EDUCATION AND RESEARCH IN BIOSYSTEMS ENGINEERING IN EUROPE

LLP Erasmus Thematic Network

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FROM USAEE-TN TO ERABEE-TN
UNDER THE RECENT DEVELOPMENTS OF HIGHER EDUCATION IN EUROPE

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Abstract
During the last decade, Agricultural Engineering University studies in Europe faced dramatic problems such as decrease of student enrolment, reduced prestige, declining funding, etc. The dramatic situation within this specific field of studies along with its chaotic state in terms of programme content was the motivation behind the establishment of a previous Thematic Network, namely USAEE-TN. USAEE-TN defined the traditional Agricultural Engineering discipline as an application-based discipline related to the production and processing of goods of biological origin from the field and the farm to the consumer (i.e. plant and animal production, post-harvest technology, process engineering, etc.). In fact, Agricultural Engineering was traditionally related to the protection of the natural environment and the preservation of the natural resources (i.e. soil conservation, rational water management, air pollution control, waste management, preservation of natural habitats, etc.). This traditional field of Agricultural Engineering is now evolving into the Biosystems Engineering field, which is a science-based engineering discipline that integrates engineering science and design with applied biological, environmental and agricultural sciences, broadening in this way the area of application of Engineering sciences not strictly to agricultural sciences, but to the biological sciences in general, including the agricultural sciences. In response to the above dramatic developments, the new Thematic Network for Education and Research in Biosystems Engineering or Agricultural and Biological Engineering in Europe (ERABEE-TN) was established in a way that it will be built-upon and further develop the outputs of the USAEE-TN by adapting and restructuring the Agricultural Engineering programs of studies and contributing to the inevitable transition from the traditional Agricultural Engineering studies towards a new European dimension in higher education in the broader area of Biosystems (or Agricultural and Biological) Engineering.

1. The USAEE Thematic Network
The motivation behind the establishment of the USAEE Thematic Network [1] in 2002 was the conclusion derived by some preliminary studies conducted by EurAgEng [2] and CIGR [3] that Agricultural engineering is under-going rapid changes as a result of:

- technological innovation;
- the dramatic structural changes of the Higher Educational system of Europe;
- major inherent problems associated with the traditional field of Agricultural Engineering studies in Europe and the emerging relevant societal needs.

In response to these dramatic changes, the thematic network USAEE - University Studies of Agricultural Engineering in Europe was established in the framework of the
Erasmus programme of the EU Directorate-General Education and Culture: 2002-2006. The USAEE thematic network project was established with the endorsement and the support of the European Society of Agricultural Engineers. The USAEE Thematic Network was composed of 31 partner Universities from 27 European countries and funded by DG Education and Culture.

The main objectives of USAEE TN were:

a. define the core curricula to be used as benchmarks for Agricultural Engineering studies in Europe; the establishment of a benchmark core curriculum serves the purpose of determining a set of minimum criteria/requirements against which any curriculum can be tested and decided whether or not it meets the criteria for its admission as a particular programme of Agricultural Engineering studies

b. define common accreditation strategies and procedures and establish the bodies/committees to carry out the accreditation of the departments which are to meet the core curricula requirements

The development of benchmarks for basic European core curricula in Agricultural Engineering was based on the requirements:

✓ Meet the FEANI criteria for being an Engineering program of studies
✓ Have the support of EurAgEng

The core curricula requirements were defined in terms of the ECTS system. The process followed was to request the official endorsement by FEANI [4] of the USAEE proposed core curricula as representing engineering programs of studies was pursued. The proposal of the European core curricula in Agricultural Engineering developed by USAEE TN was submitted to EMC FEANI and EurAgEng (Executive Board and Council) members for comments (2004-2006). In June 2006, USAEE submitted officially, after revision, the final core curricula for Agricultural Engineering University studies in Europe. In January 2007, FEANI – EMC replies ‘USAEE document combined with the FEANI criteria provide guidance to the schools in order to design an agricultural engineering programme to be included in the FEANI INDEX’.

The approval by FEANI of the proposed by USAEE TN European core curricula in Agricultural Engineering is considered a major step forward in the history of the European University studies in Agricultural Engineering.

