules; and ensuring that all injuries are investigated. As contract workers often undertake the most dangerous activities in an organization, they may require more intensive safety training than other staff. However, Rebitzer (1995) noted that organizations could be discouraged from taking direct control over contract staff as this increases their liability for injury costs. Probst (2004b) found that organizational safety climate significantly moderated the relationship between job insecurity and safety outcomes; when workers perceived safety climate to be weak, job insecurity was related to lower levels of safety knowledge and safety compliance and to higher numbers of injuries and near-misses, but the effects were significantly attenuated when safety climate was perceived to be strong. Thus, maintaining a strong safety climate can reduce or eliminate negative effects of job insecurity on safety outcomes.

Clarke (2003) warned that restructuring workforces may threaten the integrity of the underlying safety culture by eroding trust between core workers and managers; safety subcultures, which support a work group’s shared safety attitudes and behavioral norms, were identified as particularly under threat. The temporary position of contingent workers can result in stereotyping by permanent coworkers and assignment to different tasks, even though they are doing the same job, because they are not expected to remain with the company in the long term (Pearce, 1998). Contingent workers may impede team working, where contingent and employed workers collaborate on a project, because contingent workers respond more negatively to organizational change due to vulnerability and because they may not see the long-term benefits. Rousseau and Libuser (1997) argued that a mix of contingent and permanently employed workers impairs communication between workers and management (especially where temporary workers have been used to avoid industrial relations difficulties) and leads to perceived inequity between the two groups, resulting in poor communication, lack of cooperation, and even negligence, thereby increasing injury risk. Therefore, at team level, the presence of contingent workers could affect trust in management and impair morale within work groups. This is not necessarily because noncore workers have less positive safety attitudes or are less concerned with safety, but because there are barriers preventing integration of contingent and contract workers into work groups. Clarke (2003) advocated using team-based approaches to safety training, which could help to improve implicit coordination among team members (Cannon Bowers et al., 1998). However, consideration must be given to reducing status distinctions among workers, as team-based training may act to reinforce, rather than to break down, cultural barriers within mixed teams (Harvey et al., 2001).

In conclusion, long-term employment security may no longer be relied upon to ensure OHS, so that greater attention should be given to managing relationships within work groups, intensive safety training, and improving communication. Protecting an organization’s underlying safety culture and maintaining a strong safety climate may help to mitigate negative effects of job insecurity on safety outcomes (Probst, 2004b).

### 10.3.2 Selective hiring

Little systematic research is available to evaluate the effects of selective hiring on safety performance. However, there is considerable scope for including safety criteria in recruitment and selection procedures. The area that has seen most activity is personality testing (see Chapter 5). Where researchers and practitioners have attempted to develop selective hiring
procedures based on safety considerations, these have taken the form of personality tests. For example, a safety locus of control questionnaire was developed by Jones and Wuebker (1988) for use as a selection tool and Hogan (2005) reported on the successful use of the Hogan Personality Inventory (HPI), which measures dimensions similar to the big five, for making selection decisions related to safety outcomes. Although ethical questions have been raised (Zacharatos & Barling, 2004), there is growing evidence that personality may be a reliable predictor of job performance, with at least a moderate level of criterion-related validity (Ones et al., 1993; Frei & McDaniel, 1997; Salgado, 1998; Hermelin & Robertson, 2001).

There are further possibilities for selective hiring, other than personality tests, with safety criteria being included within a range of recruitment and selection procedures, including application forms, references, interviews, and assessment centers, outlined as follows:

- Application form — include questions on safety record and injury involvement.
- References — ask referees to comment from their knowledge of an applicant’s safety motivation or compliance.
- Interviews — behavioral or situational questions asking a candidate, for example, to discuss how he/she would deal with an emergency situation, either drawing on past experience or thinking through a hypothetical situation.
- Assessment centers — could include role-plays, small group discussions, case studies, and in-tray exercises and simulations that focus on candidates’ ability to cope with a safety critical situation, which could be particularly useful for managerial positions.

Using a combination of selection techniques may be the most advantageous; evidence suggests that personality tests have incremental validity and so may be usefully combined with other methods, such as assessment centers (Goffin et al., 1996). However, use of safety criteria could be problematic in situations where there are few applicants for a job or a candidate pool is small. For example, because there is a shortage of suitably qualified drivers of heavy goods vehicles in the United Kingdom, whereas employers once asked for a clean license as a job requirement, many now accept up to nine penalty points (the maximum penalty points to retain a license is twelve). A further difficulty is posed by employing nontraditional workers, as discussed in the previous section, as employers may hire few permanent workers, but depend on an increasingly contingent workforce, hired indirectly — for example, through temporary employment agencies. Employers may have little control over an agency’s hiring practices.

10.3.3 Communication and information sharing

The importance of effective communication throughout an organization has been noted repeatedly; for example, a number of high-profile disaster inquiries have noted communication failures as a contributory factor (Reason, 1990). An effective safety information system is crucial to adequate dissemination of top-down communications (e.g., safety instructions, policies, and procedures), but also for bottom-up communications (e.g., feedback from workers to the organization). In addition, positive communication between managers and workers may help to ease worker relations, which has been identified as an important HRM issue in relation to safety (see Summary Text 10.8).

Zacharatos and Barling (2004) argued that reduced status distinctions operate through encouraging communication, sharing ideas, and promoting greater concern and trust among workers. Clarke (1999) noted how misperceptions regarding safety priorities can
exist between levels and may act as a source of miscommunication. Deleterious effects of hierarchical systems that can serve to reinforce status distinctions were illustrated in the examples of miscommunication in air crashes and medical errors discussed in Chapter 8 (see Summary Text 4.4 and Summary Text 8.10). These examples highlight the case for reducing status distinctions to aid communications between hierarchical levels, and support inclusion of reduced status distinctions as an aspect of HPWS. However, not all hierarchical systems, with their strict status demarcations, are characterized by such failures. Many high-reliability organizations (those operating in intrinsically hazardous conditions, but with a very low failure rate) are military, such as aircraft carriers (Rochlin et al., 1985; Roberts et al., 1994) and nuclear submarines (Bierly & Spender, 1995). This seeming paradox reflects the different modes of operation that a high-reliability organization (HRO) can engage in: a normal mode of operation, which is characterized by hierarchical chains of command and control, with strict status distinctions between ranks, and emergency mode, where hierarchical levels dissolve in favor of expertise. The nature of HROs is discussed further in Chapter 11. In addition to hierarchical status distinctions, it is important to reduce status distinctions between different types of workers, such as core and contingent workers, to maintain positive safety subcultures within work groups (see earlier section on employment security, Section 10.3.1).

10.3.4 Reward systems for safety

Reward systems in organizations are at the disposal of managers in order to attract, retain, and motivate people in desired directions. Making compensation contingent on safe performance should act to reinforce safe behaviors. However, as noted in Chapter 3, in relation to learning and behavior modification, it is important that it is the behavior that is reinforced (safe behavior) and not the desired outcome (e.g., lower injury rates), in order to avoid the underreporting of injuries. Rewards can be divided into extrinsic (e.g., money and other material benefits, which originate from sources external to the individual) and intrinsic components (e.g., feelings of achievement, responsibility, or personal growth). Most reward systems are based on providing extrinsic rewards, for example, compensation packages to influence subordinates to improve performance. Though less visible, intrinsic rewards may also be used; for example, jobs may be redesigned to provide greater autonomy and control, creating opportunities for enjoying intrinsic rewards. Reward systems need to indicate the type of behavior or performance to be encouraged, such as effective contributions, attendance, loyalty, conformity, reporting injuries, incidents and near-misses, or making safety suggestions. In addition to their objective significance, rewards also convey meaning in terms of their symbolic value — for example, in an organization that rewards safe behavior, these rewards represent a senior management that is committed to ensuring safety. The symbolic value of reward systems is particularly important in relation to safety as this could shape workers’ perceptions of safety climate (see Chapter 6). For this reason, questions relating to rewards for safe performance feature occasionally on safety climate surveys.

Means of determining rewards have traditionally taken the form of collective bargaining (e.g., negotiations between unions and management) or through job evaluation. However, more recently, there has been a tendency to move toward more individual-based systems (e.g., performance-related pay). Another example is the national Australian Workplace Agreements (AWAs) introduced by the Australian government as a way of side stepping established collective bargaining processes. One of the features of common direct compensation packages, which are often based on payment by results (PBR), is the focus on quantity over quality, which could conflict with achieving safety-related outcomes. Performance-related pay (PRP) takes a broader perspective by rewarding actual worker
behavior rather than results or outcomes alone. Other forms of compensation package are long-term, such as stock ownership or profit-sharing, which may encourage commitment to the organization over a longer time-frame. There has been some debate regarding the targeting of PRP schemes, as individual-based schemes can create resentment amongst workers; whereas group-based schemes may have a larger effect, due to the greater sense of cooperation rather than competition among workers — for example, sharing information with other team members, training new colleagues, helping to resolve group conflict, and encouraging development of skills that are useful to the group (Halligan, 1997).

10.3.5 Safety training

There is substantial evidence to suggest the importance of training for ensuring OHS (as reviewed in previous sections). However, training program adequacy, use of refresher training, and ways in which training is employed as a risk control measure are significant issues in its success. As a technique for developing human resources, training is concerned with improving worker skills and enhancing their capacity to cope with ever-changing workplace demands. Worker training can be defined as the systematic acquisition of skills, rules, concepts, or attitudes that result in improved performance on the job (Goldstein, 1986). It ranges from very specific skills training, such as showing a worker how to operate a fork-lift truck, to more abstract development, such as training managers to adopt a more transformational leadership style. In designing a safety training program, it is important that it incorporates objectives set for both individuals and the organization, and that it follows a logical sequence. Various techniques may be used to establish priorities for training, such as a skills audit, which determines what skills the organization currently has, or task analysis, where a detailed view of the operation of a task is obtained (see Chapter 4). In addition, one would expect some reference to standards of performance and the conditions under which behavior takes place. Safety training may focus upon developing safety knowledge, skills, and values; recognition and awareness of hazards; problem-solving skills; and decision-making skills (Burke & Sarpy, 2003). The choice of training methodology and technique should be informed by the nature of the training objectives and outcomes, as well as the skills to be developed.

10.3.5.1 The learning process

A number of factors can influence the acquisition of skills to perform effectively, including knowledge of results or feedback and motivation. As noted in Chapter 3, feedback is important to the learning process. To learn effectively, trainees need to be able to measure their own progress over time. They may also seek to compare their progress with that of their peers. Sessions that incorporate a test or exam on which trainees receive feedback are an example of how this learning principle can be put into practice. Trainees can adjust their subsequent practice toward a goal of performance optimization. A related learning principle for use in training is that of positive reinforcement, provided as some form of reward. Rewards for performance during training sessions, used in combination with feedback, which also constitutes reinforcement, contribute to motivational effects (see Chapter 3). Rewards may take the form of verbal encouragement from a trainer or the satisfaction of passing a test or exam and receiving a certificate. Rewards are also necessary during training to sustain interest and motivation, which is another significant issue (also discussed in Chapter 3). Trainees need to be motivated in order to learn. Motivation may be intrinsic, that is, be generated internally by a trainee’s desire to learn, or extrinsic, derived from the training environment, for example, a trainer’s enthusiasm. Training can of itself provide motivation, for example, by demonstrating that an organization is interested in developing an individual’s skills...
and knowledge (extrinsic), or because the trainee finds the subject matter and its application fascinating (intrinsic). Summary Text 10.9 summarizes key competencies required by trainers.

A traditional debate within training is whether trainees should practice a task in separate parts and then link them together or practice the whole sequence from the start. The part method of training, where a task is broken down into sections, is most suitable where the task lends itself to chunking (e.g., when some task elements are more difficult than others and require greater time investment for practicing them) — for example, activities such as typing, swimming, or acting, can be successfully mastered using this approach. It has beneficial motivational effects as a learner can reach learning objectives more quickly, but also has the disadvantage that ultimately the parts must be linked together to form the whole. The whole method of training, where the total task is practiced continuously until it is mastered, is most appropriate for tasks where integration and rhythm are critical features of the skill; for example, driving a car. Evidence tends to support the whole task option on the grounds that if the complete sequence is learned from the start then each step is more likely to remain embedded within it. If trainees learn parts of a task separately, then they have an additional series of tasks in linking the parts together and are more likely to omit steps in the sequence at a later date. This may be particularly important in times of stress, when errors are more likely, for example, in a control room emergency. Under such

**Summary Text 10.9  Key Competencies Required by Trainers/Agencies**

1. Identify needs, customers, and markets, involving ability to undertake the tasks listed below:
   - Needs analysis for clients
   - Needs analysis on basis of business/organizational profiles
   - Segment consumer markets
   - Market programs effectively
   - Time and locate programs effectively
   - Understand business/organization development processes

2. Develop appropriate programs, involving ability to apply the competencies listed below:
   - Develop range of program typologies
   - Use relevant environment
   - Use existing materials and guides
   - Produce own material as required
   - Lay out attractive program material

3. Deliver programs effectively, involving ability to display the skills listed below:
   - Adopt flexible teaching styles
   - Deliver enterprise skills training
   - Train in an enterprising fashion
   - Teach in a multidisciplinary fashion
   - Counsel groups and individuals
   - Use invited speakers

4. Evaluate and control, involving ability to conduct the activities listed below:
   - Assess, monitor, and evaluate programs
conditions, operators are less likely to omit crucial stages in a sequence of actions if they have been taught the sequence as a whole.

A further issue is whether learning should be massed — where learning is concentrated into a short space of time, like cramming for an examination, or distributed into short, but frequent sessions. Massed learning is most suited to problem-solving exercises where it is important to persevere with the task until a solution is found. Although this method can lead to boredom and fatigue, this can be combated with appropriate rest pauses. Pacing can be more suitable, however, where the material to be learned increases in quantity and difficulty. Parkinson et al. (1989) found that attendance at multiple training courses on workplace hazard recognition resulted in increased knowledge of risks and self-reported use of precautions. Use of frequent short training sessions at the beginning of a workshift has also been found to successfully improve recognition of hazardous situations and compliance with safety procedures (Robins et al., 1990).

10.3.5.2 Types of safety training
A variety of techniques, methods, and procedures is available for training programs, including: lectures, films and videos, computer-assisted instruction, case studies, conferences, simulation (hands-on exercises), behavior modeling (demonstration), virtual reality and e-learning, and coaching and mentoring. The last few years have seen a marked increase in the use of e-learning (Chartered Institute of Personnel and Development, 2003). This includes a wide variety of approaches, such as CD-ROM, the Internet, and corporate intranets. Online training programs allow trainees to work either alone at their own pace, or with other trainees in a network facilitated by a tutor. Poor computer literacy and inadequate access to computer equipment have proven to be the main barriers to the use of e-learning by organizations (Slowman & Rolf, 2003).

To some extent the type of training will determine the most appropriate methodology; for example, whilst lectures may be effective in presenting factual safety information, multiple methods including hands-on practice may be most appropriate for more advanced safety training, such as developing problem-solving or analytical skills. Evidence generally supports using more active modes of training, such as interactive and hands-on techniques (e.g., role play), rather than passive learning (e.g., lectures and video presentations) (Cohen & Colligan, 1998). Where active techniques, such as role-play, provide a good representation of reality and there is an acceptable level of motivation, evidence suggests that trainees are able to successfully transfer their learning to the workplace (Saal & Knight, 1995). Dale and Nyland (1985) proposed a cone of learning (see Summary Text 10.10), which matches the degree of involvement that a trainee has with the extent to which material is remembered. For learning tasks involving bodily movements, active trainee participation may take the form of practicing a simple task or series of actions at one end of the spectrum, to highly complex and lengthy experience in a simulator, for example, pilot training. Those being trained for jobs with a high thinking component also benefit from active learning involvement. For example, management trainees in assessment or development centers, which incorporate group discussions, interview practice, and in-tray exercises, can derive great benefit from such events, providing that adequate feedback is given in the form of debriefing. A maxim of the theatrical profession is that you should always rehearse even the most apparently simple of actions on stage on the grounds that these can always encounter snags when carried out in practice (and often do). The same applies to training and particularly so for tasks with safety implications. It is never likely to be sufficient to be told what one should do, it is necessary to actually do it. Rehearsed action sequences provide a much firmer basis for subsequent behavior than merely listening to a lecture or watching a film. Once learned in such a way, subsequent mental rehearsal, that is,
Summary Text 10.10 The Cone of Learning

<table>
<thead>
<tr>
<th>Involvement level</th>
<th>% likely to be remembered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active, doing — for example, performing a job or task, simulating a real experience, doing a dramatic presentation</td>
<td>90</td>
</tr>
<tr>
<td>Active, receiving and participating — for example, taking part in a discussion, giving a talk</td>
<td>70</td>
</tr>
<tr>
<td>Passive, visual receiving — for example, seeing something being done, watching a demonstration, looking at an exhibit, watching a film</td>
<td>50</td>
</tr>
<tr>
<td>Passive — looking at pictures</td>
<td>30</td>
</tr>
<tr>
<td>Passive — hearing words</td>
<td>20</td>
</tr>
<tr>
<td>Passive — reading</td>
<td>10</td>
</tr>
</tbody>
</table>


Other learning principles will be involved when there is a requirement for training in problem-solving activity for novel situations. Many training programs involve participation and use of multiple methods (Brown & Nguyen-Scott, 1992; Lippin et al., 2000). In such instances, trainees may be encouraged to brainstorm possible solutions to a problem or to consult with others in seeking a solution. An important feature of problem solving may be to have available ways of breaking the mental set of an individual or group, who may otherwise be inclined to reuse a previously successful strategy, even when it is inappropriate. This approach is analogous to lateral thinking (De Bono, 1976) in which people are encouraged to create fresh approaches to a problem. One antidote is to institute practices that are designed to promote a heterogeneity of inputs, that is, from people with different skills, outlooks, and backgrounds and to avoid the classic groupthink phenomenon in which everyone in a group thinks along similar (and perhaps incorrect) lines (see Chapter 8). In the case of complex tasks (such as control room operation, work with detailed electrical or mechanical operations, or piloting a ship or aeroplane), another vital aspect of training is to ensure that trainees have a good understanding of the system and how its components interlink. Take the example of driving a car. For most of us there is little need to understand much about the workings of the car we drive, apart from basic maintenance requirements. However, Formula One drivers need expert knowledge of the workings of their cars in order to maximize driver–car performance within safe limits and to make appropriate adjustments in the event of failures in system components or changes in track conditions. There are numerous examples of failures that contributed to incidents or disasters, in which key operators did not have an adequate or accurate representation (or mental model) of the system that they were in charge of, for example Three Mile Island (Kemeny, 1979), *The Herald of Free Enterprise* (GB: Department of Transport, 1987; Summary Text 4.5), and the Kegworth air crash (GB: Department of Transport, 1990; Summary Text 4.4).

There will be circumstances in which humans have been included in a system to sort out routine or unusual problems. In these cases, training should seek to alert trainees to be aware that situations may occur that have not been foreseen, and therefore require a problem-solving approach, that is, thinking at the knowledge-based level, rather than...
referring to rules and procedures that may be inappropriate. This presents a stern challenge for safety training because it involves training for situations that cannot be predicted and which is therefore impossible to simulate or even to describe. Case studies, including examples of disasters from other industries, can be valuable as part of a problem-solving approach to complex safety issues. This is to enable participants to be directed toward analyzing situations, for example, from a risk management perspective, to imagine scenarios under which similar circumstances could befall their own organization and whether it would be adequately equipped to deal with them. This can then be developed into a consideration of ways in which their own organization is deficient in managing risk and determining personal and organizational plans to address the deficit.

10.3.5.3 Transfer of training

Transfer of learning is the process by which effects of training in one form of an activity are transferred to another form. The traditional reason for completing a university degree was to learn how to think, a skill that could subsequently be applied in graduate employment, much less important was the content of one’s degree; an attitude that is now changing, as employers increasingly seek graduates who are ready to hit the ground running with a set of more specifically vocational skills and knowledge, and where a degree in business management may be considered more valuable than one in the history of art, for example. The principle of transfer of learning is also crucial to another requirement of graduate employers, that of transferable skills, such as oral communication, giving presentations, and teamworking, which are based on the assumption that students have the ability to transfer what they have learned in one situation (university) to another (the workplace). A particular example of transfer of training within the OHS domain is that of first aid training positively affecting motivation for safe behavior (Glendon & McKenna, 1985; Lingard, 2002).

Transfer of learning in the posttraining organizational environment can be affected by factors relating to individuals (e.g., self-efficacy), groups (e.g., response of nontrained group members, acceptance of new skills in relation to established group norms), and organizations (e.g., lack of equipment or facilities). However, other factors, such as receiving recognition, support, and rewards, may be a source of encouragement when applying training (Tannenbaum & Yukl, 1992). Managers of staff returning to work after completing a training program have a critical role to play in creating a positive climate for learning transfer. They should provide frequent feedback and reward trainees for using knowledge and skills that they have acquired. They should facilitate development of a learning culture by strongly promoting or selling benefits of training for individuals and for the organization, and provide resources and policies that encourage and support training in organizations (Arnold, 2005). Lack of support can extinguish gains from safety training, whilst perceived management support has resulted in significantly higher levels of reporting and correcting safety problems (Cole & Brown, 1996). Stewart and Tansley (2002) recommended that consideration be given to developing competency and motivation of line managers so that they are better equipped to manage the learning and development of others within their domain.

10.3.5.4 Refresher training

Safety training may occur as part of the induction of new team members, but this training may fail to transfer successfully or become extinguished over time. Studies have shown that high-level job skills, which are used infrequently or not practiced, can decline rapidly — for example, between one and four months for fire-fighting and piloting aircraft (Sitterley et al., 1974); thus highlighting the need for refresher training, particularly for critical, but rarely used skills, such as emergency drills and procedures.
An important issue in learning as an ongoing process is that of learning appropriately from experiences. One problem associated with on the job learning is that it may take the form of trial and error learning. This presents another challenge for safety training: how to maximize the utility of relevant experiences by incorporating them into the learning process. Training for many skills, such as flying an aeroplane or driving a car, often aims to provide trainees with the basics and then leaves them to learn the rest by experience — learning as you go. However, young male drivers who are unsafe tend to perceive driving as essentially a skill-based activity (Rolls & Ingham, 1992) and have little appreciation of the other types of abilities involved, for example, planning and accurately perceiving risks in the environment, including other road-users’ behaviors. Subsequently, such drivers have to learn through experience (e.g., having crashes or near misses) that the time scale of decision-making in driving is longer than they first thought and that being a skilled driver involves hazard identification and risk evaluation, not just going fast. Training, for example using refresher courses, which involves discussion of trial and error or trainees’ near-miss experiences, can be a valuable way of increasing awareness of risk and improving safe behavior (Lagerlöf, 1982; Lewin, 1982).