In parallel to the core curricula-FEANI developments, a recognition implementation plan was prepared in close cooperation between USAEE and EurAgEng. The proposed recognition scheme was officially announced in September 2006, in Bonn, by EurAgEng and foresees several steps.

The core curricula, the recognition process and several other important USAEE TN outputs are available at the following web address to download all eight Proceedings of the USAEE Workshops is the following: http://www.eurageng.net/usaee-tn.htm

The proceedings concern issues on:

- Studies
- Research
- ECTS
- Agricultural Engineering core curricula meeting the FEANI criteria
- Accreditation procedures
- Employability
- Quality assurance and assessment
Furthermore a continuously updated web-site was established presenting the current programs of studies of European Universities offering programs of studies in Agricultural Engineering: [http://sunfire.aua.gr:8080/ects>Welcome.do](http://sunfire.aua.gr:8080/ects/Welcome.do)

2. The Bologna Process, European Higher Education Area and Qualifications Systems

**Quality labels**

According to the Bologna Follow Up Group (BFUG) [5], traditional models and methods of expressing qualifications structures are giving way to systems based on explicit reference points using learning outcomes and competencies, levels and level indicators, subject benchmarks and qualification descriptors. These devices provide more precision and accuracy and facilitate transparency and comparison. Without these common approaches, full recognition, real transparency and thus the creation of an effective European Higher Education Area, will be more difficult to achieve. The USAEE TN has already focused its activities on the two key issues: “benchmarks” and “full recognition”.

The European Commission, Directorate-General for Education and Culture, announced on 24 January 2006 its support towards the development of the European register and quality labels in the framework of the Quality assurance procedures established in the HEA.

In particular, the Commission supports the setting up and testing phase of transnational quality evaluation. Two European quality labels were launched in March 2006 (engineering and chemistry). Four new labels were launched in 2007. A few more areas may be added later, including a label for joint degrees at bachelor, master and possibly doctoral level.

**Accreditation of Engineering programs of studies**

Developments are already under way towards the establishment of a SINGLE European Accreditation procedure for all European Engineering programs of studies. This work has been assumed by the EUR-ACE project (EUReopean ACcredited Engineer) [6]. The EUR-ACE accreditation system is being set up within ENAEE [7] and monitored by an ad-hoc Working Group (EUR-ACE Label Committee).

Both the USAEE TN as well as its follow-up Thematic network ERABEE, participate currently in the project board of the EUR-ACE Implementation project aiming at establishing the accreditation of Agricultural (or Biosystems) Engineering programmes of studies as Engineering Programmes of studies complying with the EUR_ACE Standards Framework in the same way as for any other Engineering program of studies in Europe.

**Accreditation of Agricultural /Biosystems Engineering programs of studies**

Following the approval by FEANI of the USAEE TN proposed Core Curricula in Agricultural Engineering USAEE, the Accreditation procedure of Agricultural/Biosystems Engineering programs of studies may be synopsised in the following steps:

a. EuAgEng may undertake the RECOGNITION of these programs as being Agricultural or Biosystems Engineering programs of studies.

b. Then, the use of the terms: Agricultural or Biosystems Engineering by programs of studies that are not recognized by EurAgEng will not be as easy as it happens
today; problems will be encountered in the promotion of studies not recognised at a European level!

c. EUR-ACE stands may be applied for the ACCREDITATION of any recognised Agricultural or Biosystems Engineering program in the same way as for any other ENGINEERING program of studies in Europe.

d. The ACCREDITATION through EUR-ACE standards of any recognised Agricultural or Biosystems Engineering program in Europe awards the EUR-ACE Labelling of the accredited programs of studies. The EUR-ACE® label certificates will be:
  - EUR-ACE First Cycle level
  - EUR-ACE Second Cycle level

e. The Accredited by EUR-ACE standards Agricultural or Biosystems Engineering programs will be automatically registered in the FEANI index without any additional application and procedure

3. New Developments in Agricultural Engineering Activities and Research

The International level

Following the completion of the USAEE TN activities, a special emphasis was placed on the future of the Agricultural Engineering studies in Europe today. The USAEE TN members unanimously agreed that the Agricultural Engineering studies in Europe face new developments and new challenges through the current transient phase! It is a fact that the traditional field of Agricultural Engineering is now evolving into the Biosystems Engineering field worldwide.