10.4 Managing safety risks: an integrated approach

The traditional risk management approach has a control orientation, where risks are assessed, evaluated, controlled, and monitored. An enhanced risk management cycle, which incorporates a commitment orientation, would involve not only risk assessment and performance monitoring, but also developing strategies that enhance worker commitment. High-commitment management creates conditions that encourage workers to identify with organizational goals (such as prioritizing safety) and expend extra effort to achieve them — for example, engaging in safety-related citizenship behaviors, thereby avoiding overreliance on compliance by means of rules, regulations, and monitoring to minimize injuries (Whitener, 2001). This approach is supported by the findings of Vredenburgh (2002), which suggested that emphasis on control-oriented activities alone was associated with increased injuries, whilst a combination of control-oriented and more proactive measures (selection and training) were associated with reduced injuries. Thus, an integrated approach is called for — combining traditional risk management techniques with high-performance strategies.

10.4.1 Types of safety intervention

The first step in the risk management process incorporates collection of information about hazards, followed by evaluating the risks that they pose. Second, risks that cannot be eliminated must be reduced, through risk control measures or interventions. Then the effectiveness of interventions must be monitored and reviewed. Some interventions that may be used to control the type of human risks discussed in this book are as follows:

- Technical interventions involve reducing risk through engineering controls, such as machinery guards. Such engineering controls may be expensive to implement, for example, they may depend on introducing new technology or investing in new equipment.
- Interventions may be socio-technical in nature, that is, focusing on improving the fit between workers and technology through interface design and other ergonomic solutions (see Chapter 4).
- Interventions targeted at human resources are typically focused at an individual level and are control oriented, such as behavior modification, educational programs,
and attitude change (Chapter 3 and Chapter 6); error reduction and error management techniques (Chapter 4); and administrative controls, in the form of rules and regulations (Chapter 4).

- Training (discussed earlier in this chapter) is a common intervention. It may be either technical (e.g., relating to specific job skills) or procedural (relating to managing risk through policy, legislative or organizational requirements). It may be conceived as addressing either the organization as a whole or specific individuals or groups.
- Selection is underused, but may have potential as an intervention strategy — for example, including personality testing in conjunction with other methods (see Chapter 5).
- Other types of intervention, which are rarely considered in relation to safety, but can be particularly effective, include health promotion and stress interventions (see Chapter 7). Stress interventions, which focus at an organizational level, incorporate techniques that relate to some dimensions of a HPWS, outlined above, such as work redesign, worker participation, and autonomy.

### 10.4.2 Individual and group level safety interventions

Interventions are often implemented to target specific problems identified by risk evaluations, but rarely is thought given to integrating interventions with the organization’s strategic objectives. For example, training is a common intervention for improving safety. However, Wright and Geary (2001) maintained that training is too often used to compensate for inadequacies in the practice of management or job design. Safety training is frequently too narrowly focused on current jobs, rather than developing people’s broader capabilities.

Colligan and Cohen (2004) emphasized that when used as an isolated intervention to control risk, success will depend on the culture and management commitment to providing a safe work environment. If training is received in procedures that are impossible to implement due to inadequate equipment, resources, or supervisory commitment, then training may be counterproductive and breed resentment, for example, workers may see it as an unfair substitute for investing in newer and safer equipment or machinery. Thus, it is important to be concerned not only with training individuals and groups, but also to ensure that the organizational environment within which those parties operate is consistent with training provision. A strategic agenda for interventions that operate at individual or group level is essential so that the contribution to the organization’s objectives can be appreciated.

Another criticism of individual and group-level interventions is that they are often characterized by a control orientation such that they are used as a form of management control to shape and manipulate workers’ behavior, rather than to galvanize their commitment. For example, Zacharatos and Barling (2004) questioned including compensation packages, such as PRP, as an aspect of HPWS as they have overtones of management control. However, the degree of control could depend on how the scheme was operated. Similar accusations are made in relation to behavior modification techniques, which are often criticized for being manipulative and controlling. However, when used effectively these techniques can have positive effects on safety climate and help to build trust in managers (see Chapter 3). DePasquale and Geller (1999) highlighted the role that visible commitment of managers and supervisors played in the success of behavior safety interventions. Providing financial resources was found to be a necessary but not sufficient condition for success; rather success was associated with managerial support in providing the necessary time for observations and analysis of results, in addition to a commitment to implementing changes recommended by the program, such as environmental conditions or procedures. The study also found that programs were more successful when workers trusted that managers were capable of supporting the process (with beliefs in managers being well-intentioned having
no effect). Likewise, schemes that reward safe performance may also have a positive effect on safety climate by influencing workers’ perceptions of managerial commitment to safety. The purpose of training is often to enhance worker knowledge in order to comply with safety rules and regulations (control-oriented), rather than equipping workers with sufficient knowledge and skills regarding the system so that they can develop a mental model that is accurate enough to enable a competent level of hazard evaluation (as discussed in Chapter 4). A commitment-oriented approach might provide training in conjunction with empowerment and delegation of safety responsibilities to the workforce, perhaps through self-managing teams; thus, workers are empowered to engage in correct performance, rather than compliant performance.

An important component of a positive safety climate, which is not explicitly included as an aspect of a HPWS, is top management commitment to safety. Yet, it is evident from the previous review of HR practices in relation to OHS, that senior management commitment is crucial to their success. For example, one way of expressing management commitment to safety training is for managers to be involved, both as participants and as trainers (see Summary Text 10.11). Organizational safety climate has been shown to moderate the relationship between job insecurity and safety outcomes, such that maintaining a strong safety climate can significantly reduce or eliminate negative effects of job insecurity on safety compliance and injury involvement (Probst, 2004b). Hofmann et al. (2003) found that safety climate acts as a moderator in the relationship between leader–member exchange (LMX) leadership and safety behavior, that is, there is a significant positive association between LMX and safety citizenship role definitions in work groups with a strong safety climate, but a much smaller and nonsignificant relationship in the case of weaker safety climates. In a strong safety climate, workers with a high LMX relationship with their supervisor will be more likely to engage in safety citizenship behaviors. Thus, the nature of the safety climate is an important enabling condition for the positive safety benefits that flow from a HPWS.

Trust in management emerges as another important part of the safety equation — this concept was discussed in Chapter 6 in relation to safety climate and in Chapter 9 in relation to leadership. Zacharatos et al. (2005) found that trust in management acted as a mediator in the relationship between HR practices and safety outcomes; thus, aspects

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**Summary Text 10.11 An Example of Management Involvement in Safety Training**

Management involvement in safety training can be facilitated through a hierarchical or cascade approach to safety training. For example, in one large organization, as part of a realignment of safety culture, all senior managers — from the chairman down, were required to attend a three-day strategic safety management course, the 30 or so initial courses taking a year to complete. Each course concluded with a 1-h exam and workbook assessment, both of which trainees were required to pass, and input from a board member or other senior manager. On successful completion of this course, managers could then select from a range of other modules according to their particular needs, for example: risk analysis, hazard management, and management of contractors. Other managers and supervisors were required to take a safety management foundation course. This is an example of an organization taking a structured approach to safety training.
of the HPWS increase workers’ trust in their managers, which in turn influences safety incidents, including near-misses and minor injuries. McCauley and Kuhnert (1992) found that perceptions of the effectiveness of HR practices predicted workers’ trust in division heads; and similarly for more senior management, including the CEO (Costigan et al., 2004). Developing safety interventions based on high commitment HR practices can therefore help to develop trust in managers at all levels, which underpins organizational safety culture.

10.4.3 Organizational level safety interventions

There is a paucity of studies evaluating the effectiveness of safety interventions targeted at an organizational, rather than an individual or group level. Yet there is an increasing body of evidence to support positive safety benefits of high quality work (see Chapter 9) on communication and transformational leadership. Areas where safety interventions might be successfully targeted are described in the following subsections.

10.4.3.1 Autonomy and safety outcomes

A number of studies support a relationship between autonomy and safety outcomes, indicating that greater job autonomy is associated with fewer injuries (Harrell, 1990; Hemingway & Smith, 1999). In line with including high quality work as an aspect of a HPWS, Parker et al. (2001) found that the relationship between job autonomy and safe working was fully mediated by organizational commitment. Interventions focusing on increasing autonomy (or control) will in general increase organizational commitment, which in turn increases safe working. However, caution must always be exercised in applying work redesign programs, as the increased responsibility and decision latitude associated with greater autonomy can be perceived as an unwanted burden by some individuals, and thus be counterproductive by introducing new sources of pressure. Consultation with workers and careful monitoring of the effects of any changes is needed when implementing such measures.

10.4.3.2 Self-managing work teams

One means of increasing autonomy and decision latitude is through introducing self-managing (or autonomous) work teams (see Chapter 8). Although rarely envisaged as a safety intervention, introducing self-managing work teams has, in general, been found to yield safety benefits (Pearson, 1992; Hechanova-Alampay & Beehr, 2002; Roy, 2003). However, it is important to ensure that workers feel empowered and are not burdened with extra responsibilities without experiencing increased personal control (Manz & Angel, 1996). Furthermore, effective leadership needs to be maintained, despite delegating safety responsibilities to the team, to ensure that workers perceive that managers are still committed to safety (Roy, 2003).

10.4.3.3 Worker participation

Another organizational intervention strategy may target worker participation, which is a further means of enhancing control. Kvarnstrom (1996) found that an intervention (aimed at stress reduction, rather than affecting safety) involving participation, training, and job redesign, resulted in a significant reduction in workplace injuries.

10.4.3.4 Communication

The quality of communication has been found to have a significant effect on work injuries (Trimpop et al., 2000) and self-reported safe working practices (Parker et al., 2001). Furthermore, Parker et al. (2001) demonstrated that more open, informal communications led to higher levels of safety commitment; again highlighting the commitment orientation of
safety interventions that target improvements in communication. Flin (2003) described the use of upward appraisal as a tool for identifying communication failures between senior and middle-level managers.

10.4.3.5 Management development
Safety interventions do not necessarily need to be focused at workforce level, although they frequently do so. Management development programs might be used to develop practices that are characteristic of a transformational leadership style (see Chapter 9), and also to eliminate passive and inactive leadership practices. Management training (including role-play exercises and group discussion) has been used successfully to improve corporate regulatory compliance (Stokols et al., 2001).

The important final step in the risk management process is monitoring interventions to ensure their effectiveness. Traditionally, this might be achieved through tools such as safety audits, workplace inspections, or behavioral sampling. Safety auditing is a valuable risk management tool that is one of a variety of measures that can be used in assessing management’s OHS performance, covering the main aspects of risk management — hazard identification, risk evaluation, identification of controls, and monitoring. While a safety audit is a proactive performance measure with many advantages over other methods, for example, in terms of its scope and thoroughness, it is not an all-purpose performance measure and is best used in combination with other methods. Other proactive measurement tools include safety climate surveys and other measures that can reflect the underlying safety culture (see Chapter 11, Summary Text 10.2 and Summary Text 10.3) for further consideration of measurement issues).

10.5 Conclusions
An adequate SMS provides a framework for considering all components of safety management and for setting clear safety objectives. However, there has been a tendency to perceive the SMS as a stand-alone response to OHS legislative requirements. HRM is a critical aspect of all management, including risk management. While OHS has received little attention as an HRM topic, it is nevertheless vital to include such matters within human resources planning. The most important aspect of HRM from a risk management perspective is that it is a strategic approach to managing people. Thus, people, for example through selection and training processes, are considered as an investment and not as a cost. HRM is a proactive approach to management in which people are considered as a competitive advantage, and whom it makes good business sense to protect and to involve in organizational problem solving. Taking an integrated approach to risk management involves a process of risk assessment (hazard identification and risk evaluation), risk control, and monitoring or review, with a focus on implementing high-performance management practices (rather than control-oriented measures). Thus, the objective is to implement measures that reduce risks through encouraging commitment and high performance from workers, rather than enforcing compliance through rules, regulation, and control.

This chapter has reviewed a number of HR practices that are associated with high levels of OHS, including selective hiring, communication, reward systems, and training. However, it was noted that given the changing nature of contemporary workforces, some aspects, such as long-term employment security, stability, and good worker relations, may no longer be relied upon to ensure OHS, but that greater attention should be given to protecting the organization’s underlying safety culture and maintaining a strong safety climate within work groups. Similarly, growth in nontraditional employment arrangements means that not only should status distinctions between hierarchical levels be reduced
but also those between different types of workers, such as core and contingent workers. A range of safety interventions may be considered to manage human risks as well, some of which will be familiar to safety and risk professionals, including safety training, but others that have not been traditionally used in relation to safety risks, such as health promotion. Other interventions are relevant and have been discussed elsewhere in this book, including transformational leadership practices, self-managing teams, autonomy and control, and participation and empowerment. In particular, this chapter has highlighted the importance of senior management commitment to safety, a strong safety climate, and trust in management as underlying factors in ensuring that HR practices have positive OHS benefits. The importance of integrating HR practices into risk management processes has been emphasized throughout this chapter. However, this is not to suggest excluding the traditional merit of risk management, with its focus on housekeeping, maintenance, procedures and rules, and risk control measures to reduce environmental hazards in order to provide a safe working environment. Such a focus must be combined with HRM into an integrated risk management process, rather than OHS being viewed as separate and unrelated to mainstream management.
chapter eleven

Safety culture

This chapter addresses the concept of safety culture: the fundamental underlying beliefs and values of a group of people in relation to risk and safety. Whilst much has been written about safety culture, there is little agreement on its definition, and even less on ways of improving it, despite widespread recognition that a positive safety culture is a prerequisite for successfully managing safety risks. In this chapter, the definition and nature of safety culture is first discussed; followed by a review of theoretical models that elucidate mechanisms linking safety culture with safety performance, including a discussion of high-reliability organizations. Approaches to developing and measuring safety culture are reviewed. Ways to promote a positive safety culture are explored within the context of a risk management approach to safety.

11.1 Introduction

First use of the term safety culture is generally ascribed to the International Atomic Energy Agency (IAEA, 1986) report of the Chernobyl nuclear disaster, the cause of which was attributed to a breakdown in the organization’s safety culture. Following Chernobyl, a number of other major disasters that were subject to detailed independent public inquiry revealed the significant role played by organizational and social factors (Reason, 1990). The term safety culture was quoted by several of these inquiry reports as an explanation for the way that a combination of managerial, organizational, and social factors contributed to the disasters. These included the 1987 Kings Cross underground station fire (Fennell, 1988), the 1988 Clapham Junction rail disaster (Hidden, 1989), and the 1988 North Sea platform Piper Alpha explosion (Cullen, 1990). The idea of safety culture was highlighted for a broader range of organizations, including those involved in transportation and public safety, as well as the nuclear industry. It has continued to appear as a substantive issue in disaster inquiry reports over the past 20 years. For example, the term appeared ten times in the Special Commission of Inquiry Interim Report into the Waterfall rail disaster (McInerney, 2004), 19 times in the Ministry of Transport report into the same disaster (Ministry of Transport, 2003), and 70 times in the Glenbrook Rail Accident report (McInerney, 2001). This chapter examines the importance of the concept of safety culture and its relationship to injury causation. Chapter objectives are as follows:

- Explore the nature of safety culture
- Describe manifestations of safety culture in terms of attitudes and behavior
- Describe theoretical models of safety culture and discuss their contribution to an understanding of how safety culture relates to safety performance
- Investigate the mediation role of safety climate and occupational stress
- Discuss different approaches to the development of safety culture
- Identify methodologies for measuring safety culture
- Define positive safety culture
- Discuss ways in which organizations can develop a positive safety culture
- Locate safety culture within a risk management model of safety improvement

11.2 Defining safety culture

Giving a high priority to safety issues was defined by the IAEA as being indicative of a safety culture (IAEA, 1986; INSAG, 1991). The IAEA (1988) defined safety culture as, “that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, [nuclear] safety issues receive the attention warranted by their significance.” A variety of definitions has been proposed, a widely cited working definition being suggested by the U.K. Health and Safety Commission: “the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’s health and safety management” (HSC, 1993a, p. 23).

Pidgeon (1991) considered culture to be a shared meaning system and safety culture to be, “the constructed system of meanings through which a given people or group understand the hazards of the world” (p. 135). As its definition depends on individuals’ perceptions being shared within a group, organizational, or societal context, safety culture is essentially a social phenomenon. This feature is reflected in many definitions, for example, Cox and Cox (1991) and HSC (1993a) both referred to “shared perceptions of safety” and Cooper and Phillips (1994) to “a collective commitment of care and concern.” Definitions of organizational culture also emphasize its shared or social nature (Bate, 1984; Schein, 1985). However, Turner (1991) noted that whilst safety culture has important social dimensions it also has a technical aspect, which should not be overlooked; he emphasized the nature of safety culture as sociotechnical rather than wholly social.

11.2.1 Safety culture as attitudes

Much research has focused on the expression of safety culture through measuring safety attitudes. Mearns et al. (2003) argued that safety culture is important because, “it forms the context within which individual safety attitudes develop and persist and safety behaviors are promoted” (p. 642). Empirical work within this perspective has focused upon examining safety attitudes (often restricted to workers) as being indicative of an organization’s safety culture (Cox & Cox, 1991; Cheyne et al., 1998; Lee, 1998). Of the relationship between safety climate and safety culture, Mearns et al. (2001) considered that, “Safety climate can be defined as the manifestation of the underlying safety culture in safety-related behaviours of employees and in employees’ expressed attitudes” (p. 771). Gadd and Collins (2002) reviewed the safety culture and safety climate literature, mainly from 1998 (locating 78 references for this period), and explored links between safety culture and safety performance. They viewed safety climate as the current surface features of safety culture that are discerned from workers’ attitudes and perceptions (Flin et al., 2000). Noting the dearth of studies addressing the stability of safety culture over time, Mearns et al. (2001) cast doubt on whether safety culture or climate is stable over time.

The focus on safety attitudes has led to some debate regarding differences between safety culture and the related concept of safety climate (discussed in Chapter 6), which has
also been defined in terms of attitudes. Within the literature, the term safety climate is often used interchangeably with safety culture (Guldenmund, 2000), although this term has a different history and has been studied independently. Some authors consider climate to be one manifestation of culture, where climate reflects aspects of an organization’s culture that are visible or measurable; climate, being a more superficial concept than culture, describes important features of an organization’s current state, such as the perceived quality of an organization’s internal environment. Culture is often seen as being long term and strategic, while climate is short term and tactical. Scaled dimensional measures are the most popular way of measuring organizational climate and many of these have been devised. Dimensions typically assessed include autonomy, cohesion, trust, pressure, support, recognition, fairness, and innovation. Most researchers in the field advocate maintaining a distinction between (safety) culture and (safety) climate. They include Glick (1985), Moran and Volkwein (1992), Schein (1992), Cox and Flin (1998), Hale and Hovden (1998), Mearns and Flin (1999), Glendon and Stanton (2000), Guldenmund (2000), Hale (2000), Harvey et al. (2002), Seo et al. (2004), and Hopkins (2005). Climate is generally taken to be a manifestation of culture (Mearns et al., 2001), while culture in its various configurations, including safety, is taken to be more abstract, multilayered, stable, and global. Hale and Hovden (1998) argued for using the term safety culture within a structural frame context, reserving safety climate for nonstructural contexts (HR [human resources], political, and symbolic). Figure 11.1 shows one view of the relationship between organizational culture and climate (Glendon & Stanton, 2000). In this model organizational culture is represented at three levels as well as having breadth and time dimensions. Organizational climate measures can access certain components of the dimensions of organizational culture, but across a limited range; for example, those relating to member attitudes, beliefs, and perceptions reflect cultural breadth at the time that a survey is undertaken and perhaps a little in the past as well. However, as organizational culture change is generally taken to occur over a period of years, the time frame for assessing culture must reflect this time dimension (see Section 11.4.3 for ways of evaluating safety culture).

Figure 11.1 Relationship between (safety) culture and (safety) climate. (After Glendon & Stanton, 2000.)
A major theme in empirical studies has been defining the dimensions or components of safety climate/safety culture, particularly in terms of workers’ perceptions and attitudes toward safety. The number of dimensions identified has varied from 1 global measure to 16 distinct components (Clarke, 2000). Although there are wide variations in the number and content of these dimensions, it is possible to extract dominant themes common across studies (Clarke, 2000; Flin et al., 2000). This suggests that similar themes are being reflected in the measures, but that variations in the way that issues are presented in questionnaires may contribute to differences in factor structures. Reviews (Clarke, 2000; Flin et al., 2000) have agreed on a number of primary dimensions of safety climate, including the three listed below:

- Management commitment — managers’ actions and attitudes regarding safety
- Safety management system — perceptions of/satisfaction with company safety policy and procedures
- Risk — level of workplace risk and how workers perceive workplace risks

Flin et al. (2000) suggested that it may be possible to identify a core set of dimensions that represent generic, underlying factors akin to the big five of personality (see Chapter 5). However, empirical studies using similar safety culture measures in different industries have concluded that the structure of safety attitudes is context-dependent (Coyle et al., 1995; Cox et al., 1998), due to a failure to replicate the same factor structure across a number of different samples. For example, Brown and Holmes (1986) failed to replicate Zohar’s (1980) factor structure (Israeli production workers) using a U.S. sample of production workers; Dedobbeleer and Béland (1991) failed to replicate Brown and Holmes’ (1986) factor structure using a U.S. sample of construction workers. Thus, different factor structures were found for different industries (production vs. construction) and for different cultures. Cooper and Phillips (1994) argued that sampling across different plants, factories, or sites introduced error variance, due to differing sub-climates associated with workplaces, which explained the failure to replicate Zohar’s original factor structure. Similarly, the five-factor model found by Cox and Cox (1991) was not replicated by later confirmatory analyzes (Cheyne et al., 1998; Cox et al., 1998). However, Cheyne et al. (1998) found that the factor structure remained stable across the four plants sampled in the study (one in France and three in the United Kingdom). Cheyne et al. (2002) supported these findings in a later replication, finding evidence of a sector-wide safety culture for manufacturing. Janssens et al. (1995) also found a stable factor structure in their cross-cultural study, but the strength of the relationships in the structural model differed across countries.

The literature seems to suggest that there is some stability in factor structure across plants within the same multinational organization in different countries (Janssens et al., 1995; Cheyne et al., 1998) and within the same country across similar industrial sectors (Varonen & Mattila, 2000). However, there seems to be a strong influence from industry type, as dimensions vary due to the method of questionnaire development, which reflects issues pertinent to a particular organization or industry sector. Variations in physical hazards, work environment, teamwork, prevalence of written rules and regulations, style of management, intensity of supervision, and prominence of safety representatives and safety committees, are among organizational features likely to be reflected in safety climate/safety culture measures. Glendon and Litherland (2001) found differences between job types, but not between districts, on two of six safety climate factors: relationships and safety rules. The authors hypothesized that differences were due to varying work environments (particularly level of supervisor contact and degree of formalization). In addition, differences in methodology and item generation may account for the failure to find a stable set of dimensions. Williamson et al. (1997) suggested that different approaches to generating safety
climate/safety culture components are partially responsible for differences in dimensions found by empirical studies. They identified two differing approaches: first, asking workers for their perceptions of actual workplace characteristics (Zohar, 1980); second, asking more general questions about safety (Cox & Cox, 1991). Moreover, whilst a few studies demonstrate a systematic approach to item generation (Cox & Cox, 1991; Donald & Canter, 1994), others lack substantive theoretical underpinning, for example, constructing measurement tools by selecting items from previous questionnaires.

Identifying a set of stable and generic safety climate/safety culture dimensions has preoccupied researchers in this area for over two decades. To some extent, it might be argued that this preoccupation has led researchers to neglect potentially more interesting research questions, such as the relationship that safety climate has with other organizational variables, its antecedents, and ways of developing a more positive safety culture. A meta-analysis (Clarke, 2005) showed that questionnaire-based measures of organizational safety climate demonstrated fairly weak criterion-related validity in relation to work injuries; thus, this approach may not be the most successful means of tapping underlying safety culture.

11.2.2 Safety culture as behavior

Whilst some researchers have focused upon attitudes, others have emphasized behavioral expression of safety culture in workers’ activity. Within this perspective, safety culture acts as a frame of reference for work behavior, that is, it determines what kinds of behavior are acceptable or will be rewarded by an organization, thereby helping to shape behaviors that workers routinely engage in. For example, Merritt and Helmreich (1996) viewed safety culture primarily as a frame of reference within which company safety policy and regulations are interpreted. Guest et al. (1994) noted that it, “will include the way these issues [risk and danger] are viewed and the priority attached to them in determining day-to-day behavior” (p. 2). Similarly, Cooper and Phillips (1995) stated that safety culture is reflected in, “the dynamic interrelationships between members’ perceptions about and attitudes towards organizational goals; members’ day-to-day goal-directed behavior; and the presence and quality of organizational systems to support goal-directed behavior” (p. 6). Williamson et al. (1997) suggested that safety culture could thereby, “predict the way employees behave with respect to safety in [a particular] workplace” (p. 16).

It has been noted that although the concept of safety culture was developed to account for organizational injuries, it is increasingly used to account for individual injury involvement (Mearns et al., 2003). In the sense that safety culture influences individual workers’ behavior, this would suggest that there could be a role for safety culture in predicting worker injury involvement. Organizational safety culture, and how it is interpreted at local level, could affect development of workers’ behavioral expectations. Whilst the underlying safety culture will influence workers’ general behavioral expectations, more localized influences, such as a supervisor’s interpretation of safety policies, could also have a powerful effect. Local safety climate, which is more susceptible to transition and change, could also influence behavior; indeed, safety climate has been defined in terms of acting as, “a frame of reference for guiding appropriate and adaptive task behaviors” (Zohar, 1980, p. 96). There can be friction between espoused policies and procedures endorsed by an organization (embodifying fundamental beliefs regarding safety), and interpretations of local managers and supervisors. For example, under production pressure, supervisors may turn a blind eye to safety rule violations. A recurrent theme in safety climate/culture studies is conflict between production and safety.

The underlying safety culture should act to reinforce a degree of personal authority and responsibility in workers that enables them to recognize hazards for themselves and to
learn how to act effectively in response to them (even if this does not always mean following rules to the letter). It should also strengthen group norms to maintain safe practices, so that coworkers support each other when engaging in safe conduct (even in the face of production pressure). However, corporate culture is often based on encouraging compliant performance, rather than correct performance (see Chapter 4). Workers’ correct performance is associated both with competence to perform and accurate hazard perception (based on task training and learning from experience) and motivation (based on internalized safety values). However, both these prerequisites are only possible within an organization that is committed to empowering its workers (see Chapter 8) and that encourages internalization of positive safety values (see Chapter 6 and also Chapter 8). One of the authors is aware of a waste management company that issued safety instructions to its workers in the form of written documents for the workers to read and absorb; however, each worker had to sign to the effect that these practices will be adhered to — or otherwise face disciplinary action or the threat of dismissal. This is an example of blaming, where safety compliance is enforced through fear of disciplinary action. Barling and Hutchinson (2000) discussed the ineffectiveness of such a control-based approach to safety, highlighting advantages of a commitment-based approach (including lower turnover and higher productivity), using management practices to engender trust and affective commitment amongst workers.

Reason (1997) argued that a safe culture is informed, just, flexible, based upon problem solving rather than indiscriminate blame apportionment, and includes reporting as an essential element (see Section 11.5.1 for further discussion). Reporting mistakes and violations is likely to be encouraged when people feel that the organization trusts them and shows evidence of responding in a problem-solving manner that rewards their behavior. The development of behavioral norms in terms of reporting injuries, incidents, and near-misses will depend on the safety climate. Clarke (1998) found that significant predictors of train drivers’ intentions not to report incidents included — an incident was considered to be part of the day’s work, managers would take no notice of reports, and an incident was routine and no action would be taken even if it was reported. These results indicated a routinization effect (whereby frequently encountered incidents were more likely not to be reported) and a reluctance to report based on anticipated (lack of) management response. Clarke (1998) also found that an area in which workers’ perceptions of managers were most negative had significantly lower intentions to report incidents compared with two other areas where more positive perceptions prevailed. Failure to report incidents is indicative of a safety culture in which managers are perceived as being unresponsive to safety information.

Geller et al. (1996) found that the propensity to care actively was significantly predicted by psychological reactance, personal control, group cohesion, and extraversion at two industrial sites. People who were more willing to care actively had a greater sense of belonging within the group, felt more empowered, and were more extraverted. Of the negative predictive power of psychological reactance, Geller et al. suggested that, “given a top-down, rule-enforcement perception of corporate safety, it seems reasonable that persons scoring high on reactance would be relatively unwilling to go beyond the call of duty and actively care for the safety of other employees” (p. 7). This research suggested that encouraging safety-related organizational citizenship behaviors (OCBs) depends on a safety culture characterized by a sense of belonging and empowerment, while one that alienates people through top-down policy enforcement discourages OCBs. Social support amongst coworkers (reflected by high scores on group cohesion) is also likely to support development of OCBs within groups. Turner (1991) defined safety culture fundamentally as needing, “a genuine commitment from top management to a climate in which managers and employees can show that they care for the consequences of their actions, both for people and for things” (p. 241). Turner (1994) added that the authority to make changes is necessary to activate this care. Thus, trust is important not only in the sense that workers
have trust in management (discussed in Chapter 9), but also that workers feel that the organization/management trusts them (e.g., through empowerment, participation, giving them the authority to take responsibility for safety).

One difficulty associated with using the term culture is that it may contribute no additional meaning to another term with which it may be paired, which tends to dilute its conceptual utility. For example, the term blame culture is frequently used. While blaming may be a perceived aspect of a given culture, it will not be the only feature, and in an organization in which people may be blamed for incidents it is unlikely to be helpful to have the whole organizational culture labeled in this stereotypical way. The problem may be one of everyday usage taking over more conceptual use.

11.3 Theoretical models of safety culture

Despite widespread recognition of the importance of safety culture, the concept remains theoretically underspecified (Clarke, 2000). Some researchers (Glendon & Stanton, 2000; Guldenmund, 2000) have adopted a model of safety culture that is analogous to Schein’s (1985) model of organizational culture, with core, intermediate, and surface layers. Other attempts to develop an understanding of safety culture adopting different theoretical roots, which may create insights into the mechanisms by which safety culture affects safety-related outcomes, include those of Geller (1991, 1994, 1996), Reason (1997), Clarke (2000), Cooper (2000), and Watson et al. (2005). Empirical studies conducted within a safety climate framework, focusing on measuring safety perceptions, attitudes, and beliefs, also add value in this respect and are reviewed in this subsection. Although links between perceptions of the work environment and stress responses would be expected, there has been little cross-reference between research conducted on occupational stress and the safety climate literature. However, this relationship may present further insights into the influence of safety culture on performance (Clarke & Cooper, 2004).

11.3.1 Organizational culture approach

Glendon and Stanton (2000) described the notion of safety culture as having arisen largely from ideas about organizational culture, such that safety culture is regarded as “those aspects of culture that affect safety” (Waring & Glendon, 1998). Many definitions highlight features that safety culture shares with organizational culture (Clarke, 2000; Guldenmund, 2000; Clarke & Cooper, 2004). Organizational culture has been described as being multilayered, with three levels commonly distinguished: deepest level (core assumptions), intermediate (beliefs and values), and surface manifestations (norms and artifacts) (Schein, 1985; Rousseau, 1988, 1990). Safety culture has also been described as existing at differing levels, being, “the specific set of norms, beliefs, roles, attitudes and practices within an organization which is concerned with minimizing exposure of workers, managers, customers, suppliers and members of the general public to conditions considered to be dangerous or injurious” (Turner, 1991, p. 241). In reviewing the literature on organizational and safety culture, Guldenmund (2000) defined safety culture as, “those aspects of the organizational culture which will impact on attitudes and behavior related to increasing or decreasing risk” (p. 251). Guldenmund conceptualized safety culture as having the following three levels:

Outer layer — Comprising artifacts, which are visible, but hard to comprehend in terms of underlying culture, for example, statements, meetings, inspection reports, and posters.
Middle layer — Comprising espoused values/attitudes regarding hardware, software, people, and risks, which are relatively explicit and conscious, for example, attitudes, policies, procedures, and job descriptions.

Core — Comprising basic assumptions regarding the nature of reality and truth, time, space, human nature, human activity, and human relationships, which are mainly implicit and have to be deduced from artifacts and espoused values, as well as through observation.

Models of this nature attempt to retain the holistic and integrative nature of organizational culture. Measurement methodologies advocated by this approach emphasize the need to tap into the multiple layers of safety culture, using triangulation (see Section 11.4.3.4).

11.3.2 Total safety culture

Geller (1991, 1994) proposed the concept of total safety culture (TSC), which is based on a behavioral approach to safety. This concept emphasizes achieving TSC status through implementing applied behavioral techniques. Geller (1994) defined a TSC as an environmental setting where, “everyone feels responsible for safety and pursues it on a daily basis, going beyond the call of duty to identify unsafe conditions and behaviors, and intervene to correct them . . . safe work practices are supported via rewarding feedback from peers and managers; people actively care on a continuous basis for safety . . . safety is not a priority that can be shifted depending on situational demands; rather, safety is a value linked with all other situational priorities” (p. 18). A TSC can be developed through coaching managers to extinguish unsafe behaviors and to encourage actively caring for safety. These techniques have been widely applied by Geller and colleagues (see, e.g., Geller & Glaser, 1996; Geller, 1998, 2001). The basic theoretical model underlying TSC is that of behavioral psychology, which emphasizes manipulating cues and consequences in order to reinforce desired behavior, and to eliminate undesired behavior (Chapter 3 provides a more detailed description of behavior modification). Although the model focuses on behavioral change, it recognizes dynamic interplay between behavior, individual, and environmental context.

As discussed in Chapter 3, behavioral change is most successful when supported by environmental and attitudinal changes. Therefore, the model incorporates the interplay between the three factors outlined below:

1. Environment — Including equipment, tools, machines, housekeeping, physical layout, and temperature.
2. Person — Including knowledge, skills, abilities, intelligence, motives, personality, attitudes, and beliefs.
3. Behavior — Including safe and unsafe work practices, complying, coaching, recognizing, communicating, and “actively caring” (exceeding the call of duty to protect another person’s safety).

Summary Text 11.1 outlines the ten principles on which the TSC model is based (Geller, 1994).

As noted in Chapter 3, substantial empirical evidence supports positive benefits of behavioral safety programs. Geller and colleagues have reported specific success of programs designed to develop TSC status (Geller, 1998, 2001; Geller & Williams, 2001). The model has been extended to include self-management for workers who work in isolation or who are subject to little supervision (Hickman & Geller, 2003a, 2003b). Thus, workers are responsible for manipulating cues, monitoring target behaviors, and self-administering rewards. A number of studies have successfully increased safety practices using self-management
Chapter eleven: Safety culture

Summary Text 11.1 Ten Principles of Total Safety Culture (TSC)

- The culture, not safety legislation, should drive the safety process — workers should be motivated to achieve safety outcomes for themselves, rather than to comply with external regulators (such as OSHA).
- Integrate behavior-based and person-based factors to create success — using a behavior-based approach to safety and taking into consideration personal factors (such as attitudes, knowledge, and motivation); these two approaches should be integrated to create a TSC.
- Focus on process, not outcomes — shift focus away from outcomes (reducing work injuries) to actual behaviors; develop incentive and recognition programs to encourage personal control over individual and team behavior.
- Behavior is directed by cues and motivated by consequences — promote understanding of the behavioral model of safety and involve workers in designing and implementing behavioral intervention strategies (usually based on including cues to direct target behavior and consequences to motivate their occurrence).
- Focus on achieving success, not on avoiding failure — using positive reinforcement to promote safe behavior is more successful than monitoring losses (such as injuries), which tends to focus on failure; safety accomplishments might include, purchase of safer equipment, correction of safety hazards, or increases in safe behavior.
- Observation and feedback lead to safe behaviors — introduce an effective observation and feedback process, whereby workers observe each others’ behavior and offer supportive feedback, that is, act as safety coaches; this must be based on substantial worker training and accountability.
- Effective feedback occurs via behavior- and person-based coaching — support workers in giving and receiving feedback through developing coaching skills (including persuasive speaking, active listening, ability to objectively and systematically observe behavior, ability to recognize cues and consequences, capacity to acknowledge small-win changes, and ability to use humor, build self-esteem, and reward with praise in order to gain acceptance).
- Emphasis on observing and coaching — workers not only need the knowledge, skills, and ability to use observation and coaching, but also the motivation.
- Emphasize self-esteem, belongingness, and empowerment — increasing the likelihood of safe behavior through increasing personal self-esteem (feelings of being valued), team cohesion (feelings of belonging), and empowerment (feelings of responsibility).
- Shift safety from a priority to a value — ensure that safety is linked consistently with all aspects of the job (including productivity and profitability), rather than as a priority (as priorities can change).

techniques (McCann & Sulzer-Azaroff, 1996; Olson & Austin, 2001; Hickman & Geller, 2003a, 2003b). However, as the process is essentially subjective and potentially inaccurate, several problems are implicit in a self-management approach. Some studies have attempted to overcome these difficulties by combining self-monitoring with objective feedback, in samples of bus drivers (Olson & Austin, 2001), short-haul truck drivers (Hickman & Geller, 2003a), and miners (Hickman & Geller, 2003b).

The TSC model is essentially a control-oriented approach, where managers define and specify unsafe behavior and reward compliance. Thus, its success depends on managers being able to correctly identify critical behaviors and apply appropriate reward strategies. It also assumes a model of injury causation in which correcting unsafe work behaviors and encouraging safe workforce behaviors is sufficient to maintain a positive safety culture. The model does not indicate that any change is required at hierarchical levels above the workforce. Despite acknowledging interplay between person, behavior, and environmental factors, the major driver of cultural change is located within the behavioral domain. Proponents of behavior-based safety programs point to their relative ease of implementation, as they require little formal training and can be administered by on-site managers or supervisors (Cantor et al., 2004). However, as noted in Chapter 3, successful use of such approaches depends not only on their application, but also on the cultural maturity of the organization (Section 3.6.3). Thus, whilst improved safety culture may be an outcome of behavior-based interventions, to some extent, a baseline level of safety culture is also a prerequisite for improvement. The TSC model incorporates some factors associated with occupational safety highlighted in other chapters, including the importance of safety motivation (Chapter 3), team cohesion and empowerment (Chapter 8), and integrating safety into all aspects of a job (Chapter 10). Some evidence suggests that, under certain circumstances, behavioral safety programs can lead to a sustained improvement in safety culture over time (see Chapter 3).

### 11.3.3 Safety culture: an informed culture

Reason (1997) conceived of safety culture as, “the engine that continues to propel the system towards the goal of maximum safety health, regardless of the leadership’s personality or current commercial concerns” (p. 195). Thus, unlike safety climate, which can be significantly affected by current conditions, including the state of the economy and current leaders, safety culture is an underlying driving force that has a degree of constancy. Its power is derived from not forgetting to be afraid, although this is most appropriate for organizations operating in high-hazard environments. An informed culture, characterized by collecting safety-related data and conducting proactive checks (see Chapter 10 on collecting safety data), comprises the four components described below:

1. **Reporting** — Encouraging feedback and workforce participation (see previous section on safety culture as behavior, Section 11.3.2). This might be achieved through confidential reporting systems that provide indemnity against disciplinary proceedings, ensure confidentiality or de-identification, and maintain separation between those handling reports and those imposing sanctions. Reporting systems with these characteristics aid development of trust between workers and managers. Reports should be easy to make and provide timely and useful feedback.

2. **Just** — Where people are rewarded for providing safety-related information (see Chapter 10 on reward systems), but are clear on differences between acceptable and unacceptable behavior (suggesting that an appropriate blame culture might be preferable to a no-blame culture).
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3. Flexible — Being adaptable in the face of hazards or danger (as in response modes of high reliability organizations, see Section 11.3.10). Flexibility can be achieved by decentralizing control and by using diverse teams that can operate autonomously (see Chapter 8).

4. Learning — A willingness to learn the right lessons and to implement solutions.

It is important that learning takes place in the upper echelons of management and throughout the organization. This approach to learning is embodied within the learning organization, in which there is a focus on facilitating the learning of all workers and by being alert to the need for continuous transformation (Pedlar et al., 1989). In essence the aim is to create a culture of continuous learning for all workers. Systematic self-analysis of an organization's experience, especially its mistakes, is a necessary prerequisite for an organization that wants to be a learning organization. Sharing information about key aspects of the strategic direction of the organization and important operational issues in connection with policy implementation, together with information from stakeholders (e.g., suppliers and customers), is heavily underlined. Managerial qualities of a learning organization have been described and operationalized (Senge, 1990; Argyris, 1991; Beard, 1993; Garvin, 1993; Senge et al., 1999) as outlined in Summary Text 11.2.

11.3.4 Reciprocal safety culture model

Maintaining that many researchers have over-emphasized the importance of shared perceptions and attitudes toward safety, Cooper (2000) defined safety culture as, “the product of multiple goal-directed interactions between people (psychological), jobs (behavioral) and the organization (situational)” (p. 118). Cooper (2000) drew an analogy between this model of safety culture and Bandura’s social learning theory (1977), which highlighted interactive relationships between person, behavior, and situation (echoing the person–behavior–environment model underlying Geller’s TSC model described on Section 11.3.2). Thus, safety culture is the product of interactions between the three components outlined below:

1. Safety climate — Internal, psychological factors relating to the person, including attitudes and perceptions; this element of safety culture can be assessed using safety climate questionnaires.

2. Safety-related behavior — Ongoing and observable behavior; this element can be measured through such techniques as behavior sampling and observation.

3. Safety management system — For example, organizational policies, practices, and procedures, and management style (the situation); this element can be measured with objective safety audits.

The model reflects the dynamic nature of safety culture as it emphasizes interrelationships between the three components. Investigations into influences upon safety culture might usefully focus on any of the interactions between safety climate (person), safety management system (situation), and safety-related behavior, or how one element is conditional on the other two. It also supports a triangulated approach to measuring safety culture (see Section 11.4.3.4). Although there is no empirical test of the three-way interaction between these elements, some studies have focused on relationships between two of them. Glendon and Litherland (2001) conducted a safety climate survey and behavior sampling of workers’ safety critical behaviors, but failed to find a significant relationship. However, evidence of a significant direct relationship between safety climate and behavioral
Summary Text 11.2 Characteristics of a Learning Organization

- Adopt a systems perspective when examining the various strands of interdependent action within the organization. Systems thinking also encourages workers to keep the big picture in mind and to develop sensitivity to the external environment.
- Be highly focused in effort, be patient, and be introspective and objective when confronting assumptions and ideas underpinning present practices. Double-loop learning, which can amount to adopting a critical perspective whereby things are challenged, would take place here if members use feedback to test the validity of current values and practices. This contrasts with single-loop learning, where the aim is to correct errors that arise from using particular operating instructions.
- Place value on self-development and continuous development, so that expertise is allowed to flourish and problem solving is enhanced. There is a climate characterized by the generation of knowledge and its widespread dissemination, as well as a willingness to modify worker behavior in response to new knowledge and insights.
- Develop shared views of where the organization is now and develop a shared vision of the future, reflected in members developing a common purpose and commitment with respect to the primacy of learning in the organization. Leadership is crucial in promoting a shared vision.
- Promote team learning where members come together and freely share ideas and opinions in order to improve problem solving. An important principle is putting new knowledge and insights into action. These could be innovations in the way the company is organized and in the management of people, leading to creativity and flexibility in the contribution of the human resource.


observations, undertaken as part of a behavioral safety initiative, was reported by Cooper and Philips (2004).