Biosystems Engineering is a science-based engineering discipline that integrates engineering science and design with applied biological, environmental and agricultural sciences, broadening in this way the area of application of Engineering sciences not strictly to agricultural sciences, but to the biological sciences in general, including the agricultural sciences. The distinction between Agricultural and Biosystems Engineering is the following:
  - Agricultural Engineering applies engineering sciences to agricultural applications
  - Biosystems (or Agricultural and Biological) Engineering, extends this application of engineering sciences to all living organisms applications, including agriculture. Biosystems engineers on top of the aforementioned areas can also be involved in the expanding new areas of bio-based materials, bio(agro)-fuels, biomechatronics, etc., in the assessment of food traceability, quality and safety and in the design of environmentally friendly and sustainable systems.

The major international political priority relevant to Biosystems (or Agricultural and Biological) Engineering studies was set in USA and Canada back in 2003 by the American Society of Agricultural Engineers (ASAE) and the Canadian Society of Agricultural Engineering (CSAE), respectively. This political priority regarded major changes in the curricula, also reflected in the change of the Societies’ name which was considered as a major issue. At that time it had become evident that traditional Agricultural Engineering Departments experienced a marked decline in students.

Since the majority of such Departments in USA and Canada added a ‘bio’ modifier term (i.e. Biosystems, Biological, Bioresources, Bioengineering, etc.) in their titles and aligned their academic programs with the biology-based curriculum (including as
a main sub-system agricultural engineering), student enrolment increased. As a result in 2005 ASAE and CSAE decided to change their name to [8]:

- American Society of Agricultural and Biological Engineers (ASABE)
- Canadian Society for Bioengineering (CSBE)

*The POMSEBES Project*

In response to these new developments, a new project was launched in the framework of the EU-US Atlantis programme 2006: POMSEBES - Policy Oriented Measures in Support of the Evolving Biosystems Engineering Studies in USA – EU; 2007-2008 [9].

The main objective of POMSEBES is to provide a platform for a systematic exchange of experiences and ideas between the established Biological Engineering studies in the US and the evolving Biosystems Engineering studies in EU aiming at the establishment of appropriate policy oriented measures to support and guide this evolution. One of the most important outcomes of this project was to clarify the confusion in the various terminologies used. In particular the following terminology was proposed:

**Biosystems Engineering**

Biosystems Engineering is defined as an evolving science-based engineering discipline that integrates engineering science and design with applied biological, agricultural and environmental sciences [10].

Biosystems Engineering concerns education and research in the physical sciences and engineering to understand, model, process or enhance biological systems for sustainable developments in agriculture, food, land use and the environment.

**Biotechnology**

Biosystems Engineering is not Biotechnology which is defined as:

Techniques that use living organisms or parts of organisms to produce a variety of products (from medicines to industrial enzymes) to improve plants or animals or to develop microorganisms to remove toxics from bodies of water, or act as pesticides [11].

Or, a multidisciplinary field in which biological systems are developed and/or used for the provision of commercial goods or services [12].

**Biomedical Engineering**

Biosystems Engineering is not Biomedical Engineering which is defined as:

The application of engineering principles and techniques to the medical field. It combines the design and problem solving skills of engineering with the medical and biological science to help improve patient health care and the quality of life of healthy individuals [13].

More information and outputs of the POMSEBES project may be found in its web-site [9] including a paper to be presented in the AgEng2008 conference in Crete 23-25 June, 2008 [14].
The EU level

The major challenges of the Higher Education Area in Biosystems Engineering in Europe actually concern the transition of the traditional Agricultural Engineering programs of studies into the new evolved discipline of Biosystems Engineering. Very few viable Biosystems Engineering programs currently exist in Europe and those initiated are at a primitive stage of development.