11.3.5 An approach from subcultures

Pidgeon (1998a) and Pidgeon and O’Leary (2000) emphasized the need to be aware of subcultures. They considered organizational differentiation into subcultures to be due to social structures and power relations, which can influence sense making in constructing different versions of reality. Hopkins (2005) considered that the right culture is needed to make safety systems work and that because culture relates to groups, organizations may have multiple cultures or subcultures. Following criticism that he had described organizational culture as a monolithic entity, Schein recast his earlier conceptualization of culture as applying at group level thus: “The culture of a group can now be defined as a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems” (Schein, 1992, p. 12).
Cox and Cheyne (2000), Glendon and Litherland (2001), Lee and Harrison (2000), and McDonald et al. (2000) found differences in safety climate dimensions between organizational subgroups, while differences between high- and low-injury groups were found by Brown and Holmes (1986), Sherry (1991), and Guest et al. (1994). Hofstede (1994) Beck and Wolfson (1999), and Clarke (1999) are among those who deemed it more appropriate to address group cultures rather than organizational cultures. Other researchers have found evidence that different worker groups can hold different attitudes toward safety culture and risk (Marek et al., 1987; Chute & Weiner, 1995; Pidgeon, 1998a; Mearns et al., 1999). Gadd and Collins (2002) identified subcultures as challenging the notion of an organization having a cohesive culture, for example, based upon different work and perspectives on risk.

Harvey et al. (2002) considered that it remained to be clarified whether safety culture consists of the same concepts for everybody within an organization or whether different subcultures exist. Testing for differences among 60 items between shop floor and management respondents, Harvey et al. (2002) found about half to be significant at \( p < .001 \). For plant differences (two plants), nearly half were significant at \( p < .01 \), with shop-floor workers mainly accounting for inter-plant differences and managements scoring similarly. They also found significant differences between shop floor and management in respect of: commitment/responsibility/involvement, job satisfaction, management style/communication, avoid responsibility (worker only factor), good vs. poor management (management only factor), and some differences between the two plants, mainly with respect to the workforces. Harvey et al. concluded that safety culture is more appropriately applied at group than at organizational level and that distinct subcultures existed. Compared with shop-floor workers, management had largely positive views of themselves, expressing greater commitment to safety, more involvement, and seeing responsibility for safety as their concern. Shop-floor groups had more negative views about management communication, management commitment to safety, personal responsibility for safety, and being listened to. There were also differences between shop-floor workers in the two plants. The authors identified three safety cultures and used attribution theory to explain differences between management and shop-floor groups (see Chapter 3 on attribution theory).

Comparing perceptions of supervisors and general workers on seven safety climate dimensions, Lu and Shang (2005) found that the only significant difference between supervisors’ and general employees’ perceptions of safety climate was on the safety management scale. Respondents were clustered into four groups on the basis of their scale scores, most of which discriminated between the clusters. Reported safety performance also differed between some of the four operator groups, which were labeled as follows in order of their safety performance ranking:

- Safety training and management oriented
- Safety management oriented
- Job safety and supervisor safety oriented
- Coworkers’ safety oriented

McDonald et al. (2000) identified a professional subculture within aircraft maintenance organizations that spanned four organizations and differentiated between technicians and management. Technicians believed that they were responsible for aircraft safety and should exercise their professional skills and knowledge to carry out this responsibility. Management believed that technicians should follow set task procedures explicitly, while acknowledging that if all technicians did this then production would be delayed. In a study of offshore workers, Collinson (1999) suggested that groups viewed safety from the
perspective of their own subculture, rather than sharing an overall view of safety. In particular, Collinson found that contract workers' terms and conditions were markedly inferior to those of workers employed by the organization and that they did the most dangerous and physical work. Their work experience resulted in them becoming distanced from the organization and its safety culture, and they experienced a higher injury rate than did company employees. Collinson suggested that workers' perceptions of a blame culture had a greater effect on their behavior than did the safety culture promoted by the organization.

Also in an offshore environment, Adie et al. (2005) found that the level of safety culture influenced perception of injury risk for three occupational groups studied. Compared with nonoffshore divers and offshore workers, professional offshore divers gave the lowest rating to safety culture in injury prevention. The authors noted that these workers received the bulk of their safety training as part of standardized induction, which could hinder developing a sense of safety culture, given that induction training does not cover the kinds of things learnt within organizations through experience. They suggested that, compared with the other two groups, offshore divers may be less likely to perceive safety culture as important in injury control because they receive less consistent education in safety culture, due to a more short-term contract work pattern, and less long-term acculturation. For all three groups, safety culture was less influential in perception of injury risk control than were supervisory quality and worker/diver competence. Other than safety culture, the main attributes that workers felt influenced injuries were supervisory quality, worker competency, and time pressure.

Cheyne et al. (1998) and Hofmann and Stetzer (1996) found coexisting subcultures such that differentiation could be along lines of multinational plants or hierarchical levels within an organization (Cheyne et al., 1998). Mearns et al. (1998) found a range of fragmented subcultures in an offshore environment, differentiated inter alia according to seniority, age, and occupation. One possible challenge is to find a unifying superior safety culture — for example, as measured by management commitment to safety or workforce safety behaviors. Gherardi et al. (1998) found ambiguity and differentiation along professional background and work task dimensions — reflected in engineers and site managers from a construction company ascribing different meanings to injury causes and prevention.

Noting the growing appreciation of differentiation and ambiguity within the organizational culture literature (Frost et al., 1991; Martin, 1992, 2002; Alvesson, 1993, 2001; Parker, 2000), Richter and Koch (2004) used multiple-method ethnographic action research in three case studies to demonstrate the extent and influence of integration, differentiation, and ambiguity in respect of safety culture. Failing to find a unified safety culture they rejected Schein's (1992) notion of little variation within a unit, instead noting that integration in the three workplaces was a weak safety culture element, while differentiation and ambiguity were much more evident. They identified multiple safety cultures and found that cross-level interactions and impacts of macro-cultures were important in fragmenting cultures within and between groups. They determined that safety cultures were being continually created as actors interacted with other internal and external actors.

Richter (2003) described an ethnographic and action research study of safety culture in three Danish organizations with the ultimate aim of implementing effective injury prevention programs that would be consistent with each organization's (sub)cultures. In Enterprise A Richter found three safety cultures, each with a different focus, risk orientation, attitude toward injuries, and perception of the safety function. For example, in one culture the focus was on work content and production at the expense of safety, while risks were accepted as a condition of work and deemed to be controllable by skilled workers. Another safety culture was represented by work being viewed within the perspective of a long working life, risks and risk taking were unacceptable and injuries were considered to be counterproductive. To some extent these contrasting cultures were reflected among first-line managers and top
management. Enterprise B revealed four safety cultures. In one of these, risks were conceived as being connected to workers’ risk taking and injuries were explained by workers’ incorrect handling of the production system or by safety rule breaches, which incorporated the concept of guilt. Prevention was oriented toward controlling worker behavior while sanctions, including dismissal, were available. The primary role of the safety group was to serve a policing function. An alternative safety culture viewed risks as connected to technical failures and injuries as caused by technical errors. A third safety culture understood risks as connected to procedures and work conditions and injuries as multicausal.

Richter (2003) concluded that safety cultures that are diverse in interpreting safety issues and characterized by guilt, blame, or expert orientation, set up barriers to injury prevention. Safety cultures that are united by common themes are more likely to result in safer workplaces. The common denominator of the cultures represented in Enterprise A was mastery, which could serve as motivation to improve safety within the organization. Richter concluded that barriers to injury prevention activities included limited worker involvement in cultures characterized by behavior control, blame, or expert orientation. Cultures reflecting some common understanding, without a rigid division of labor and worker participation were more likely to provide a supportive environment for successful injury-prevention programs. Richter observed that the features outlined below characterized the more successful organization in terms of sustained injury rate reduction:

- Top management took safety seriously and provided required resources
- Workers were resourceful and were part of a participatory system
- Manager–worker relations were characterized by a degree of equity and mutual respect
- A nonhierarchical work organization with broadly based jobs that stimulated workers’ problem-solving abilities

Evidence for the existence of safety subcultures within many organizations is now very strong, which is important to recognize when seeking culture change. As Pidgeon (1998a) pointed out, to be effective, any culture change program must take account of existing subcultures, how they interact, and power relations between them.

11.3.6 Work climate model

Clarke (2000) conceptualized safety culture as operating through workers’ perceptions of work climate, comprising the three components outlined below:

- Perceptions of management commitment to safety — deriving from workers’ perceptions of managers’ and supervisors’ safety attitudes and actions.
- Perceptions of the safety management system — relating to aspects such as training, policies and procedures, reporting systems, and safety equipment provision.
- Risk perceptions — reflecting workers’ safety attitudes and perceptions of workplace hazards and the relative risks posed to their personal safety and feelings of safety.

These elements relate most specifically to safety behaviors, such as OCBs, reporting, and the tendency to commit violations, which support the safety health of the organization; rather than errors (which derive more directly from latent failures; Reason, 1990). This proposed association could account to some extent for the lack of a substantial relationship between organizational safety climate and injuries (Clarke, 2005) as work climate components are not directly linked to the unsafe acts that lead to injuries. This model is supported
by a number of studies that have demonstrated the mediating role played by safety climate (Neal et al., 2000; Barling et al., 2002; Griffin et al., 2002; Zohar, 2002b). Although Clarke’s (2000) model indicated three distinct dimensions of work climate, it is likely that there will be relationships between these dimensions, specifically that both perceptions of the safety management system and risk will influence perceptions of management commitment to safety (O’Toole, 2002). O’Toole (2002) identified seven factors: management commitment to safety, education and knowledge, safety supervisory practices, worker involvement and commitment, drugs and alcohol, emergency response, and off-the-job safety. In a study of safety culture in large construction companies using focus groups and interviews, Biggs (2005) identified five components: collaboration and communication, personalization of injuries, teamwork, leadership, and safety knowledge.

11.3.7 A social capital theory of safety culture

Although not explicitly a model of safety culture, Watson et al. (2005) drew together the literature on social relationships and safety to develop a model to predict perceptions of a safe work environment (i.e., safety climate). Social capital theory (SCT) identifies a number of social dimensions of the organizational environment that impact on worker behavior and perceptions of the work environment (Coleman, 1988). SCT suggests that interpersonal relationships provide dividends for those who invest in them. Watson et al. (2005) proposed a model in which key social relationships (shared worker norms, trust in supervisor, and belief in management’s safety values) predicted perceptions of a safe work environment and worker at-risk behavior. Key dimensions of this model are reflected in definitions of safety culture considered earlier (see Section 11.3), which emphasize shared behavioral norms and perceptions of management commitment to safety.

Supporting evidence for a SCT approach to safety culture can be drawn from a number of sources, including research conducted by Clarke (1999), Hofmann and colleagues (Hofmann & Morgeson, 1999; Hofmann et al., 2003), and Zohar (2002a). Clarke (1999) suggested that accurate intergroup perceptions are essential for positive communications and are required to build trust, which is a foundation of safety culture. Zohar (2002a) also noted the importance of communications between workforce and supervisors; his study found that more safety-related interactions between supervisors and workers resulted in improved safety climate and fewer work injuries (see Chapter 8). The importance of reducing status distinctions that can impede such communications was noted in Chapter 10. The LMX (leader member exchange) theory of leadership is based on the concept of social exchange. As discussed in Chapter 9, high-LMX relationships between first-line leaders and workers result in subordinates expanding their formal role definitions to include safety citizenship behaviors (Hofmann et al., 2003) and being less injury involved (Hofmann & Morgeson, 1999). The importance of interpersonal communication in this relationship is emphasized by Hofmann and Morgeson’s (1999) finding that the association between high-LMX relationships and fewer injuries was mediated by safety communication, indicating that high-LMX relationships facilitated more effective communications, which in turn assisted in reducing injury rates. Watson et al. (2005) found that trust in supervisor and shared norms predicted perceptions of a safe work environment, whilst management safety values and shared norms predicted at-risk behavior. The role of shared norms, which Watson et al. (2005) found to be influential in terms of forming perceptions of the safety climate and engaging in unsafe behaviors, is discussed in Chapter 6. Within a group context, the social norm describes behavioral expectations in respect of group members, which can have a powerful effect on behavior. Thus, the SCT approach to safety culture focuses upon the influence of shared behavioral norms, management commitment to safety, and trust as important interpersonal aspects of safety.
11.3.8 The role of safety climate

In safety climate studies, the main measurement tool is the questionnaire, which yields quantitative data lending itself to statistical analysis and perhaps causal model development. However, this approach usually only provides cross-sectional data, which present a snap-shot of underlying safety culture. Nevertheless, these studies can provide useful insights into mechanisms linking safety culture with safety performance. Using statistical modeling techniques, such as structural equation modeling (SEM), a number of attempts have been made to develop causal models (including, Meliá et al., 1992; Oliver et al., 1993, 2002; Witt et al., 1994; Janssens et al., 1995; Tomás & Oliver, 1995; Flin et al., 1996; Cheyne et al., 1998, 2002; Cox et al., 1998; Fleming et al., 1998; Rundmo et al., 1998; Thompson et al., 1998; Tomás et al., 1999; Brown et al., 2000; Seo, 2005). Many of these models demonstrate the multilayered nature of safety climate and the role it plays in mediating the relationship between organizational variables and safety performance (including, safety compliance, safety participation, and unsafe behaviors).

Neal et al. (2000) examined effects of workers' perceptions of different aspects of their work environment (appraisal and recognition, goal congruency, role clarity, supportive leadership, participative decision making, professional growth, and professional interaction) and safety climate in terms of workers' perceptions of management values, communication, training, and safety systems. Results suggested that the influence of organizational climate is completely mediated by safety climate, as organizational climate did not contribute to performance once safety climate effects were partialled out. As noted in Chapter 6, workers' individual responsibility emerged as an important aspect of safety climate, which mediated both the relationship between personal involvement and safety activities, and between workplace hazards and safety activities (Cheyne et al., 1998). Cheyne et al.'s (1998) model, further validated by Cheyne et al. (2002), demonstrated that the effect of organizational variables (safety management and safety standards/goals) on individual safety-related behavior is mediated by communication, personal involvement, and individual responsibility, again highlighting the importance of these variables in linking safety culture with safety performance.

In a study drawing on the health belief model (HBM), discussed in Chapter 6, Seo (2005) found that a number of different pathways linked perceptions of safety climate with unsafe behavior. The strongest relationship was a significant direct effect of safety climate on unsafe behavior, such that a more positive safety climate significantly reduced unsafe work behavior. Two (significant, but weaker) indirect pathways were also supported; one via safety barriers, and the other via perceived work pressure, perceived risk, and safety barriers. In the former case, a more negative safety climate was associated with more safety barriers (related to following rules and regulations and wearing protective clothing), which led to increased unsafe behavior. In the latter case, this relationship was further mediated by higher work pressure and higher perceived risk. Although the strongest relationship was the direct one, findings emphasized wide-ranging effects of a positive safety climate, which also affected perceptions of work pressure. The next section (Section 11.3.9) discusses indirect effects via occupational stress in more detail.

11.3.9 The role of occupational stress

Although evidence is limited, empirical relationships between safety culture and experiencing workplace stress are supported, which may help to explain the occurrence of work injuries (Clarke & Cooper, 2004). Morrow and Crum (1998) found that safety culture was a significant predictor of occupational stress. In multiple regression analysis, partialling out the effects of objective risk factors (including risk exposure, prior injury, and tenure), safety
culture was found to significantly predict stress, such that a more positive safety culture was associated with lower stress. Goldenhar et al. (2003) found significant bivariate correlations between safety climate and stressors, including job control, skill use, responsibility for others' safety, and job certainty. One way of interpreting these findings is that a more negative safety culture will engender perceptions of management unconcern with worker safety, reduce confidence in workplace safety, and increase perceptions of danger, leading to increased workplace stress. On the other hand, experiencing high levels of stress is also likely to affect safety culture, fostering negative perceptions of management commitment, dissatisfaction with safety, and reduced feelings of individual responsibility for safety. Thus, the relationship between safety culture and occupational stress is likely to be reciprocal, as illustrated in Figure 11.2. The diagram shows that stress has an indirect effect on injuries, mediated by safety culture (the experience of stress at work affects the way that workers perceive the work environment, leading to more negative safety attitudes and beliefs) and also that safety culture has an indirect effect on injuries, mediated by occupational stress (how the work environment is perceived by workers affects the experience of workplace factors as stressful). Post hoc analyzes in Morrow and Crum's (1998) study indicated that safety importance interacted significantly with safety culture to explain additional variation in stress — that is, the relationship between safety culture and stress was moderated by the importance attached to safety by the individual. Thus, to reduce feelings of workplace stress it is important that an individual feels personal responsibility and ownership of safety.

Figure 11.2 also represents the direct effects of stress on injuries (via workers' safety-related behaviors) and indirect effects mediated by worker health. Goldenhar et al. (2003) found that occupational stressors (job demands, job control, and responsibility for others' safety) had significant direct effects on near-hits and, in addition, responsibility for others' safety also had a direct effect on injuries (see Chapter 7). The study also found evidence of a partially mediated model, whereby the effect of stressors on near-hits and injuries was mediated by psychological (tension, depression, and anger) and physical (nausea, headaches, insomnia, and back pain) symptoms. Specifically, job insecurity and harassment were related to both near-hits and injuries through psychological and physical symptoms, whilst skill under-use was associated with near-hits through psychological symptoms. Evidence also supports a relationship between mental health (anxiety and depression) and work injuries (Oliver et al., 2002; Siu et al., 2004). At organizational level, effects of job stress on the workforce may include increased absenteeism, high turnover, or lowered job performance — for example, high absenteeism may
lead to staff shortages, increasing workload on remaining personnel, and making errors more likely. At an individual level, reduced health and well-being can affect efficiency, motivation, and error proneness. Even if individuals attend work when feeling ill or distressed, their performance will be reduced, leading to increased error likelihood and feelings of resentment, possibly resulting in violations. An indirect relationship between safety culture and injuries, mediated by general health, has been supported. Siu et al. (2004) found that safety attitudes predicted occupational injuries, but that the relationship between safety attitudes and injuries was fully mediated by psychological distress. Oliver et al. (2002) also found that the effect of organizational involvement (including aspects of supervisory and coworker support, as well as safety management) on work injuries was partially mediated by general health (measures of anxiety and depression). Thus, there is support for both direct and indirect (mediated by health) effects of safety culture on injuries.

11.3.10 High-reliability organizations and safety culture

Reason (2000) described high-reliability organizations (HROs) as those that have intrinsic safety health; they operate in high-hazard conditions, performing exacting tasks under pressure, but maintain a low incident rate. Examples include naval aircraft carriers, nuclear submarines, and air traffic control (Roberts, 1989, 1993; Rochlin, 1989; Bierly & Spender, 1995). These organizations demonstrate characteristics of Reason’s informed culture (see Section 11.3.3), being just (operating error management systems that focus upon identifying system failures rather than blaming individuals), flexible (normal operations are hierarchical in nature, but have the flexibility to respond to local circumstances by devolving control to experts on the ground), and learning (workers throughout the organization are trained to recognize and manage errors; there is a willingness to learn from mistakes). A collective ability to discover and correct errors before they are able to escalate to crisis point has been described as cultures having the requisite imagination (Westrum, 1993), collective mindfulness, organizational mindfulness, or simply risk awareness, which may represent alternative ways of describing safety culture. Learning can be considered as a by-product of this process (Weick & Roberts, 1993; Weick et al., 1999; Weick & Sutcliffe, 2001). By way of contrast, Hopkins (2005) described a risk-blind culture as one in which front-line operators were not trained to look for possible mishaps.

It has been argued that the source of high reliability in HROs is organizational culture (Weick, 1987). La Porte (1996) identified the three components of high-reliability culture as:

1. An organizationally defined intention to provide for reliability and the seriousness of hazards
2. A set of reliability enhancing operations (including, structural flexibility, decentralized decision making, and continual search for improvement)
3. A set of fundamental values relating to group spirit, personal responsibility, and the importance of operational experience and expertise

Mindful organizing involves preoccupation with failure, meaning, for example, that long periods without incident, instead of breeding complacency, generate a search for errors, lapses, and possible routes to major failures. HROs have well-developed near-hit reporting systems — that is, well-developed reporting cultures (Reason, 1997). They are also reluctant to simplify potentially complex issues, as all information could be important. Their workforces are socialized so as to notice more, explore complexity, and to check on everything.
A high-reliability culture is characterized by centralization of control, but also a degree of delegation; this balance being managed through a, “powerful system of selection, training and mutual monitoring, criticism and advice ... [which results in] extremely efficient communications which gives the system the ability to absorb damage and surprises, and so deliver high reliability” (Bierly & Spender, 1995, p. 655). Gaba et al. (2003) demonstrated that safety climate was stronger in 226 squadrons of naval aviators (HROs) compared with health care workers based in 15 hospitals (non-HROs). Thus, high reliability is associated with decentralization of decision making, a no-blame culture, effective communications, and organizational learning within the context of a superior safety culture. LaPorte and Consolini (1991) observed that during crises in HROs, decision making may be devolved to the lowest level, where relevant expertise resides. As HROs’ front-line people maintain situational awareness and are committed to resilience, management is willing to defer to expertise irrespective of where it might reside in the organization (Weick et al., 1999). This can be enhanced by appropriate selection (Flin, 2001). Temporary informal networks may be used to deal with crises. Studies of HROs show that even authoritarian organizations can have the necessary degree of flexibility to maintain high safety standards, although this is by no means always the case (Clarkson et al., 2001; Hopkins, 2005).

11.4 Approaches to developing and measuring safety culture

A distinction has been made between safety culture as something that an organization is and something that an organization has (HSC, 1993a; Cox & Cox, 1996; Reason, 1997), reflecting two broad and contrasting perspectives — the interpretive (or symbolic) vs. the functionalist approach (Geertz, 1993; Waring, 1996; Waring & Glendon, 1998; Parker, 2000; Alvesson, 2001; Richter & Koch, 2004).