A positive element is the fact that accreditation at European level is under development (EU coordinated projects, like EUR-ACE, aiming at accrediting Engineering programs of studies across Europe). The Commission recently launched a call to support networking of national qualifications frameworks and development of sectoral qualifications frameworks at European level. Such a sector, among others, is the evolving field of Biosystems Engineering.

The needs for the transition from Agricultural to Biosystems Engineering in Europe may be summarised as follows:

a. Europe should keep step with the latest developments in Biosystems Engineering occurred at the international level: strong competition in education, research and economy

b. Biosystems Engineering should evolve as an integral part of the rapid developments in the Higher Education Area in Europe Education and Research in Biosystems Engineering or Agricultural and Biological Engineering in Europe (ERABEE-TN)

4. Education and Research in Biosystems Engineering or Agricultural and Biological Engineering in Europe (ERABEE-TN)

Facing new developments and new challenges through the ERABEE TN work

In response to the above dramatic developments, the new Thematic Network for Education and Research in Biosystems Engineering or Agricultural and Biological Engineering in Europe (ERABEE-TN) was established

ERABEE-TN will be built-upon and further develop the outputs of the USAEE-TN by adapting and restructuring the Agricultural Engineering programs of studies and contributing to the inevitable transition from the traditional Agricultural Engineering studies towards a new European dimension in higher education in the broader area of Biosystems Engineering. The new Thematic Network is composed of 33 partner Universities and 2 students associations from 27 European countries and funded by DG Education and Culture.

Among the new developments and new challenges to be faced by the ERABEE TN work included are the following:

- In the future, it is anticipated that the bio-based economy will grow significantly in Europe.
- Enterprises in the areas of bio-energy and renewable resources and bio-based materials are likely to increase, creating new employment opportunities for Biosystems (or Agricultural and Biological) Engineers.
- Advancements in science and technology will create new opportunities in areas such as bio-safety, risk assessment, sensor/bio-sensors, electronics and use of information technology, remote sensing, GPS/GIS and biomaterials.
New emerging opportunities are likely to occur in developing and under-developed countries in areas of environmental quality, infrastructure and rural development (agriculture and bio-energy).

**Expected impact of ERABEE**

**Development of quality assurance**

The European Commission is discussing already what will come after 2010 in Bologna [15]:

"Quality is what matters most. The adaptation of names and titles is necessary".

"The Lisbon Strategy has set the objective to make European education and training systems a world quality reference; the Bologna Process, equally, intends to make European higher education more attractive to students and scholars from around the globe".

Especially for the development of quality assurance, National and European resources are devoted to improving the effectiveness of what is called internal quality assurance or ‘quality culture’. The Commission is supporting a series of activities of Erasmus Thematic Networks and University Associations (EUA). These actions intend to help universities go through peer reviews and collegial benchmarking Exercises [5]. And then there is external quality assurance, which is a relatively new thing.

An important instrument for the quality assurance is ENQA [16], founded in the year 2000. Nowadays, quality assurance agencies are active in almost all 46 Bologna signatory states. Most countries have one publicly funded national agency, but some countries have several.

The increase in quality–assurance activities by universities and agencies will lead to an exponential growth in data on university performance. Quality reviews produced by the agencies are available on the web - hundreds today and thousands tomorrow.

Another agency, ECA [17] has taken the initiative to design a template for a review summary called "Accreditation Statement". These statements and the underlying reports will be made accessible through a new web site called Qrossroads [18].

Among the interested readers of the reviews produced by the agencies are the journalists and rankers of this planet. European Commission supports initiatives to arrive at more sophisticated multi–dimensional rankings which do justice to the variety of objectives of Europe’s universities.

The OECD Ministers have given a cautious green light to a feasibility study that would look into the measurement of university performance. Performance would be measured in terms of learning outcomes. The European Qualifications Frameworks as well as the Tuning project [19] could feed into this exercise. ERABEE TN has foreseen synergy with the Tuning project along this line.

The development of a European Quality Assurance Register in Higher Education (EQAR) is a rather new element of the overall quality assurance framework. The Register is independent and will allow people to identify the agencies that do a serious job.

Agencies will be checked against European standards and guidelines by external reviewers and endorsed by a Register Committee which has the confidence of higher
education institutions, students, employers, teacher unions and public authorities. The prospect of the Register and the high professional standards it sets will help agencies improve their performance.

**University-enterprise co-operation**

A Forum for dialogue on university - enterprise cooperation in the field of education was planned for spring 2008. The Forum would be a place for structured dialogue on themes such as curricula reform, continuing education and stakeholder involvement in university governance.

It is expected that structured partnerships with the business community can make education and training programmes more relevant to society's needs. They can bring additional funding to higher education, for example through expanding the research capacity or providing retraining courses for the workforce.

The flagship initiative for better links between business and higher education for the European Commission is the European Institute of Technology. A political agreement on the EIT is expected before the end of the year. With its innovative form of governance, its interdisciplinary opportunities for high level study and research and the involvement of stakeholders, public and private, it is a particularly striking emblem of the openness of the European Higher Education and Research Areas.

The EIT's attraction lies in the fact that it does not impose rigid structures but that it facilitates the contact between students, teachers, researchers and business around promising new knowledge areas, shrinking the distances between education, research and innovation.

ERABEE TN plans to establish connections with the EIT and follow closely the relevant developments in the field of Biosystems Engineering.

**References:**

2. European Society of Agricultural Engineering, [http://www.eurageng.org](http://www.eurageng.org)
11. [http://www.nsc.org/ehc/glossary.htm#b](http://www.nsc.org/ehc/glossary.htm#b)
15. Ján Figel’—Commissioner for Education, Training, Culture, and Youth
19. [http://relint.desto.es/TuningProject](http://relint.desto.es/TuningProject) and [http://www.let.rug.nl/TuningProject](http://www.let.rug.nl/TuningProject)
OVERVIEW

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The present proceedings comprise of the papers prepared for the 1st ERABEE Workshop that was held on 3-4 of April, 2008 in Madrid, Spain. Network partners presented the current status on the “Definition of the Emerging Biosystems Engineering Discipline in Europe” and a brief overview of the situation in EU, based on the twenty three gathered paper-reports, is displayed herebelow.

1. In reference to the core curriculum included in the FEANI Report Template (http://www.eurageng.net/files/usaaee-corecurriculum.pdf) propose possible revisions in the existing modules, and/or suggest any new module(s) that might be included with regards to the Biosystems Engineering discipline.

![Bar chart showing suggested changes of core curricula and suggested courses]

- No information: 5
- No changes: 9
- Suggested courses: 6
- Suggested changes of core curricula: 4

2. Current situation of the Biosystems Engineering discipline or any relevant to it discipline in your country

![Pie chart showing existing study programme or specialisation of Agricultural Engineering: 81% and no relevant study programme: 19%]
3. Need for such a transition or evolution from the traditional Agricultural Engineering programme of studies to the new emerging discipline of Biosystems Engineering.

4. Impact of such transition with regards to the: a) Institutional structure, b) students' enrolment, c) professional status and d) national and international attractiveness and to which extent?
5. Societal need for such a transition identified at a national level

Comment: The social need of the transition from the existing to the expanded Agricultural or Biosystems Engineering programme of studies has not been identified yet at the national level, with the exception of the Bulgaria case. They show that 58% from the opinions envisage positive social effect with regards to the professional structures and industry in the mentioned area.

6. Such a transition will have an influence on the labour market and on the employability of the Biosystems Engineering graduates in your own country

![Bar chart showing influence on labour market and employability](image-url)
Abstract
At BOKU Vienna there do not exist independent curricula for Agricultural Engineering or Biosystems Engineering. Engineering modules are included in other curricula like Agricultural Sciences, Civil Engineering or Food Science and Technology. Nevertheless the discussion about Biosystems Engineering will be helpful for better understanding of roles of engineering within the university. The transition to Biosystems Engineering seems to be a justifiable and necessary way of evolution of the engineering. From the point of view of the small Austrian national labour market, the creation of cooperative European curricula is proposed.