11.4.1 Interpretive approaches

Interpretive approaches assume that organizational culture is an emergent complex phenomenon of social groupings, which serves as the prime medium for organizational members to interpret their collective identity, beliefs, and behaviors. Organizational culture is not owned by any single group but is a unique creation of all the organization’s members. From assumptions characterizing interpretive approaches to organizational culture, it follows that managerial attempts to manipulate culture, for example, driving rapid organizational change, are likely to fail because of the application of an inadequate model of processes that they are attempting to manipulate. Cox and Cox (1996) described safety culture as an emergent property of the organization as a system; and several authors have used the phrase derived from gestalt psychology greater than the sum of its parts (Cox & Cox, 1996; Reason, 1997; Lee, 1998). Gherardi and Nicolini (2000) observed that safety culture emerges from operational practice within a community. These interpretive standpoints assume the following points:

- Culture is a complex outcome of all people in the organization (not just senior managers)
- Strategy supports culture (not vice versa)
- Culture cannot be trained or sloganized into people
- Culture change cannot be engineered quickly, but is by slow learning (Waring, 1996)
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An implication of the interpretive view is that culture cannot be considered as a simple thing that can be bolted on to an organization (Turner et al., 1989); safety culture is not easily developed, changed, or manipulated. This perspective contrasts sharply with a functionalist view suggesting that culture is amenable to management control as it is essentially an expression of organizational strategy. Waring (1996) emphasized the importance of understanding the influence of organizational power relations and politics on organizational (and safety) culture. These aspects are critical to organizational learning (Pidgeon, 1997). Thus, an interpretive approach to culture change focuses upon the importance of such contextual factors and emphasizes that change cannot be achieved through structural changes per se.

Adopting a modified form of symbolism Richter and Koch (2004) noted that an interpretive approach involved people constructing events, which are reproduced by networks and symbols that enable shared meanings and actions. They maintained that success depended on whether change strategies were meaningful to local actors. Ambiguity refers to potential for irreconcilable differences in meanings and symbolic interpretations (Frost et al., 1991; Alvesson, 1993).

11.4.2 Functionalist approaches

The assumption underlying functionalist approaches is that organizational culture is an ideal to which organizations aspire and that it can be manipulated to serve corporate interests. That the prime function of organizational culture is to support management strategies and systems is premised on the assumption that it can be reduced to relatively simple models of prediction and control (Waring, 1996). This approach primarily aligns organizational culture to support managerial ideology, goals, and strategy, in extreme cases involving managerial use of culture to coerce and control. Cooper and Phillips (1995) argued that because safety culture is expressed in goal-directed behavior this allows actions to be formulated that shape, change, or manage safety culture. Reason (1997) suggested that safety culture could be socially engineered by, “identifying and fabricating its essential components and then assembling them into a working whole” (p. 192); furthermore, he criticized interpretive approaches, comparing their perspective on culture change as, “akin to a religious conversion,” suggesting rather that, “there is nothing mystical about it … [a safe culture] can be acquired through day-to-day application of practical down-to-earth measures” (Reason, 1998, p. 305).

The interpretive/functionalist dichotomy underlies the debate as to whether all organizations can be said to have a safety culture or as Reason (1997) argued, “Like a state of grace, a safety culture is something that is striven for but rarely attained” (p. 220). This functionalist position is also maintained by Hopkins (2005), who equated safety culture with a culture of safety, maintaining that only organizations with an overriding commitment to safety can be said to have a safety culture. Some representatives of an integration perspective link this with managerial prerogatives and top-down attempts to change culture (Peters & Waterman, 1982; Deal & Kennedy, 1986; Hofstede, 1991). However, Pidgeon (1998a, 1998b) considered that it is unrealistic for culture change to be brought about by top-down safety management measures. A top-down approach is also implicit in Gadd and Collins’ (2002) safety culture literature review, and Hale and Hovden’s (1998) analysis. While Reason’s (1997) use of safety culture to refer to effective safety culture is an absolutist position, he also expresses sympathy with the HSC’s (Health and Safety Commission) definition, which is a relativist position. Reason (1997) aligns himself with the functionalist position, citing Hofstede (1994), although Hofstede’s own position is something of an amalgam of functionalist and interpretive approaches.
A functionalist view favors the regulators’ approach that organizations can change their existing safety culture to one that can result in improved safety performance, whilst the interpretive view indicates that such a change will be difficult to achieve and cannot be imposed by senior management. In practice, many organizations display elements of both approaches. For example, by adopting risk management practices, an organization invokes functionalist aspects of its safety culture; while a more interpretive side may be revealed by individual and group commitment to open-ended learning from past mistakes, such as those leading to injuries (Glendon & Stanton, 2000).

11.4.3 Measuring safety culture

The type of approach adopted will determine the measurement model used to gauge safety culture in organizations. Typically a functionalist perspective views culture as a route to identifying, assessing, controlling, and monitoring apparently measurable features of an organization’s internal environment — a risk management approach as described in Chapter 2 and by Althaus (2005). In contrast, an interpretive approach seeks data from multiple sources with a prime aim of advancing learning through increased understanding — more of a risk identification approach as described in Chapter 2 and by Althaus (2005). Potential ways of measuring safety culture, considering both approaches, are discussed in the following subsections, organized into measures reflecting aspects of safety systems, safety attitudes and perceptions, safety behavior, or a combination of these features. The methods outlined are described in greater detail in Glendon (2006).

11.4.3.1 Safety systems

The following three methods are among those that can be used to assess safety systems in organizations and the extent to which they are functioning effectively.

- **Documentary analysis**: This technique involves systematically reviewing a relevant sample of documents produced by an organization — for example, policies, instructions, rule books, and emergency procedures. Content analysis can be used to identify underlying themes or categories. However, documents may represent an ideal position, one to which the organization may aspire, but has not reached in reality. Therefore, this technique may be usefully combined with others to give a more holistic representation of an organization’s safety culture.

- **Safety audit**: This is a methodical, planned review to determine whether a safety management system (SMS) meets its stated objectives. It critically examines all relevant system aspects to identify strengths, weaknesses, and areas of risk. Safety auditing can be a powerful tool if tailored to a particular organization or domain. Limitations of safety audits include that they can only be a snap-shot of an organization at a particular time, and are bounded by a lack of depth. Safety audits are discussed in more detail in Chapter 10.

- **Systems methodology**: A systems approach could be used to study safety culture as a component of a SMS (see Chapter 10). Within this framework, three main approaches can be identified: first, a hard systems approach, which may involve event tree analysis, fault-tree analysis, or other engineering based techniques; second, a disaster-based approach might consider an organization from a case-study perspective and seek to identify risks that it faced and how they could be addressed; finally, a soft systems approach considers an organization as a cultural phenomenon, and a more ethnographic methodology would be adopted — for example, using rich pictures (Waring, 1996).
11.4.3.2 Safety attitudes and perceptions

As noted earlier in this chapter, a substantial amount of research has focused on measuring safety attitudes and perceptions, primarily in relation to safety climate. Self-completion questionnaires are widely used to collect data from large samples for statistical analysis. The various methodologies available for measuring workers’ attitudes and perceptions include those described below:

- **Questionnaires and surveys**: Survey questions generally require answers to precoded response categories, although some may also include open-ended questions. Within organizations, surveys might use a stratified sampling approach, so that sufficient numbers of individuals from different levels are invited to participate. Well-designed surveys can provide valid and reliable quantified assessments of people’s attitudes and perceptions throughout an organization. They are a quick and cost-effective means of obtaining quantified data that can attract high response rates. They may be administered online, using e-mail or a website, or in traditional paper format. However, surveys only provide a view of an organization at a particular time (cross-sectional data), although if repeated at intervals, longitudinal data can be obtained (and used to assess issues over time). Longitudinal studies often suffer from attrition effects (as the same participants fail to contribute to later stages, e.g., because they leave the organization, change department or job role, or lose interest in the study).

- **Interviews and focus groups**: One-to-one interviews may range from highly structured precoded (in which an interviewer administers survey questions), through semi-structured types (including both multiple choice and open-ended answers), to purely open-ended questioning (designed to collect qualitative data in the ethnographic tradition). Focus groups are discussion-based interviews on specific topics with multiple respondents. The aim is to understand respondents’ perspectives on target issues through generating and analyzing primarily qualitative data. Limitations include a restricted range of issues that can be addressed in a session. The process also depends upon the facilitator’s ability to build rapport with respondents and to extract relevant information within a limited time, while keeping the discussion on track. Although generating rich data, the analysis can be very time consuming.

- **Projective techniques**: These are used to tap into people’s feelings about an organization, adding an important affective dimension to the study of an organization’s culture. Projective techniques are designed to reveal how respondents feel about their organization. For example, respondents might be asked to complete 20 statements that begin with the words, “This organization . . .” Another technique might require respondents to draw a picture of their organization or to represent it through plasticine modeling. A prime advantage of these open-ended techniques is that data are unbounded by researchers’ preconceptions about how people within an organization might feel, for example, as occurs with precoded questionnaires. However, interpretation of projective technique responses can be problematic.

- **Repertory grid analysis**: This method involves identifying (typically 10–12) elements within a selected domain (in this case, an organization’s safety culture), which each respondent rates on a number of constructs (typically 12–15), usually on a 5-point scale. Elements are domain components, and could include for example, senior management, middle management, first-line management, and various identifiable professional or occupational groups. Bipolar constructs are usually generated using a methodology that involves drawing three elements at random for a respondent to state how he or she thinks two are alike and differ from the third — for example,
aloof–approachable, rigid–flexible, or committed–uncommitted. The grid is constructed by locating elements on one axis and constructs on the other. Dedicated software can be used to analyze the completed grid, so that results represent a particular respondent’s view of relationships between parties within the organization, including their perceived similarities and differences. Aggregated responses can provide a wider view of an organization’s safety culture.

11.4.3.3 Safety behavior

Although safety behavior is often measured using self-reports, in which respondents are asked to estimate their own behavior, more objective methodologies for evaluating behavior are also available. Measures that reflect safety behavior include those described below:

- Observation: Techniques range from structured observation (e.g., using standard schedules to record and observe the performance of samples of workers’ behavior) to less structured ethnographic approaches. Structured observation may use some form of task analysis to break down a job into individual task elements, which can be developed into a schedule. Other techniques include behavior-based sampling (which can measure and reinforce safe working) and human reliability analysis (which can be used to identify possibilities for critical errors in complex workplace systems and make recommendations to mitigate their effects or to remove/reduce either their likelihood or potential outcome severity — see Chapter 4). Participant observation generates more qualitative data and involves one or more observers spending considerable periods of time within an organization, either overtly or covertly collecting data usually using a semi-structured approach. While structured observation can gather both accurate and rich data, it is also relatively expensive.

- Shadowing: This technique involves a researcher being paired with a person within an organization to observe and record relevant aspects of their work activity, ideally on the basis of a predetermined plan or representative sampling. This method can incorporate verbal protocol analysis, whereby respondents are encouraged to describe verbally the nature of their work in real time so that the researcher can understand how the work is done. While rich data can be obtained from this technique, it is labor-intensive for both researcher and respondent and relatively costly. However, relatively brief shadowing episodes can minimize these limitations.

- Work diaries: These involve selected organization members completing daily diaries to record critical incidents, issues, or events that are of particular importance to the area of interest, in this case safety. As events are recorded in real time, the data are likely to be more accurate than if recalled at a later date. However, the task can be quite onerous for respondents. In addition, work diaries may affect the behavior they are recording due to increased self-awareness and reflection on performance. This method may be used as an alternative to shadowing.

- Action research: This approach extends participant observation to involve organization members and researchers or consultants in continuing active partnership to improve selected aspects of organizational performance, such as safety. A typical action research cycle could involve planning and designing an intervention, implementing, and reviewing a program. One ethnographic approach to studying safety culture derived from participant observation is action research-based with a more systematic formulation (Glendon & Stanton, 2000). This method involves researchers and participants working alongside each other throughout a study period, so that the researchers can develop an understanding of the meaning of events and activities for participants. Daily debriefing sessions can be used to identify problems and to
reflect on safety culture issues. This method has the advantage of collecting data over a period of time and providing high-quality data. However, it is a long-term investment for both organization and research team.

11.4.3.4 Triangulation

As discussed in Chapter 6, a research tradition has developed in relation to safety climate that has seen the proliferation of exclusively psychometric (e.g., questionnaire/survey) measurement approaches (Cox & Flin, 1998; Glendon & Litherland, 2001). Ojanen et al. (1988) argued that the only way to measure safety climate is by surveys. However, these approaches have a restricted range in respect of representing measures of safety culture (see Figure 11.1). As safety culture exists at different levels and across several dimensions, it can be argued that a range of measures is required to assess it. Thus, triangulation is an important research principle, which maintains that multiple sources should be used to focus upon a particular problem or issue, ideally using both qualitative and quantitative techniques. In this way, limitations of various individual methodologies can be counterbalanced for a more robust analysis of the issues and greater generalizability of results. Forms that triangulation might take include those listed below:

- Data — from more than one source
- Method — using more than one technique
- Researcher — more than one individual involved in data gathering
- Sampling — from more than one group within an organization
- Time — collecting data on more than one occasion
- Analysis — analyzing the same data in different ways

Various researchers have advocated a triangulated approach to measuring safety culture, including Cox and Cheyne (2000), Flin et al. (2000), Cullen (2001b), and Farrington-Darby et al. (2005). Cooper (1998, 2000) proposed a methodology for changing safety culture that incorporated risk assessments, safety audits, training, climate surveys, and behavior change programs, whilst Vecchio-Sadus and Griffiths (2004) advocated a range of measures to enhance safety culture within an organization. Farrington-Darby et al. (2005) followed up a safety climate survey with a qualitative approach involving interviews and focus groups of railway trackside workers in which trade unions were involved at all stages and feedback of results was arranged in advance. These authors identified 40 primary factors that influenced safe behavior and safe culture, varying from immediate trackside factors (e.g., weather), through medium distance factors (e.g., supervisory style), to distal factors (e.g., contradictory rules). The organization used the research findings to institute a change program involving: risk assessment training, interactive briefings, safety critical role training, communication improvements, managing contract staff, reporting systems, and greater management commitment.

11.4.3.5 Safety culture and injuries

While injury data can be problematic, where adequate data exist and can be compared with safety culture measures, this can provide useful validation for some of the techniques described above. Cooper (2000) and Richter and Koch (2004) concur that injury rate is not a simple indicator of safety culture. Adopting an interpretive approach to organizational culture that is aware of possible multiple safety cultures, Richter and Koch (2004) sought to develop a safety culture oriented toward injury prevention. They considered that a qualitative approach to safety culture that follows an interpretive approach could enhance understanding of how organizations interpret and handle risks and injuries, as well as
barriers to injury prevention, arguing that such an approach is required to go beyond superficial change.

In a study of hazardous offshore environments, Mearns et al. (2001) found that perceived management commitment was strongly positively related to satisfaction with safety activities, willingness to report incidents, and perceived supervisor competence. Perceived management commitment and satisfaction with safety activities were both significantly negatively correlated with unsafe behavior measures. Willingness to report injuries was negatively correlated with unsafe behaviors under incentives. Comparing scores on safety climate scales in Year 1 with Year 2 injury rates, these authors found a negative correlation between satisfaction with safety measures and injury rate and a positive correlation between injury rate and general unsafe behavior. The study indicated that only very practical measures, such as high satisfaction with safety measures and low incidence of unsafe behavior, were directly correlated with personal injury. Perceived management commitment was strongly positively correlated with satisfaction with safety activities, willingness to report incidents, and perceived supervisor competence. Other studies have found that management commitment, measured as a safety climate scale, was a strong predictor of individual level injury involvement (Hofmann et al., 1995; Harper et al., 1996; Hofmann & Stetzer, 1996; Sutherland et al., 1997; Cheyne et al., 1999).

Silva et al. (2004) developed a 78-item questionnaire to measure both organizational climate and safety climate, which they used in 15 Portuguese companies from various sectors in which they also measured injury rate, injury frequency rate, and injury severity rate. They found that their Organizational and Safety Climate Inventory significantly discriminated between organizations and that safety climate content, safety practices, and personal involvement were all highly correlated with injury rate. Their analyzes suggested that a stronger safety climate is associated with fewer injuries and less severe injuries. However, Navestad and Saxvik (1996), and Reason (1998) suggested that safety climate data aggregated to installation level may predict organizational performance as measured by near-hits and dangerous occurrences more accurately than by personal injury.

In his analysis of the Glenbrook rail disaster (McInerney, 2001), Hopkins (2005) determined that it was more important to ask why errors occurred than asking who is to blame, which is typical of a rule-based culture. Characteristics of the rule-based culture of the organization involved were those outlined below:

- Rule-focused and impossible for operatives to know all the rules
- Rules overly complex with many inconsistencies and impracticalities
- Existence of silos meant restricted communication and responsibilities
- On-time running was paramount
- A risk-blind or risk-denying culture resulted in worker disempowerment

Despite these barriers, workers developed workable informal ways of operating the system. If something went wrong the usual reaction was to consult the rulebook to determine which rules had been infringed and by whom. Little attention was paid as to whether the rules were effective risk control measures. “The existence of rules seemed actually to deaden awareness of the risks which the rules were intended to control” (Hopkins, 2005, p. 39). Hopkins observed that inquiries focusing on rule violations tended to stop at the point at which a rule has been found to be broken, rather than to explore all the other factors that could have contributed to an incident.

The silo mentality meant that there was a tendency to ignore problems facing people in other parts of the system or to recognize that some problems might require a system-wide solution. Antagonism between parts of the rail system and between different occupational groups arose partly as a result of historical changes. On-time running resulted largely
from external stakeholder pressure — mainly passengers in this case. The percent of trains running on time was measured — giving the message that this was a priority. "Management had set up a system which enabled it to monitor performance with respect to on time running in an extraordinary detailed way. . . . By way of contrast, the only safety statistics he [network operations manager] saw were the numbers of injuries occurring to train crews and signallers, and these were made available to him once a fortnight" (Hopkins, 2005, p. 53). A similar culture that placed performance above safety considerations was also identified as a feature of the Ladbroke Grove inquiry (Cullen, 2001b).

11.5 Changing toward a positive safety culture

There is little or no theoretical basis for determining what makes an organization's safety culture positive, healthy, strong, excellent, or merely good (Glendon, 2006). However, Hopkins (2002, 2005) distinguished between an absolute concept of safety culture on one hand (i.e., only organizations that have achieved a certain level of safety awareness can be said to have a safety culture), and, on the other hand, a relativistic conception (i.e., all organizations have a safety culture, but these exist on a continuum). Proponents of the former designation include Hopkins (2005) and Reason (1997). While a relativist approach permits comparisons on a spectrum, an absolutist approach requires identification of the threshold that an organization has to reach in order for it to be said to have a safety culture. The latter approach can be difficult to apply in practice as the definition of threshold level can only ever be arbitrary; whereas a relativist conception accepts that all organizations possess a safety culture, however poor many of these may be. Ultimately this is not among the most important safety culture debates.

11.5.1 Indicators

Glendon (2006) identified a number of listings purporting to represent the characteristics of a good safety culture (see Summary Text 11.3); although these vary, they commonly emphasize the importance of senior management commitment to safety and effective communications. The HSC (1993) suggested that organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures. From their review, the HSC (1993a) concluded that effective health and safety provision depends as much on organizational culture as upon specific attention to health and safety matters. Pidgeon (1991) argued that the three essential elements of a good safety culture were those outlined below:

- **Norms and rules for handling hazards**: These are explicit or tacit corporate guidelines for defining what is and is not to be regarded as a significant risk
- **Attitudes toward safety**: Individual and collective beliefs about hazards and the importance of safety, together with motivation to act on those beliefs
- **Reflexivity on safety practice**: A search for new meanings in the face of uncertainty and ambiguity about risk

Factors identified as supporting development of a positive safety culture include management (e.g., commitment, ability, leadership, participatory style, and communication) (HSE, 1997a; Lingard & Rowlinson, 1997; Reason, 1997; Simard & Marchand, 1997; DePasquale & Geller, 1999; Cox & Cheyne, 2000; Pidgeon, 2001; Gadd & Collins, 2002); supervisors (e.g., lead by example, support, and participatory style) (O’Dea & Flin, 2001); individual and behavioral factors (e.g., involvement, competence, and attitudes)
Summary Text 11.3 Features of a Positive Safety Culture

The Confederation of British Industry (1990) argued that important elements of safety culture included those listed below:

- Executive safety role for line management
- Leadership and commitment of chief executive
- Involvement of all employees
- Openness of communications
- Demonstrated care and concern for all those affected by the business

Ryan (1991) identified these four critical indicators of safety culture:

- Effective communication
- Good organizational learning
- Organizational focus upon health and safety
- Managing external factors that affect the organization’s financial health

The International Civil Aviation Organization (1993) maintained that a good safety culture is one in which the following points held:

- Senior management strongly emphasize safety
- Staff understand workplace hazards
- Senior management accept criticism and are open to opposing views
- Senior management foster a climate that encourages feedback
- Communicating relevant safety information is emphasized
- Realistic and workable safety rules are promoted
- Staff are trained to understand the consequences of unsafe acts

(Geller, 1997; Cooper, 2000; van Vuuren, 2000); reporting systems (e.g., report near-hits, no-blame approach, feedback, and confidential) (Brown et al., 2000; Cullen, 2001b); workforce involvement in risk assessment and developing best practice (Embrey, 2000b); rules and procedures (e.g., clear and practical) (HSE, 1997a); and good communications (Brown et al., 2000).

Pidgeon (1991) elaborated that effective norms and rules are not just about developing prescriptive procedures to deal with foreseeable hazards, but being alert to unforeseen hazards, and monitoring for information from a variety of sources, including outsiders and internal whistle-blowers. This openness operates at both individual and collective levels. Promoting safety attitudes depends on propagating norms and rules for handling hazards throughout an organization, and for senior managers to hold realistic views about the organization regarding hazards. Positive safety attitudes need to be developed by all members of an organization and cannot be imposed by any one group. Pidgeon also suggested that reflexivity could be developed through feedback systems, for example, incident, injury, and near-hit reporting at industry-wide as well as organizational level.

Several researchers (e.g., contributors to Cox & Flin, 1998) have argued that diversity and flexibility are essential to an organizational culture that contributes positively to safety. This challenges a functionalist assumption that a monolithic culture across an entire organization is desirable, and is premised upon the certainty of an unknown future in which
incidents or disasters will differ from those previously experienced and also be difficult to imagine, but which could nevertheless occur. A number of authors (Reason, 1997) caution that seeking to use components of safety culture as a defense in depth against major incidents, perhaps through a total safety culture ideal, is doomed to long-term failure through organizational complacency as well as lack of diversity and flexibility of response.

11.5.2 Drivers of change

Much has been written about the virtues of having a positive safety culture, but much less guidance issued about how organizations should go about changing toward this goal (Clarke, 2000). The following sections identify drivers of change through discussion of a number of different approaches to achieving a positive safety culture.