1. Definition of Biosystems Engineering
As Biosystems Engineering can be understood an engineering discipline for living systems (plants, animals, soil), especially understood within the area of agricultural primary production. In my understanding of Biosystems Engineering, the difference to Agricultural Engineering consists of the shifting of focus more to these biological aspects additional to classic engineering. For demonstrating this may be given a short statistic of publications in the journal “Biosystems Engineering” (ISSN 1537 5110, Elsevier, the former “J. of Agricultural Engineering Research”) between 2000 and 2007:

The greatest amount of publications takes the group “Postharvest Technology” with more than 25%. “Postharvest Technology” and “Structures and Environment” (mainly climatic engineering) together takes a percentage of nearly 50% of all publications of the last 8 years. The classic Agricultural Engineering (“Power and Machinery”) however is represented with about 13% of publications. Adding the areas “Automation and Emerging Technology” and “Precision Agriculture” to “Agricultural Engineering”, the “Agricultural Engineering” represents less then 30% of publications between 2000 and 2007.

These figures may be understood as the result of a consequent evolution of Agricultural Engineering during the last years in Europe. It seems to justify the change of labels.

2. Revision of existing modules
There seems not to be a need for greater revisions in core curriculum Agricultural/Biosystems Engineering according FEANI Report. I find all the above mentioned aspects of Biosystems Engineering in this curriculum, which can be laying the foundation of further evolution of this discipline.

3. The current situation of the Biosystems Engineering discipline.
At BOKU Vienna, the sole agricultural university of Austria, there is neither an independent study of Agricultural Engineering nor of Biosystems Engineering. Some modules of Agricultural/Biosystems Engineering are included in curricula of
Agricultural Sciences. Some parts of Agricultural Engineering are included in curricula of Civil Engineering. The curricula of Food Science and Technology include also areas of competence, which could be understood as belonging to Biosystems Engineering.

At this special situation of BOKU Vienna there is not to expect a development of an independent curriculum Biosystems Engineering within the near future. Nevertheless the discussion about Biosystems Engineering – instead of Agricultural Engineering – seems to be helpful for finding more understanding within the university and within the society, for the being of Agricultural Engineering. It can help to get a better standing of “Engineering” in competition with other disciplines within university.

4. Impacts of transition

In my estimation, the transition from Agricultural Engineering to Biosystems Engineering will not have any immediate impacts on the institutional structure at our university. The same is to expect for possible impacts on students enrolment and professional status. But the national and international attractiveness of Agricultural/Biosystems Engineering as institution (institute, department) are to expect to be growing in future. As a consequence of better standing within the university, I could imagine a very attractive scenario for our university in participation in international curricula of Biosystems Engineering. We could participate with our special strengths and the same could do the other partners. For students so very attractive new ways of international education in Biosystems Engineering with new professional perspectives could emerge.

5. Societal needs for transition

In my opinion – not based on questionnaires – the growing societal interest in Agricultural Engineering taking care of environment and resources is evident. Just so the public interest in safety of food chains and in animal welfare is evident and justified. These interests can be derived from political discussions in Europe. But not last the interests of young people at university produce a justifiable pressure in above mentioned direction.

6. The influence of transition on labour market.

The traditional “Agricultural Engineers” are recruited partly from secondary technical schools, partly from common technical universities. This may be valid for the national Austrian labour market. The transition to Biosystems Engineering will probably not cause a significant change at this small labour market. But it could point out a better suitability of this education to the requirements of future. Especially the fields of renewable energies and of environmental technologies could become more and more promising working areas for engineers with high biological competence. But the labour market of future will be a European market or even a worldwide market. Therefore I will affirm once again the opportunity and the advantages of international networking curricula constructions in Biosystems Engineering.
Abstract
Biosystems/biological engineering is a multidisciplinary research discipline with a focus on the application of modern engineering methodologies not only for the analysis, optimization and control of biological processes but also for the transformation of biological systems into derived products and systems. To deepen the understanding of the interaction between technological and biological systems and processes, the importance of quantitative modelling increased dramatically during the last two decades. To crystallize the importance of the multiscale modelling concepts in biological systems analysis, the K.U.Leuven is investigating the potential of introducing a new module in the curriculum of biosystems/biological engineering encompassing these multiscale modelling concepts.