11.5.2.1 Direct cultural change

As noted in Chapter 9, much research emphasizes the importance of the role played by managerial staff in organizational safety. Managers’ attitudes toward safety contribute to an organization’s safety culture; therefore, senior managers need to possess both genuine commitment to improving safety and also capability to action their commitment in policies and practice. Reason (1997) referred to the “three Cs” listed below, which are essential at the most senior level of management, as a driving force toward a positive safety culture:

- Commitment — in terms of motivation and resources
- Competence — collecting the right type of information in order to take action
- Cognizance — being aware of dangers

Although Reason (1997) noted that safety culture is more enduring than current top management commitment, this would be a point of leverage for changing toward a positive safety culture, as increased evidence of senior management commitment to safety would cascade down an organization through improvements in safety climate at workforce level. Methodologies could include qualitative and ethnographic techniques reviewed in the previous section to evaluate existing safety culture. Interventions at this level involve working with senior managers to institute a cultural change throughout the organization. As noted in Chapter 9, management training can be effective in changing corporate behavior in relation to safety compliance (Stokols et al., 2001). However, there are relatively few documented illustrations of successful interventions at this level.

The culture change style of intervention has been described as a trickle-down approach (DeJoy, 2005) — that is, change is instituted at the most senior levels and positive effects then dissipate throughout the organization. One difficulty with this type of model is that it depends on effective communication (another indicator of a positive safety culture). Clarke (1999) demonstrated that even where senior managers, first-line managers, and the workforce share similar patterns of safety perceptions, misperceptions concerning other groups could still exist. Interventions to change the safety vision of senior managers will not be effective unless the message can be communicated to the workforce. Flin (2003) reported on the use of 360° feedback and upward appraisal in one organization to identify and reduce communication failures between senior management and workforce, where the role of middle managers in this process was emphasized. Another important aspect of ensuring cultural change is managing the crucial relationship between first-line management and workforce; if enhanced trust can be developed at this level, it can help to cement new cultural values within an organization.
11.5.2.2 **Indirect cultural change**

The wider literature on organizational change presents substantial evidence of the difficulties in achieving successful culture change. Senior (2002) argued that culture could not be changed by trying to change it; rather, culture change depended on changes in behavior, which in turn lead to changes in attitudes and values underlying behaviors. Whilst a culture change approach based on engaging senior managers in order to change their values and beliefs is designed to have a trickle-down effect, a behavior change approach is based on engaging the workforce to change their behavior, which then has a bubble-up effect (Dejoy, 2005). This indirect changing of safety culture has been demonstrated in a number of examples within this book of initiatives that are implemented not with the intention of changing safety culture, but that nevertheless act as initiators of cultural change. These include those described below:

**Behavior modification programs** (Chapter 3). These are aimed at changing specified unsafe worker behaviors through reinforcement and feedback. The literature shows that the most effective programs continue to improve safety performance where there is ongoing management support, mutual trust between managers and workers, and action taken to tackle problems identified by the process (e.g., task or work redesign, and environmental changes). However, these changes can only be observed in organizations that already exhibit a degree of cultural maturity prior to program implementation (including, managers’ express willingness to empower workers to make observations and recommendations; workers express willingness to trust managers; and adequate systems in place to deal with more frequent communications between management and workforce) (The Keil Centre, 2000). Behavioral safety programs cannot transform culture in an organization that is strongly negative — for example, exhibiting distrust and suspicion between managers and workers, industrial relations problems, and lack of resources and management commitment (Fleming & Lardner, 2002). A key outcome for a successful behavior program is enhancing interpersonal trust between workers and management.

**Health promotion programs** (Chapter 7). These are designed to improve individuals’ health and well-being through a variety of techniques, including improved diet, increased exercise, weight loss, smoking cessation, and stress management techniques. These programs have demonstrable effects on worker health (Dugdill & Springett, 1994; Demmer, 1995), and have also been shown to reduce work injuries (Shannon et al., 1997; Mearns et al., 2003). Safety benefits of health promotion programs may derive from their direct and indirect effects on both perceptions of safety culture and experiencing occupational stress (see Figure 11.2). Workers’ perceptions of managers’ concern for worker well-being by introducing a program may serve to improve safety climate, directly affecting work injuries and also enhancing general well-being. In addition, successful health promotion programs could actively promote general health and well-being, which directly affects work injuries. In the longer term, use of stress management techniques and increased resistance to stress (through greater physical health and fitness) can help to reduce the experience of occupational stress, which can also have direct and indirect effects on injury liability. However, as noted in Chapter 7, stress interventions, particularly when implemented as isolated initiatives may only have temporary effects in reducing stress (Murphy, 1988). Thus, stress symptoms are reduced as a result of treatment and job perceptions become more positive in the short term. However, these changes may decay over time as workers return to an unchanged work environment, with the same level of stressor exposure. Evidence suggests that multi-perspective approaches to stress intervention, which include measures aimed at both prevention and remedial action, have wide-ranging effects, including long-term improvements in mental and physical health, improved work climate, better industrial relations, and greater
productivity (Giga et al., 2003). Such approaches often include primary-level intervention techniques, such as work redesign, increased autonomy, and worker participation.

**Autonomous work teams** (Chapter 8). Decentralizing decision-making powers to groups of workers, involving increased responsibility and control at group-level. Introducing autonomous (or self-managing) teams is rarely undertaken to improve safety; however, positive safety benefits have been documented (see Chapter 8), particularly associated with team empowerment (see Chapter 9). Increased autonomy and worker participation associated with team empowerment can encourage team members to take greater responsibility and ownership of safety, which in turn can serve to enforce behavioral norms (rules or standards established by group members to denote what is acceptable and unacceptable behavior) and promote safety-related behavior, particularly in the face of production pressures. Autonomous teamworking has also been noted as an indicator of high-performing organizations; thus, it may form part of a range of commitment-oriented management systems, which together contribute to a high standard of safety performance and low injury rates (see Chapter 10).

**Safety committees** (Chapter 8). These formal committees, including workers, are set up specifically to deal with safety issues; joint consultative committees are likely to include managers and union representatives. Although evidence for the effectiveness of these committees is mixed, O’Toole (1999) showed that plants that encouraged wider worker participation in safety activities, beyond the safety committee structure, experienced less severe injuries. Factors influencing success in reducing injuries included managerial support for worker participation and voluntary initiation of safety committees (i.e., those initiated by the organization, rather than those established in compliance with regulatory requirements). Thus, the workforce could view introducing and operating safety committees as an indicator of management commitment to safety, influencing safety climate. A more positive safety climate will ensure that any changes recommended by the safety committee are less likely to meet with workforce resistance.

As can be seen from these examples, in many cases, cultural change is achieved due to (1) an initiative demonstrating management commitment to safety and (2) worker participation leading to greater ownership and involvement in safety. In other words, indirect change comes about through changes in safety climate. However, rarely does this type of indirect cultural change take place in isolation; it is usually accompanied by environmental or other changes, such as improved safety measures, safer work environment, behavioral changes in managers and supervisors, or an enhanced reward system. Cultural change also depends on the initial cultural baseline of an organization. For example, where safety committees were instituted in response to regulatory pressure, they were significantly less effective in reducing injuries; similarly, behavioral change programs failed to produce lasting effects in companies characterized by a weak or negative work climate. Therefore, recognizing the need to change and willingness to enact change are prerequisites for the success of indirect bubble-up approaches to culture change.

Dejoy (2005) drew a clear distinction between two opposing approaches to workplace safety — one a behavior-based approach and the other a safety-culture approach — reflecting the extremes of the functionalist vs. interpretive distinction described earlier. However, the main differences between these approaches lie in the level of intervention and the techniques used to achieve change — the former focuses on actual behavior and uses applied behavior analysis or behavior modification techniques; the latter focuses on attitudes, culture, and sometimes uses questionnaires, but often ethnographic techniques, such as in-depth interviews. Nevertheless the aim of both approaches is changing toward a positive safety culture. This is evident, for example, in the work of Geller, one of the main proponents of a behavioral approach, who advocates behavioral techniques as a means to gaining a
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total safety culture (TSC; Geller, 1994). TSC status bears every resemblance to aspects of safety culture considered earlier in this, and previous, chapters, being characterized by the features listed below:

- Personal ownership of, and involvement in, safety: everyone feels responsible for safety and pursues it on a daily basis
- Engagement in safety citizenship behavior: going beyond the call of duty to identify unsafe conditions and behaviors, and intervene to correct them
- Supportive communications: safe work practices are supported via rewarding feedback from peers and managers
- Safety is an ongoing process: people actively care on a continuous basis for safety
- Safety is given top priority: safety is not a priority that can be shifted depending on situational demands
- An integrative approach to safety management: safety is a value linked with all other situational priorities

It is clear from the review in this chapter that a number of barriers can affect the success of both trickle-down and bubble-up approaches to developing a safety culture. Trickle-down techniques are vulnerable to communication failures, even where there has been success in changing top managers’ safety vision, due to perceptual differences between levels (Clarke, 1999; Flin, 2003). However, top management commitment per se is not sufficient to institute a change toward a positive safety culture. As noted by Reason (1997), not only is commitment required at the most senior level, but also competence and cognizance — that is, managers must have the requisite knowledge to apply the most appropriate solutions and also awareness of the relevant problems — described by Dejoy (2005) as the issue of right problems, right solutions. On the other hand, behavioral safety programs do not always have lasting effects on an organization, as positive effects may be difficult to sustain in the long term (see Chapter 3). In addition, behavioral programs in particular have been criticized for being control oriented and victim blaming. As noted earlier, the need for change is only recognized by managers as existing at workforce level, rather than elsewhere in the organization (including their own contribution). Dejoy (2005) referred to these as problems of right messages, right people, as bubble-up approaches that depend on managers sending appropriate messages to workers (i.e., that they are interested in their welfare and genuinely committed to improving safety) and also effective communication of information from workforce to management. In response to drawbacks associated with both models of change, Dejoy (2005) proposed an integrated approach, focusing on multilevel problem solving. This requires both management support and worker input, and includes both trust and effective commitment to developing a positive safety culture. The problem-solving core of this model bears resemblance to Reason’s informed culture (see Section 11.3.3), with its emphasis on collecting and analyzing safety information.

Managers are often frustrated by the failure of safety initiatives, which in their minds should have worked, and do not understand the reasons for their failure (Gillen et al., 2004). For example, a comprehensive training program was implemented by an organization in a qualitative study conducted by Gillen et al. to avoid problems with compliance. However, in the next project the same problems recurred with the training seemingly having no effect. As noted in Chapter 10, one of the most common reasons for the failure of training programs is a lack of a positive climate for transfer of learning, including support from first-line managers. In addition, particularly when used in isolation, training will have no effect if the newly learnt procedures cannot be implemented due to inadequate equipment, resources, or supervisory commitment (Colligan & Cohen, 2004). Indeed, it
could be counterproductive as it might only serve to demonstrate management’s inability to provide a safe working environment and their unwillingness to invest in appropriate equipment. There is also a danger in applying isolated, prepackaged safety solutions from external consultants who do not understand the particular problems faced by an industry or an organization. A quote from one of Gillen et al.’s interviewees illustrates this well, “hiring fancy consultants, especially for a small or medium sized company, to prepare a voluminous safety program [can be unsuccessful] ... [one company] had a box full of big books, [they] set them on the table, [and said] ‘This is our safety program.’ [But] you look out of the window, there are guys thirty feet up in the air, no safety belt, no hard hat, leaning over. It just didn’t work. It was just one of the worst things I’ve ever seen” (p. 238). Reflecting a number of the points discussed in this section, Summary Text 11.4 describes one organization’s safety culture change program (Bryden & Hudson, 2005).

11.5.2.3 Climate change

The body of work on safety climate, and its relationship to safety culture, was reviewed earlier in this chapter (see Section 11.3.8). Safety climate acts as another point of leverage for changing underlying safety culture, which can be accessed indirectly through successful safety interventions, but also directly through the use of safety climate surveys. The U.K. Health and Safety Executive (HSE) developed a climate safety tool (CST) with the explicit aim of helping organizations to promote worker involvement in health and safety and to improve aspects of their existing health and safety culture and climate (HSE, 1997b). The tool involves workers answering a large number of precoded questionnaire items and contributing suggestions for safety improvements on an additional open-ended form. The Keil Centre (2002) evaluated the effectiveness of this tool over five years of its implementation in U.K. organizations. Whilst their report was largely complimentary about users’ perceptions of the effectiveness of the tool for improving safety in their organizations, results also highlighted some difficulties associated with measuring safety climate as a means of promoting a positive safety culture. Key results from this study are outlined below:

- Due to the volume of data collected by a survey of staff perceptions and attitudes, many organizations felt overwhelmed by the amount of data produced.
- Organizations did not take actions as a result of the survey, due to resource and time limitations, unless there was a strong commitment to see the CST through (e.g., from the project manager).
- Effective communication of results depended on preexisting communication channels for disseminating results (this was best achieved by organizations that also provided a good prebrief and gained a high response rate).
- Interest had a tendency to tail off unless workers were kept informed about progress on actions (“If you don’t do it again [workers get the feeling that] it’s ‘flavour of the month.’ And the worst thing to do is to raise expectations and deliver nothing.” The Keil Centre, 2002, p. 13).
- Sustained levels of worker participation and interest in the intervention were more closely related to visible actions being undertaken by the organization as a result of the CST process, rather than undertaking the CST itself.

Thus, a number of the problems with safety climate surveys identified in this report bear some similarity to those highlighted for other safety interventions, including maintaining interest and enthusiasm, effective communication systems, need for management commitment, and management willingness to make environmental and other
Summary Text 11.4 Shell International Exploration and Production's Hearts and Minds Safety Culture Change Program

The context for the Hearts and Minds safety program included the Swiss cheese model of accident causation (Reason, 1990; Wagenaar et al., 1994), continuing commitment to managing safety, health, and environmental (SHE) issues, the Piper Alpha disaster and subsequent report (Cullen, 1990), and ISO 14001 standards.

One aim was to move beyond a management systems top-down control approach as the basis for effective SHE performance. While the program was designed to run itself as far as possible, requiring no consultants and minimal external facilitation, it was carried out in collaboration with researchers from universities in The Netherlands and the United Kingdom. The underlying philosophy was Westrum’s (1993) 5-stage evolutionary approach to safety culture, representing increasing trust, accountability, and information outlined below:

- Pathological — noncaring, based upon not getting caught
- Reactive — things may happen only after accidents
- Calculative — based upon systems, audits, and collecting statistics
- Proactive — resources available to work on problems; procedures “owned” by workforce
- Generative — chronic unease, new ideas welcomed, and safety seen as profit center

Consistent with an incremental change approach program micro-tools to support development of an advanced safety culture needed to have the characteristics described below:

- Seek to change attitudes and behaviors, be documented, and achievable within one hour
- Fit with daily activities, such as toolbox talks and safety meetings
- Be used by supervisors and their crews
- Based on facts about human behavior, be fun to use, and effective

The tools were developed as workshops, described in brochures with a maximum of 12 pages. The three described below had wide application:

- Risk assessment matrix — takes people through the RA (risk assessment) process so that they better understand the risks that they personally face
- Seeing yourself as others see you — an upward appraisal tool to confront senior managers’ safety priorities, trust, and commitment
- The rule of three — to aid people’s personal situation awareness

Four brochures for particular problem areas identified were:

- Rule breaking and failing to follow procedures — based upon research into types and causes of violations, in which participants identify violations within their areas and seek solutions toward greater compliance. Improvement could come from removing the cause of a violation.
• Improving poor supervisory skills — developed from a leadership model, involving supervisors working in groups to develop practical improvement plans.
• Working safely to eliminate unsafe acts — using behavior-based safety management principles to work through a sequence involving precontemplation (ignorance), contemplation (awareness), preparation (planning), and action (doing), plus monitoring (improvement/maintenance).
• Driving for excellence — because a majority of fatalities occurred on the road, taking drivers and supervisors through workshops to deal, inter alia, with commercial pressures and expectations.

General versions of the brochures are available from www.energyinst.org.uk/heartsandminds


changes recommended by workers. The counterproductive effect of raising worker expectations, but failing to deliver visible results, is also highlighted. There is some indication that safety climate surveys may operate in a quite similar fashion to behavioral safety programs and other indirect cultural changes, where the main drivers of change are associated with demonstrating management commitment to safety by introducing a program and the visible enactment of that commitment through instituting environmental, organizational, or work design changes. Disadvantages of using a methodology such as safety climate surveys to achieve these outcomes include that large-scale surveys can provide a large amount of data that may be difficult to interpret, it is a rather unstructured way of prioritizing follow-up actions, and there is a tendency for organizations to be guided by a relatively unsystematic reviews of workers’ safety suggestions. While this methodology has the advantage of encouraging worker participation, in cases reviewed by The Keil Centre, organizations found this difficult to manage, particularly giving positive feedback to those making suggestions.

As discussed in Chapter 10, an integrated risk management approach is recommended for managing human risks in organizations. This approach emphasizes systematic assessment and evaluation of risks throughout an organization, prioritizing risks and developing action plans to manage them, and implementing organizational as well as individual and group-based risk management interventions. The strength of such an approach is a focus on managerial and organizational interventions to manage risk, which recognizes the importance of all levels of management in safety (an aspect that is largely overlooked in other approaches, including behavioral and culture change perspectives). Furthermore, integrating a systematic risk management perspective with human resource management emphasizes using HR practices to enhance safety through worker commitment and involvement. Management commitment to such a system is likely to become embedded as executives see short-to-medium term bottom-line benefits of lowered costs and reduced injuries, and be further reinforced by longer-term benefits of enhanced worker relations and improved productivity. The extent to which such a risk management approach to safety can facilitate development of a positive safety culture is discussed further in the following section.

11.6 Safety culture and risk management
A number of authors have devised guidelines for developing a safety culture, including Toft (1992), Wilson-Donnelly et al. (2005), and Glendon (2006). Key points from
Summary Text 11.5 Guidelines for Developing a Safety Culture

Toft (1992) argued that a holistic approach is required to change safety culture, involving the factors listed below:

- Sustained management commitment
- Sound safety policy
- Visible management support
- Allocating sufficient resources
- Using appropriate safety management techniques
- Continuous motivation of all staff
- Safety training provision
- Fostering a no-blame culture
- Organizational learning
- Persistence of purpose

Glendon (2006) suggested that, from various sources, key safety culture dimensions included those listed below:

- Extent of trust and shared concern for safety among groups within the organization
- Variety of perceptions and other aspects of culture among sub-groups
- Organizational learning, including reflection on practice and feedback systems
- Norms and rules permitting flexibility in dealing with all types of safety issues
- Top management commitment, support, and resource allocation
- Soundness of safety policy and applied safety management techniques
- Continuous motivation of all staff
- Safety training provision
- Fostering a problem solving and not a blaming approach to safety issues
- Persistence of purpose

Wilson-Donnelly et al. (2005), based on an extensive review of the safety literature pertaining to manufacturing industry, proposed the guidelines outlined below for creating a safety culture:

- Make people believe in safety: start at the top — get commitment from upper level management, provide feedback to workers.
- Send appropriate signals that safety matters: communicate them clearly and precisely — effective safety policies and procedures; avoid normalization of deviance (i.e., normal violations as discussed previously in Chapter 4); get workers involved.
- Encourage discussion and documentation of errors: create a climate for learning; have good information flow; and develop an error reporting system (these are the fundamentals of an informed safety culture as described by Reason, 1997, see Section 11.3.3).
- Search for solutions: examine all levels and promote different methods — including existing multilevel approaches to accident investigation.
• Prepare people through training: provide the competencies needed — including safety culture training (where the aim of the training is to create an awareness of risk taking and appropriate courses of action when a dangerous situation occurs).

These publications are summarized in Summary Text 11.5. Repeated themes within these guidelines, including an emphasis on top management commitment and safety training, are also reflected in empirical evidence identifying key antecedents of a positive safety culture.

11.6.1 Antecedents of safety culture

Hopkins (2005) identified sources of culture as including public pressure, disaggregation of industry bodies, and isolation of different occupational groups. Concluding that management commitment to safety had less impact on safety cultures and quality of safety activities than sometimes found in the safety climate literature (Mearns et al., 1998) and Richter and Koch (2004) suggested that macro-cultures had an important impact on the quality of safety work — for example, management networks, trade unions, professional identity, and societal regulation — which impact across organizations. Also important were internal structures and social relations, including division of labor, work content, power relations, traditions of participation, and broad commitment to safety.

A body of empirical research has attempted to identify factors that influence perceptions of safety culture. For example, in a study examining perceptions of three distinct groups of workers in U.S. haulage firms (drivers, dispatchers, and safety directors), Arboleda et al. (2003) examined four possible antecedents of safety culture: drivers' safety training, driver scheduling autonomy, opportunity for safety input, and management commitment to safety. The authors defined safety culture as, “the level of concern their organization demonstrated regarding safety and fatigue” (p. 192). The study found that two antecedents (driver fatigue training and driver opportunity for safety input) significantly impacted perceptions of safety culture for all three groups; one antecedent (driver autonomy) had no significant effect for any group; whilst the third antecedent (management commitment to safety) was significantly predictive for all groups, but the strength of the relationship varied between groups (such that the relationship was strongest for drivers, followed by dispatchers, and finally safety directors). The nonsignificance of driver autonomy was accounted for by its potential to encourage drivers to work longer hours, which increased bonuses but diminished safety. The authors concluded that senior managers should be sensitive to how their commitment to safety is viewed by workers, as their perceptions of safety culture are largely determined by their perceptions of top management commitment to safety. Clarke (1999) also supported perceptual differences between hierarchical groups in relation to safety priorities. Gillen et al. (2004) used focus groups of construction managers to identify antecedents of a positive safety culture; factors identified by managers included the following three factors:

1. Management commitment to and support of safety practices. The most successful managers were described as, “involved, proactive, principled, innovative and not afraid to take a stand” (p. 235) — characteristics that relate to aspects of transformational leadership discussed in Chapter 9. Managers need to buy into safety, that is, preaching safety and meaning it (p. 240).
2. Training. Safety training and continuing education to keep skills up-to-date — this was particularly effective within smaller firms when combined with incentives, such as lower insurance premiums.

3. Changes in workplace culture. Setting safety goals; decentralizing and empowering people who have a day-to-day working knowledge; and acknowledgement that work can be done safely. Failure to modify existing cultural norms (e.g., we’ve always done it this way) was identified as a major obstacle to establishing a positive safety culture.

These studies, which focused on managers’ perceptions, reinforce findings described throughout this book, which have been largely derived from studies of lower-level workers. For example, workplace safety climate was found to have strong positive correlations with job control, training, and social support (Goldenhar et al., 2003). Thus, research has emphasized worker autonomy, adequate safety training, and support from managers, supervisors, and coworkers, and worker participation and management commitment to safety as important antecedents to perceptions of a positive safety culture across an organization.

11.6.2 Safety culture as a form of risk control

According to an anecdote from a colleague of one of the authors, it has been observed that university students who sit toward the front of a lecture theatre achieve significantly better marks than do those sitting toward the back — however, high marks cannot be achieved simply by moving from the back of a lecture theatre to the front. Likewise, organizations seeking to implement a set of safety practices and procedures, even though research, has highlighted these practices as associated with a positive safety culture cannot be ensured of success. Gillen et al. (2004) showed that managers who have done the right thing might nevertheless observe little or no effect on their safety record. However, just as a student’s arrival at the front of a lecture theatre must be accompanied by an increase in attention and motivation to learn, so organizations implementing safety initiatives must accompany them with changes in attitudes and beliefs throughout the organization. As Reason (1997) argued, identifying and developing essential characteristics of a safety culture through social engineering is not enough to truly have a safety culture: one can construct the elements of a safety culture, but like Frankenstein’s monster, it requires a certain spark to bring it to life (Clarke, 2000). This is usually much easier said than done. Despite relative consensus in respect of factors that influence development of a positive safety culture, conspicuous by its absence is rigorous empirical research needed to guide organizations in the practical application of such factors.

In the absence of such practical advice, there is a danger that organizations’ attempts to develop a safety culture may actually reinforce a cycle of failure (Pidgeon, 1998a), particularly where inappropriate models are implemented to encourage organizational change (such as a traditional engineering model; Toft, 1992). Hopfl (1994) warned that management attempts to impose a corporate culture on workers can conceal discrepancies and gloss over dysfunctional aspects. Mechanisms used to develop safety culture may focus on a common rhetoric, underpinned by observable artifacts, including appropriate methods, manuals, systems, and structures, which ensure standardized behavior from workers. However, overemphasizing external appearance of safety can lead to workers placing greater stress on consensus of behavior than the meanings upon which that behavior is based. Rather, a safety culture must imply, “some level of relationship between the corporate culture of an organization and the culture of the workplace” (Hopfl, 1994, p. 55).
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While there has been a tendency amongst organizations to take a rather narrow view of safety interventions, there is growing evidence that at least some are taking a broader perspective. For example, interventions aimed at altering safety behavior — such as reducing violations, can be targeted at changing safety culture (Parker et al., 1995). Such interventions would target the climate within which violations occur, rather than the behavior itself (e.g., strict enforcement of all rules and regulations). A safety culture that encouraged over-rigid application of rules and regulations would be likely to create a frame of reference within which behavioral consensus (compliance) is perceived as valued above appropriate (safe) conduct (Hopfl, 1994). Developing a just culture involves, “an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behavior” (Reason, 1997, p. 195). This approach can be reinforced by rewarding acceptable behavior and sanctioning unacceptable behavior — as opposed to a no-blame approach, where blame is not attached to actions. A safety-based intervention of this kind would be most effective as part of a broader intervention package aimed at improving worker communication throughout an organization. Neal et al. (2000) suggested that interventions aimed solely at improving safety motivation (e.g., bonus and incentive schemes) are unlikely to be as effective as interventions that target both knowledge and motivation.

Morrow and Crum (1998) found that safety culture was a significant predictor of work-related attitudes, including work satisfaction, job involvement, organizational commitment, and intention to stay. The authors noted that, “improved safety perceptions may have positive spillover effects on employee-related attitudes, perceptions and behaviors” (p. 310). In a study examining the impact of safety-related variables on nonsafety outcomes, Michael et al. (2005) found that workers’ perceptions of management commitment to safety were positively correlated with job satisfaction and withdrawal behavior; there was also a strong positive association with affective commitment. Thus, there are potentially much wider benefits, in terms of more general job-related performance, from developing a positive safety culture than just safety-related outcomes. This acts as further evidence for integrating safety into mainstream management.

11.6.3 A risk management approach to safety

In Chapter 10, a risk management approach to safety was advocated that incorporated an emphasis on strategic integration of safety with other organizational objectives and using commitment-driven HR practices to encourage worker involvement and participation. This constitutes a systematic approach to identifying and evaluating risks within an organization. A major obstacle to successful implementation of safety initiatives identified by Gillen et al. (2004) was a failure to link safety with productivity. Operating safely should be as much a part of an organization’s mission as being financially successful. When safety is embedded as an organizational value, it represents an important step toward achieving a positive safety culture. Hopkins (2005) observed that, “Organizational cultures may be detrimental to safety, not because leaders have chosen to sacrifice safety for the sake of production, but because they have not focused their attention on safety at all. . . . if leaders attend to both production and safety, the organizations they lead will exhibit a culture which potentially emphasizes both” (p. 9).

11.6.3.1 Management commitment to safety

As noted earlier, a major driver of safety culture change is senior managers’ commitment to safety; however, this must be accompanied by both competence and cognizance (Reason, 1997). These factors can be enhanced through an effective risk management approach to safety, such that relevant knowledge and expertise is drawn from the process of identifying,
assessing, and evaluating risks. Whilst there is no simple generic ten-point plan that can be implemented to develop a positive safety culture as a result of the risk assessment process, as illustrated in this chapter, there is a wide range of potentially effective safety interventions that would demonstrate visible management commitment to safety. Schein (1992) observed that leaders create cultures by, “what they systematically pay attention to . . . this can mean anything from what they notice and comment on to what they measure, control, reward and in other ways systematically deal with” (p. 231).

Change in safety culture is achieved through visible management actions showing workers that their managers care about and are concerned with safety, for example, rewards, incentives for safe performance, training, investment in safety, and managing safety as any other function (Gilkey et al., 2003). For further practical examples, see Summary Text 11.6. Where management’s commitment to safety is clearly demonstrated through action, this is likely to lead to more positive worker perceptions of management process. O’Toole (2002) provided preliminary evidence of a strong causal relationship between improved management commitment to safety and a significant reduction in injuries. When workers gain the impression that managers are genuinely interested in improving safety, rather than only implementing safety systems in order to appease regulators and to comply with legislation, this encourages them to trust their managers. Trust in management is an important intermediate variable that can significantly influence safety-related outcomes. It has been found to mediate the relationship between transformational leadership and worker well-being (Sivanathan et al., 2004) and also the relationship between HPWS (high performance workplace system) and safety incidents (Zacharatos et al., 2005).

11.6.3.2 Worker involvement
Another driver of safety culture change involves harnessing worker commitment, involvement, and participation. Vecchio-Sadus and Griffiths (2004) suggested a number of promotional techniques that could be used to raise awareness of safety initiatives amongst workers (see Summary Text 11.6). As noted in Chapter 10, a number of HR practices can be used to encourage worker commitment, such as empowerment and decentralized decision making. Hofmann and Morgensen (1999) used a social exchange model to suggest that management commitment to safety encouraged return of worker loyalty through safe working behavior. O’Toole (1999) found that merely providing the opportunity and encouraging workers to participate in the safety process at eight manufacturing sites resulted in lower lost-time injuries and reduced injury-severity rates. Among seven safety factors, O’Toole (2002) found that management commitment to safety had the greatest positive perception by workers. O’Toole’s results suggested that worker perceptions were related to management commitment to safety, which in turn appeared to be related to injury rates. Whilst demonstrating management commitment to safety can help to build trust between workers and managers, interpersonal trust is a two-way street — managers must also trust their workers. This can be particularly difficult initially as within poor safety climates managers tend to view workers as responsible for injuries (and vice versa). However, as safety climate improves, views of both groups become more realistic and less polarized (Prussia et al., 2003).

Employing practices that encourage worker participation can serve to demonstrate that managers value workers’ opinions and suggestions, as well as acknowledging workers’ operational experience and expertise. Reason (1997) discussed how reporting systems could be used to develop feelings of trust through confidentiality, indemnity against disciplinary proceedings, and separating the system from those who impose sanctions. However, this trust will be undermined in a work environment in which, for example, workers repeatedly encounter unworkable rules, managers fail to take action, supervisors put production before
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Summary Text 11.6 Examples of Practices to Encourage a Positive Safety Culture

Indicative practices of management commitment to safety include those listed below (Gillen et al., 2004):

- Being willing to shut down unsafe sites
- Evaluate subcontractors on safety history as well as price
- Define safety expectations for workers and subcontractors
- Uniform enforcement of safety standards for all workers
- Praising workers directly for safe performance

Examples of safety-related rewards include those listed below (Gillen et al., 2004):

- Bonuses or raises for safety managers tied to safety performance
- Sending workers, rather than supervisors, on safety training or to conferences
- Employee ownership of the company
- Recognition for safety ideas or suggestions

Strategies used to motivate workers include those listed below (Vecchio-Sadus & Griffiths, 2004):

**Major strategies:**

- Promote management commitment — best demonstrated by allocating resources, including time, high shop-floor visibility, participation in risk assessments and consultative committees, and by completing actions.
- Promote worker empowerment, for example, by nonadversarial labor management and an incident investigation approach that does not focus on blaming individuals.

**Support activities:**

- Mission statements, slogans, and logos
- Published materials (library, statistics, and newsletters)
- Media (posters, displays, audiovisual, e-mail, and Internet)
- Seminars and training (short talks and group meetings)
- Special campaigns (Health and Safety Week, health promotion, emergency response, inductions, incident reporting and investigation, risk assessment, and environment)

safety, or workers are blamed when things go wrong. Positive reinforcement of safety culture must be seen to work on a daily basis throughout an organization in everything it does, thereby encouraging establishment of new group norms and internalization of safety values (see Chapter 6). The Keil Centre (2002) noted that conducting a climate survey was often not responsible for improvements in safety culture per se, but rather that enhancement was much more closely related to changes in the work environment instituted as a result. It is
also important to consider the dynamics of work groups when instituting cultural changes. Clarke’s (2005) meta-analysis of the relationship between safety climate and work injuries found the strongest relationship at group level. Thus, interventions should be considered not only from the perspective of the impact they will have upon individuals, but also the effect they will have on work groups and intergroup relationships.

Turner and Pidgeon (1997) observed that what constituted an acceptable risk within an industrial process is continually negotiated implicitly and explicitly. Hopkins (2005) explained that worker empowerment meant that a worker could refuse to do a job that they considered to be unsafe, for which they needed adequate risk awareness training. An incident reporting system is also essential and management needs to respond appropriately to incident reports. A focus on rules, blame, and production rather than expertise could disempower workers. Risk denial also reduces the power of workers to raise safety concerns. Workers need to be empowered to make safety-related decisions. Shaw and Blewitt (1996) and Vecchio-Sadus and Griffiths (2004) maintained that in addition to management commitment to occupational health and safety (OHS) and strong OHS management systems that are consistent with the desired culture, a key component of safety culture was worker empowerment and OHS involvement. Kelly (1996) observed that workers were more likely to demonstrate commitment to OHS if they were actively involved in decision making and problem solving and that empowerment was greater when workers were managed by principles rather than by endless rules. Worker empowerment promoted feelings of self-worth and belongingness, promoting the status of safety (Kelly, 1996).

Vecchio-Sadus and Griffiths (2004) maintained that properly managed change could result in improvements in the areas outlined below:

- Safety culture — management commitment and accountability, more workers taking ownership of their work environment.
- Risk management — more risk assessments, better job safety procedures, and other physical environment improvements.
- Overall performance — for example, lost time injury frequency rate (LTIFR), compensation claims, insurance premiums, incident investigations, and winning research contracts because of better safety culture.

11.6.3.3 Barriers
A number of barriers could hinder the risk management process, primarily time, money, and resources. Investing financial resources in implementing safety initiatives is crucial. As noted by The Keil Centre (2002), the worst course of action is to raise worker expectations of change and then fail to meet them, as this highlights managers’ inability to improve working conditions. However, commitment of resources in terms of personnel is also important. Safety initiatives often fail due to the lack of a champion to see them through. This is further evidence of the need to fully integrate safety into mainstream management, where safety is no longer viewed as an optional extra. Vecchio-Sadus and Griffiths (2004) described the necessity to sell safety initiatives to senior management as one of the most common challenges of health and safety professionals.

A further barrier is found in terms of embedded cultural norms and worker attitudes. Adie et al. (2005) discussed the point that safety culture is viewed primarily as a function of the organization as reflected in workers’ definitions. Thus, it is essential to develop worker commitment so that workers are more willing to see the relevance of their own input and individual responsibility for safety. This is particularly important where workers are contingent (e.g., temporary or short-term contract workers). Adie et al. (2005) found that divers on offshore oil rigs (who were often short-term contract workers) were most likely
to rate safety culture as having the smallest effect on risk perceptions compared with other factors, including supervisory control, worker competency, and time/financial pressure.

Rundmo (2000) found that perceived management priority of safety over production was a significant predictor of nonacceptability of rule violations, while worker acceptance of rule violations was a strong predictor of risky behavior. In organizations where safety climate was perceived to be poor, Prussia et al. (2003) found that managers believed that workers were responsible for workplace safety. They also found that similar perceptions of safety between supervisors and nonsupervisors were associated with worker perceptions of good organizational safety, and suggested that an indicator of poor safety culture was an attitude that safety was the responsibility of someone other than the workers themselves.

Describing a Royal Australian Air Force (RAAF) case study, Hopkins (2005) noted that, “attempts to enhance safety can be entirely negated by existing features of an organization’s culture, and . . . these features need to be tackled directly before any real safety improvement can be achieved” (p. 81). While the RAAF had an incident reporting system, it could not identify events with harm potential. For example, there was no effective reporting system for maintenance problems. As a result of public pressure the RAAF had greater concern for air safety than for ground safety. Other external factors affecting RAAF culture included government cost-cutting and downsizing. RAAF cultural values included: priority of operations over logistics, a can do attitude to problems, priority of platforms over people, and command and discipline system. The F111 desal/reseal programs relied on personal protective equipment (PPE) as the first line of defense rather than designing in engineering and administrative controls. While the RAAF recognized the hierarchy of controls in its publications, it did not put these into practice and there was no attempt to identify substitute nontoxic chemicals. This illustrated the platforms over people culture. There was also the very real threat of disciplinary action if orders were not obeyed. Normal OHS legislation did not apply to military operations on the grounds that it was believed that empowering workers to refuse to do a job that they considered unsafe could undermine the military authority system (Clarkson et al., 2001). In this case, a lack of risk awareness started at the very top (government). Hopkins (2005) argued the need to start from first principles to determine critical aspects of safety and how they can be accommodated. Even discussing risks of a job can lead to identifying means of control — that is, a risk assessment, while a degraded system is likely to pose additional risks.

It is also important not to ignore individual differences. Some individuals are more safety conscious than others and respond more readily to training. Recognizing individual differences in interventions to improve safety can help to ensure their success (see Chapter 5 on the influence of personality). For example, it has been noted that for interventions involving enhanced autonomy, workers who find added responsibility a burden rather than a benefit, may reject increased control.

11.7 Conclusions

This chapter has illustrated the variety found in definitions, theoretical approaches, and ways of measuring and developing safety culture. Despite attempts to draw these disparate views together, differences still exist. In terms of moving toward a positive safety culture, three approaches were identified: direct cultural change, indirect cultural change, and climate change. Each approach depends on a number of restricting factors. Direct cultural change depends on effective communication to overcome misperceptions concerning other groups, and successfully managing relationships between first-line management and workforce. Indirect cultural change depends on senior managers recognizing the need to change and being willing to enact change. Safety climate surveys depend on effective
communication systems and also need management commitment and a willingness to make environmental and other changes recommended by workers. Thus, it is evident that the main drivers of change are associated with demonstrating management commitment to safety and visible enactment of that commitment through instituting environmental, organizational, or work design changes. An integrated risk management approach aims to systematically identify, assess, and evaluate a range of physical and psychosocial risks within an organization and to recommend a range of interventions designed to enhance safety through developing a positive safety culture.
chapter twelve

Risk management — conclusions

A paradox that currently appears to beset a satisfactory convergence between risk-management theory and practice is that the more cogently developed models of risk, for example, cultural theory and the social amplification risk framework (Chapter 2 gives detailed descriptions of these and other approaches to risk), may be theoretically elegant and able to explain many aspects of risk in society, yet struggle to provide a basis for practical prescriptions for risk-management applications in organizational and other settings. Conversely, the least conceptually satisfying models, bordering on the atheoretical in the technical approach, have had the greatest practical contributions to make to risk-management practices to date. One potential option might be to seek greater convergence between the theoretically sophisticated and more practically relevant approaches to risk and its management. This brief chapter seeks to determine whether such integration might be achievable and illustrates some possible frameworks.

12.1 Staged approaches to managing safety risks

In their seminal discussion of the ages of safety, Hale and Hovden (1998) identified the first age as being that of technical risk assessment and prevention, followed in the 1970s and 1980s by the age of the human factor, and since the 1990s by the age of management systems. Seeking reconciliation between different approaches to safety management, Reason (1997) described person, engineering and organizational models for managing safety (Lucas, 1992). A finer grained analysis of the age of management has been proposed by Sue Cox and her colleagues (Cox & Cheyne, 2000), who characterized the 1980s as the time of line-management responsibility, or dependent culture; the 1990s as the period of independent culture, characterized by workers being responsible for their own safety, and the 2000s as the era of interdependent culture — a value-driven approach of which high-reliability organizations (HROs) are leading exemplars. Cox’s notion is of organizations progressing through these stages in evolutionary fashion.

However, like the evolution of the human triune brain (MacLean, 1990, 1993) characteristics of successive ages of safety may well not supplant earlier ways of thinking and acting (i.e., the cultures) of previous eras; rather they are more likely to build on previous structures, so that the contemporary collage of safety philosophies and practices remains rooted in the technical era, but has suffused this with layers of human factors applications and management systems. If the brain analogy is appropriate, this could imply that (high level, cortical) risk-management systems that appear to drive contemporary occupational health and safety (OHS) (or SHE [safety, health, and environment], QHSE, etc.) programs serve
more as the arbiters of which technical (represented as the corpus striatum or hind brain) and human factors (the socio-emotionally oriented limbic system or mid-brain) approaches to implement, and how to achieve this, rather than as stand-alone safety-systems architecture. If a fourth age of safety might be predicted, then it could be integrationist, in which some characteristics of HROs, described in earlier chapters, become more widely adopted. These might include genuine workforce empowerment — perhaps driven by a combination of a shrinking skills base and further erosion of dysfunctional social hierarchies within highly individualized cultures of Western industrialized countries, continuing competitive pressure for enhanced workplace performance, and greater understanding by political decision makers of the importance and desirability of an integrationist rather than a confrontational approach to industrial relations.

One example is provided by Håvold (2005), who recommended safety orientation as a concept that could unite safety climate and safety culture in the search for an international industry standard in safety, and which has similarities with Sue Cox’s notion of interdependence. Conceived as a continuous measure, if widely adopted, safety orientation would sidestep the pseudo-debate as to whether all organizations have a safety culture or whether only those at the very top end of the distribution do so. Håvold’s notion is that safety orientation would take account of the culture of the society in which an organization happened to be located, as well as relevant cultures and subcultures within and external to an organization, indicative of a multilevel analysis approach. The six contextual factors in Håvold’s model are organizational culture, professional culture, industry culture, national culture, regulations, and market competitiveness. Håvold’s model is an amalgam of some of the approaches described in this book and his notion of safety orientation incorporated the following factors:

- Safety rules
- Management commitment to safety
- Safety behavior
- Communication
- Work situation
- Job satisfaction
- Competence
- Management priorities and organizational risk
- Satisfaction with safety activities
- Reporting culture and supportive environment
- Fatalism

Derived from a selected literature review, unlike theoretical bases underpinning the notions of safety climate and safety culture, while Håvold’s model lacks what are generally considered to be essential groundings for a concept that could gain widespread acceptance, time will tell whether this represents a viable safety and risk currency that can satisfy both scientist and practitioner elements.

Hale and Hovden’s (1998) analysis also incorporated the notion that organizations might progress, in their case through a hierarchy of four frames, such that safety issues within a structural frame need to be addressed before organizations can move through the human resources and political frames, to arrive at managing risks within the symbolic frame. They noted the dominance of studies considering associations of safety performance with structural frame features and at the other end of the spectrum the near-absence of studies addressing organizational learning and change and SHE management. Their main findings are summarized in Table 12.1.
**Table 12.1** Main Findings from Published Studies on Organizational Factors and OHS Performance

<table>
<thead>
<tr>
<th>Frame</th>
<th>Main findings</th>
</tr>
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</table>
| **Structural** | *Positively associated with success in developing internal control systems:* Measurable goals, competence in organizational development, and access to external expertise and available resources  
*Positively related to low injury rate:* Availability of financial resources, problem-solving approach, stable workforce, safety training systems, good communication channels, good coordination and centralization of safety control, specialist in-company safety service, good records, small span of supervisory control, time for supervisors to plan, risk assessment activity, and evaluation and review systems  
*Ambiguous findings:* Some studies found positive association between quality and quantity of rules and good safety performance, while others did not (possible bias in reporting studies finding an effect?). Imposing centrally made rules on work groups is warned against by a number of studies |
| **Human Resources** | *Related to low injury rate/good environmental performance in at least one study:* Encouragement of participation/empowerment/innovation, feelings of control/efficacy/autonomy, informal organization, group norms, interpersonal/group communication, caring, leadership style — interpersonal skills and perceived concern for group and its dynamics, social policy, quality of work life, career progression, and mature workforce |
| **Political** | *Low injury rate related to:* Openness to criticism, good labor relations, low stress, and low grievance rates  
*Good safety performance related to:* External pressure from regulators and “order-seeking” management (as opposed to crisis management approach)  
*High injury rate related to:* Sanctioning of violations  
*Introducing an internal control system related to:* Good labor relations  
*Ambiguous findings:* Company profitability and availability of resources positively related to high safety in two studies but not in a third; both absence and presence of safety incentive schemes found to be related to low-injury rate (one study each); discipline — some studies found this was related to low-injury rate, others that low-injury organizations used counseling rather than discipline, while a third found these to be unrelated; no clear evidence on having a safety committee and safety performance, although on balance seemed to be better to have employee involvement in some form |
| **Symbolic** | *Positively related to safety:* Top management commitment, visibility of management commitment, supervisor commitment, personal commitment, importance of safety as a value, safety attitudes of coworkers, high satisfaction with safety program, and work as a source of pride in the organization  
*Low accident rate associated with:* Attribution of causes and attention to human factors rather than safety being viewed as a purely technical issue  
*Ambiguous findings:* Evidence on promotion of safety — one study found a relationship but not another, which Hale and Hovden attribute to the stage of the SHE management programs in the respective organizations |

12.2 Beyond a standards approach

Several countries have developed risk-management standards (RMSs) (including Australia/New Zealand, Canada, Japan, and the United Kingdom). In this section the joint Australian/New Zealand risk-management standard (Standards Australia, 1999: AS/NZS 4360) is used as a generic illustration of how RMSs alone are inadequate for managing the typically complex array of organizational risks. A RMS approach adopts an: identification, analysis, prioritization, treatment, alternative selection, implementation, and review sequence in respect of risks (see Waring & Glendon, 1998 for more detailed descriptions of RM approaches). From five major project case studies, Barber (2003) observed that 125 nontrivial risks were generated internally by these projects and that in four of these projects more than five of these risks were classified as severe, yet were not identified in risk registers or reports. Of all internally generated risks, just over one third were found to be treated in a managed way. Barber considered the shortcomings of an RMS-based approach to risk management to include those outlined below:

- It is reductionist, relying heavily on independently identifying and managing individual risks, thereby not reflecting real-world complexity of frequently interrelated risks.
- It relies upon documenting risks, yet many risks are difficult to identify or quantify — risks that are hard to document (e.g., internally generated risks) are effectively invisible to the risk-management process, possibly resulting in major disasters occurring in organizations that were apparently robust (McLucas, 2003).
- The approach to soft (e.g., human or organizational) risks is superficial and does not address underlying etiology.
- While it may be systematic, it is neither holistic nor systemic in identifying risks, thereby constraining the type of risks that are likely to be identified — for example, excluding subtle or temporary risks.
- It does not include a time-urgency dimension to augment traditional probability and consequences dimensions, meaning that there is no way of prioritizing risks on the basis of their relative time urgency.
- Other risk dimensions are also omitted, including treatment costs, political or other sensitivities, and interdependencies — that is, whether one risk impacts the probability of consequences of another risk in the matrix.

While Barber (2003) considered AS/NZS 4360 to be adequate for dealing with many engineering risks and for operating within an insurance environment for which historical data are available — the first two approaches to risk considered in Chapter 2, it is much less effective in dealing with softer, complex, and interrelated risks faced by organizations. Thus, a RMS should be considered as one tool in a repertoire of RM methods. Other tools are being developed, which may be able to capture more of the soft aspects involved in identifying risks, such as the use of cognitive mapping (Clarke et al., 2004).

Some literature suggests that, while there is limited evidence that a possible relationship exists between improved OHS performance and highly developed OHS management systems (OHSMSs), evidence is suggestive rather than conclusive (Gallagher, 2000; Gallagher et al., 2003). In a study of 20 cases, Gallagher (2000) found variation in respect of OHS performance within all four cells of a matrix formed by conflating two management approaches (traditional and innovative) and two safety strategies (safe person and safe place), although the innovative management safe place quadrant appeared to
perform best. Gallagher et al.'s (2003) conditions for OHSMSs to succeed were those listed below:

- OHSMSs must be customized to organizational needs and developed with stakeholder input
- Senior executives must be committed to OHS performance, provide adequate resources, make line managers accountable, and lead by example
- All organizational functions must be integrated with OHSMSs
- Workers must be encouraged and able to participate and be independently represented

It is interesting to note that Gallagher et al.'s list incorporated features of all three developmental stages of safety management proposed by Cox as among the requirements of OHSMS success.

Toft and Reynolds (1997) observed that relying on prescription might increase rather than reduce risk, if people thereby considered that risks have been taken care of. As an example, Barber noted that even if an ineffective team member could lead to catastrophic consequences in some circumstances, it is highly unlikely that this risk would be formally documented. Similarly it is unlikely that other latent conditions (Reason, 1997), such as inappropriate higher management policies, conflicts between key team members, or inadequate decision making at senior level, would be documented using only an RMS approach. Such risks tend to be managed in other ways, including living with (i.e., accepting) a risk as part of the broader, or informal management system, or finding ways around the risk without recourse to formally documenting or acknowledging it.

In the tradition of Reason's (1997) notion of latent conditions, or continual vigilance characterizing HROs (Weick, 1987, 1989, 1995, 2001; Roberts, 1989, 1990; Rochlin, 1989; Weick et al., 1999; Weick & Sutcliffe, 2001), or Pidgeon's perspective through safety imagination, organizational learning, and flexibility (Pidgeon, 1988, 1991, 1997), or Toft and Reynolds' (1997) informal inquiry designed to enhance active organizational learning, Barber's (2003) approach is to build upon that offered by an RMS on the basis of a philosophy that assumes that all decisions could lead to unseen risk and that unpredictable and unknowable risks could emerge at almost any time. Reason (1997) noted that safe and reliable organizations are characterized by their ability to shift from centralized control to decentralized mode whereby local operations depend largely on first-line supervisors' expertise, and that paradoxically, the success of such transformation depends upon a strong hierarchical culture. Barber's key trilogy of requirements for an effective approach to risk management comprises asking, and adequately answering, the following questions:

- Is the system alert to risks and opportunities, including those that are subtle, complex, or emerging?
- Is it effective in analyzing and understanding the true nature of those risks and opportunities?
- Does it respond appropriately for both long-term and short-term success?

Barber's basic equation has systemic alertness combined with rich understanding of risks leading to effective decisions and increased likelihood of project success. Each of these components has a series of interrelated questions about its likely effectiveness.

In moving beyond a purely RMS-based approach to managing risks, Barber and Burns (2002), and Barber (2003) considered the following features listed here as being attributes
of systemically aware and responsive project organizations:

- Performance management systems encourage appropriate risk behavior
- Clear accountability structures
- Integration of all risk systems, including quality and OHS
- Knowledge and information management enables awareness and understanding
- Tools and techniques match risk complexity at each management level
- Leadership and culture encourage all types of risk to be acknowledged

In common with other writers, Barber begins to expound an approach to risk management that reflects a developing schema in which ways of managing purely technical risks (the corpus striatum in our brain analogy), perhaps incorporating economic criteria (see Chapter 2 for a more detailed discussion), lays the basis for more social and organizational responses (as in the brain’s limbic system), which in turn are governed and sanctioned by reference to a high-order system (as the organizational cortex). Linking the evolutionary approach with that of adaptation (see Chapter 2 for a more detailed discussion of these approaches), complex organizations that have survived and thrived over a long period are likely to have managed well the risks that they have faced. Their cultures and systems are likely to have supported identification, analysis, and treatment of all types of risk, including those that are sensitive and difficult to document. Within such a context, RM is part of a broader task of managing for success.

Building upon a range of theoretical approaches to risk for evaluating and managing risks, including some of those considered in Chapter 2, Klinke and Renn (2002) identified the following three major strategies:

- Risk-based approaches
- Reduction activities derived from applying the precautionary principle (PP) (e.g., ALARP, BACT)
- Standards

In addressing a series of controversial issues in risk management, Klinke and Renn’s aim was to combine scientific accuracy with political feasibility while reflecting social diversity, much as in the more specific approach to increase the influence of pragmatic science that would combine both scientific rigor with best practice within organizational psychology, advocated by Anderson et al. (2001).

As do a number of the approaches to risk described in Chapter 2, Klinke and Renn (2002) set out an agenda for greater participation in risk decision making, including particularly intransigent issues associated with living with uncertainty. Within a context of competing approaches, with environmentalists supporting the PP and industrial and commercial interests fighting for a traditional risk-based approach, Klinke and Renn advocated a precautionary approach in the face of uncertainty, arguing for vulnerability management, robust response strategies, and developing resilience (Collingridge, 1996). Seeking reconciliation between physical and psychological (e.g., fear) harm from realized risks, Klinke and Renn added seven risk evaluation criteria to the traditional extent of damage and probability of occurrence, these being: uncertainty, ubiquity, persistence, reversibility, delay in effect, violation of equity, and potential for mobilization. Their analysis led to the description of six risk classes, named as characters from Greek mythology, which they identified as originating during a period of critical social change for the human species as our ancestors made the transition from being primarily hunter-gather groups to larger communities based on agriculture and animal husbandry. They claim that these changes would have
Chapter twelve: Risk management — conclusions

wrought a, “new culture of anticipation and foresight” (p. 1080). Klinke and Renn’s risk classes are as follows:

- Damocles — low probability risks with large damage potential (e.g., large-scale technology such as nuclear energy, chemical plants, dams; also widespread flooding).
- Cyclops — uncertain probability of occurrence, high and well-known disaster potential (e.g., many natural hazards).
- Pythia — uncertain probability both of occurrence and extent of potential damage (e.g., nonlinear climatic changes such as global warming).
- Pandora — high ubiquity, persistence, and irreversible risks with uncertain probability of occurrence (e.g., some human interventions in the environment).
- Cassandra — high probability of occurrence with high and well-known extent of damage, but considerable delay between triggering event and damage occurrence (e.g., climate change and loss of biological diversity).
- Medusa — high potential for psychological distress and social mobilization, but low threat (e.g., some technological innovations).

In seeking convergence between risk-based, precautionary, and discursive strategies for RM, the authors considered the three main challenges to be complexity, uncertainty, and ambiguity. Supporting a resilience-based approach, Klinke and Renn proposed a management toolkit that included: “containment … (to render exposure reversible), constant monitoring, development of equi-functional replacements, and investments in diversity and flexibility” (p. 1086). Their approach also included as low as reasonably achievable (ALARA) and best available control technology (BACT).

12.3 Integrating individual and organizational adaptive features

While the emphasis in the Chapter 2 discussion on behavioral adaptation was on how individuals adapt, an implicit focus within the present chapter concerns organizational adaptation. However, Ash and Smallman (2003) have indicated one way in which individual and organizational adaptation might converge, which is where the fate of many might hinge upon the decisions of one or a few. This has traditionally been within the realm of military history, which provides many examples of where battles, and even wars, were won or lost on a crucial combination of decisions made by a small number of critically positioned individuals. However, Ash and Smallman noted a growing tendency for some types of organizations to be arranged so that dangers are faced by a relatively small number of highly skilled individuals, for example in fighting wars, fires, or crime, while society demands success in these endeavors with minimal casualties. At the time of writing the war in Iraq provides an illustration of this effect. This creates considerable pressure on individuals who are required to manage high hazard situations, particularly those involving dynamic risk — characterized by rapidly changing circumstances. People are readily accused if they get it wrong and there may be little or no forgiveness or acknowledgement of human frailty if people in command err in the heat of the moment, particularly where large numbers of casualties result. Ash and Smallman cited the example of the police chief who ordered the opening of gates at Sheffield’s Hillsborough stadium before an FA Cup semifinal football match in 1989, which led to 96 deaths (see also the example of the shooting down of an Iranian airliner by the USS Vincennes in Summary Text 7.8). Blame will be apportioned to individuals acting under time pressure and uncertainty (Flin, 1996).
In their study of firefighters, Ash and Smallman (2003) found that managers and operational staff had distinct safety and risk communities or cultures. While managers established rules to provide guidance on safety, operational staff experience was that these rules often conflicted with incident management realities (Gherardi & Nicolini, 2000). For example, the dynamic assessment flowchart devised for use by crew commanders at incident sites, comprising a combination of risk assessment and cost benefit analysis, was seldom used in practice. While instructions appeared to make good sense, in practice they could rarely be successfully applied. Hence management seemed to be dissociated from decisions made by incident commanders faced with dynamic risk. In these circumstances operational staff devised their own decision-making parameters. In emergencies, sensemaking may be ad hoc and complex, and unless organizations provide those charged with making and acting upon the critical decisions with the requisite authority, a common safety culture cannot develop.

Clarke and Cooper (2004) suggested that while operators run risks, those higher in organizational hierarchies take risks and there is evidence that organizational factors such as industry sector and governmental control directly affect risk propensity (Williams & Narendran, 1999). The literature suggests that habitual behavior is important, such that inertia — habitual response to risk, and outcome history, are both related to risk propensity (Sitkin & Weingart, 1995; Pablo, 1997). More experienced decision makers may focus on their past ability to cope with obstacles — thereby raising their level of confidence and increasing the likelihood of risk-oriented behavior. Less experienced individuals may also tend toward risky behavior for a different reason — that their confidence is raised because of a lack of knowledge of possible consequences (Clarke & Cooper, 2004).

Ash and Smallman (2003) indicated how Weick’s (1995, 2001) framework of sensemaking could be used to represent key features of how humans respond to dynamic risk. Of Weick’s seven properties of sensemaking, Ash and Smallman identified four of particular relevance to dynamic risk decision making by fire incident commanders. These are: social (relating to the decision maker’s socialization and audience for outcomes), extracted cues (content salience due to context and personal disposition), plausibility (acting on sufficient plausible, albeit incomplete, information), and identity (personal relevance of current issue as an indicator of cognitive processes).

12.4 Beyond prevention

What of the future for safety and risk management research and practice? Since the 1970s the focus of OHS has shifted from studies of accidents, injuries, and diseases, to an appreciation of the importance of organizational philosophies and structures that emphasize not merely harm prevention, but positive health, well-being, and enhancing human capabilities. Among others, Hale and Hovden (1998) have documented these relatively rapid changes in perspective. Within 20 years concepts such as safety culture and safety climate have blossomed into dominant approaches within mainstream OHS research and practice, overtaking such outmoded concepts as accident prevention and loss control. In practice, the approach to managing OHS through the lens of risk management, including the crucial tool of risk assessment, has only been with us since the early 1990s. At the cutting edge the current generation of scientist practitioners has witnessed a marked conceptual change in our whole approach to workplace safety and risk.

These changes in perspective could be considered in parallel with an emergent movement within psychology, including organizational psychology, termed positive psychology, popularized most famously by Martin Seligman (Seligman & Csikszentmihalyi, 2000; Diener & Seligman, 2002). While only a few years old (the concept had not been described
within the academic literature when the first edition of this book was published), this attractive notion is gaining a sturdy foothold as it captures the imagination of increasing numbers of behavioral scientists. Historically this is by no means a new approach — philosophers have been debating the positive side of human nature for countless centuries, although within psychology, a positive approach to the human condition has been relegated to a place well outside the mainstream, despite the work of Maslow (1954) and other psychologists within the humanistic tradition, most famously Carl Rogers, but also Victor Frankl, being widely known. Examples of widely cited researchers from the more recent generation of psychologists who devoted much of their research and application to positive aspects of individual functioning include Michael Argyle (1987) and Peter Warr (1990, 1994).

The contemporary positive psychology movement has been fuelled by such findings as that of Luthans (2002), whose search of the psychological literature revealed a ratio of 375 : 1 of published work addressing people’s negative rather than their positive aspects or capabilities. To some extent, this reflects a clinical bias within the psychological literature, meaning that concepts such as depression, fear, anger, and anxiety remain highly represented. However, increasingly psychologists are turning their attention to analysis and

Summary Text 12.1 An Organization Recognizing and Promoting Workforce Resilience

In its 2004 Corporate Responsibility Report, under the Resilience and Mental Well-Being heading, GlaxoSmithKline (GSK) reported numbers of mental illness cases and days lost as a result of mental illness in 2004, recording a substantial reduction from corresponding 2003 figures. The report explained that, mental illness was the leading cause of work-related sickness absence, accounting for 33% of all work-related lost time illnesses.

The report described resilience as the, “set of skills and behaviors needed to cope successfully with the pressures of a rapidly changing work environment” — the same set of skills that helped to prevent work related mental illness. It outlined how GSK’s strategies on resilience and mental well-being in the United Kingdom and United States would develop into a group-wide strategy during 2005. They maintained that in 2004, 150 teams used the company Team Resilience Toolkit that was developed in 2003, to identify and manage risks, as well as to measure performance.

The report outlined health and stress-reduction programs that GSK is implementing in many countries that are relevant to local culture and conditions, and described awards that had been won as a result in more than one location. For example, the report noted that GSK’s, “Resilience and Mental Well-Being strategy was recognized by the U.K. Health and Safety Executive as a Beacon of Excellence” and as, “one of the best stress prevention strategies that they had seen.”

The report unashamedly identified employee resilience and mental well-being as being key to ensuring its business success, the implication being that this was a corporate-driven rather than a purely philanthropic or humanistic initiative. However, if the outcome is improved worker health and well-being, then at one level it could be argued that what matters is the end result for individuals as well as for the organization.

Summary Text 12.2 The Continuing Problem of Worker Ill Health

Three case examples serve to highlight the need for continuing vigilance in respect of worker health and the damaging effects of work-induced sickness and death.

Many workers and their families have suffered serious ill effects from asbestos exposure. In Australia, the building products group, James Hardie Industries set up a trust that was separate from the rest of the company to cover anticipated future claims, although many commentators considered that the sum (AUD293 million) was grossly inadequate to meet all potential claims. As part of its strategy to protect it from claims that exceeded the trust funds, in 2001 the company moved its corporate base from Australia to The Netherlands. This was in an attempt to protect its growing U.S. business from possible future asbestososis and mesothelioma claims that resulted from exposure within James Hardie controlled work locations. Some senior company executives were forced to resign in 2004 after a NSW special commission report revealed the misleading and deceptive conduct in establishing the Australian compensation trust, which was inadequate to meet its future asbestos illness victims’ claims, particularly now that U.S. claimants had joined the queue of claimants. One estimate put the costs of asbestos-related lawsuits to U.S. businesses as $U.S.54 billion since the 1970s. It was reported that for James Hardie Industries, the eventual payout to its Australian victims alone could be AUD4.5 billion.


Thousands of Australian workers in the 1960s and 1970s were involved in unprotected sandblasting operations, leaving them exposed to the possibility of silicosis, involving a debilitated quality of life, and early death from respiratory failure. As with asbestos, while knowledge of the link between silica particles and lung disease has been known for over 100 years, employers were either ignorant or amoral in denying workers adequate protection.


The RAAF F-111 deseal/reseal case was referred to briefly in Chapter 11. At the time of writing there is vigorous political debate about the adequacy of the AUD21 million compensation package for the 400 former and current RAAF workers who suffered a range of health problems as a result of exposure to solvents involved in cleaning the fighter aircraft fuel tanks.


associated applications of concepts such as self-esteem, self-awareness, optimism, control, and mastery, as key aspects of human nature. Nevertheless, there is, for example, a long way to go before the vast literature on stress is overtaken by the still barely embryonic literature on resilience. However, the existence of a major global company’s website that includes a program for developing team and individual resilience (see Summary Text 12.1) could be a sign that organizations are beginning to upgrade their appreciation of the need
to enhance the value of their human capital (an example of another positive term that might be replacing the more denigrating or neutral term human resources). However, even the expression human capital harks back to the traditional economic trilogy of resources required for business — land, labor, and (financial) capital, with entrepreneurship being added later, and is due for replacement with an expression that more adequately reflects not only the contribution of humans to the production process, but also humans as agents requiring recognition in their own right.

Within the context of research in organizations, including that focused on safety and risk, Wright (2003), and Wright and Wright (2002) have criticized what they term the long-standing committed-to-management approach, in which organizational researchers have, explicitly or implicitly, adopted the perspective of the dominant party — that is, owners or managers. They advocated a committed-to-participants approach, in which the well-being of all organizational stakeholders are considered to be appropriate topics for organizational research and promotion. Wright (2003) argued that positive organizational psychology offered a more balanced view of human nature than that offered by a more traditional utilitarian approach. Such an approach is consistent with a commitment-oriented approach to management as discussed in Chapter 10 and managing risks through developing a positive safety culture (see Chapter 11).

For safety and risk scientist practitioners a clear message is that we could be moving into an era of greater recognition of positives and that the future lies in proactively managing safety and risk within best practice organizations in a way that accords due respect to individuals in their capacities as workers, managers, customers, or other stakeholders. However, it should not be forgotten that around 1 million people annually lose their lives as a result of harm contracted in the world’s workplaces and that stress and job dissatisfaction remains rife for large numbers of workers. Therefore, for the foreseeable future, this approach must operate in parallel with the need to address the effects and reasons for entrenched opposition to positive OHS activities that result in multiple injustices in OHS, including those affecting many vulnerable groups who have no trade union or other form of voice (Peterson & Mayhew, 2005). These groups include not only workers in developing countries, referred to in Chapter 1, to whom many OHS problems have been transferred, but also many workers in developed economies who continue to suffer ill health, traumatic injury, and death as a result of poor work practices at the hands of ignorant and amoral employers (see e.g., Summary Text 12.2). There are serious flaws in the political and insurance systems in respect of adequately compensating victims of exposure to toxic substances at work. If the ethical investment movement continues to gather momentum then this could be an additional weapon that might be used against employers who will not deal proactively with worker health and safety. Motivated by a strong desire to witness continuing improvements in OHS practice, scientist practitioners’ weapons include rigorous research and scholarship to support the continuing search for best practice in managing workplace safety and risk.
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Environmental and Occupational Health and Safety

HUMAN SAFETY AND RISK MANAGEMENT
SECOND EDITION

Reflecting a decade’s worth of changes, Human Safety and Risk Management, Second Edition contains new chapters addressing safety culture and models of risk as well as an extensive re-working of the material from the earlier edition. Examining a wide range of approaches to risk, the authors define safety culture and review theoretical models that elucidate mechanisms linking safety culture with safety performance.

Filled with practical examples and case studies and drawing on a range of disciplines, the book explores individual differences and the many ways in which human beings are alike within a risk and safety context. It delineates a risk management approach that includes a range of techniques such as risk assessment, safety audit, and safety interventions. The authors address concepts central to workplace safety such as attitudes and their link with behavior. They discuss managing behavior in work environments including key functions and benefits of groups, factors influencing team effectiveness, and barriers to effectiveness such as groupthink.

Features
• Focuses on physical aspects of workplaces and people’s behavior in them
• Explores the impact of leadership on safety performance, failures of leadership, and managing leadership roles to reduce risk and improve organizational safety
• Examines workplace stress and how to deal with it effectively, providing individual and organizational intervention strategies
• Provides a review of theoretical models that elucidate mechanisms linking safety culture with safety performance
• Discusses changes in terminology such as the controversy over the term “accident”