The curriculum Biosystems engineering delivers a master degree spread over two academic years. About 20 students are studying in the master. In 2014, according to a Flemish decree under construction, this number should at least be 40, to prevent removal of the master.

1. Definition of Biosystems/Biological Engineering
Biosystems/biological engineering is a multidisciplinary discipline in applied science with a unique character in which integration of and interaction between biological and technical systems play a central role. Relying on this core concept, we come to the following more refined definition of biosystems/biological engineering:
Biosystems/biological engineering is a multidisciplinary research discipline with a focus on the application of modern engineering methodologies not only for the analysis, optimization and control of biological processes but also for the transformation of biological systems into derived products and systems. Engineers and researchers active in the biosystems/biological engineering solve problems in the interface between those biological systems – micro-organism, plant, animal, human – and their technical environment like machines, constructions, bioreactors, sensors, … All activities in biosystems/biological engineering are subjected to the following ethical imperatives:

1. The design of the technology functions in harmony with the living organism;
2. The efficient use of natural and renewable resources in harmony with the environment;
3. The preserve an optimal health of the envisaged biological system.

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The interaction process between the biological and technical system moves between two extremes:
a. At the one end, the technical design is central and the biophysical properties of the biological system are the constraints imposed upon the technical design; the biological system does not experience considerable transformations during the process; an example is the design of a spraying machine for site specific application, the constraints or boundary conditions are the optical properties of crop and weed; the central point of the knowledge and skills of the biosystems/biological engineering is in the area of technical processes and systems.
b. At the other end, the biological system is central, in its technical environment. The system is manipulated and, by this possibility subjected to considerable transformations. An example is the production of insulin in a bioreactor with genetically engineered coli bacteria. The central point of the knowledge and skills of the biosystems/biological engineer is situated in the area of biological processes and systems. Another example is the field of precision livestock engineering where the process is managed based on real-time information measured on production animals.

The closer the skills and activities of the biological/biosystems engineer approach the second extreme, the more unique and original will be his profile and character. Mechanical, electrical, chemical, and so on, engineers have a stronger technical education but when the synergy and interaction between technical and biological systems is becoming an essential focus, biosystems/biological engineers are in favour as they have a broad generic knowledge of biological systems and processes.

2. Additional module in the education of biosystems/biological engineering

Biosystems/biological engineering is a technology driven research discipline in which biological systems and processes are related to humans, animals, plants and microorganisms and encompass primary food production, handling and processing of products of biological origin, biochemical and microbial processes, ex vivo engineering of animal and plant tissue and cell cultures, health care issues, preservation of our natural resources.

To deepen the understanding of the interaction between technological and biological systems and processes, the importance of quantitative modelling increased dramatically during the last two decades. This can go from black box input-output models derived with systems identification techniques, to detailed mechanistic models based upon (bio)physical laws.

Since biological systems are assembled in different levels of organization which are all interconnected with each other (e.g. a mamal, on the highest level living in an ecological system, has for example a digestive system composed the following pieces in downscaling order: organs, tissue, cells, cell organells, biomolecules, …). This multiscale concept that applies for any biological system, is given in Table 1:

**Table 2.** Multiscale concept for mechanistic modelling of bioprocesses

<table>
<thead>
<tr>
<th>Scales</th>
<th>Processes</th>
<th>Research domain</th>
<th>Methodologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macroscale level</td>
<td>Macroscopic transport processes</td>
<td>Quantitative ecology, Process engineering, Integrative</td>
<td>Biological reaction kinetics, transport phenomena, …, Mathematical systems theory</td>
</tr>
<tr>
<td>• input-output</td>
<td>• energy and mass balances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• compartment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• tissue or higher</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To crystallize the importance of the multiscale concepts in biological systems analysis, the KULeuven is investigating the potential of introducing a new module in the curriculum of biosystems/biological engineering encompassing these multiscale modelling concepts.

a. This module with the provisional title “Biological engineering” will encompass the issues as described in Table 2. Discussions are started about the following issues:

b. how to put this module in a general framework such that more curricula can include it in their education;
c. how to organize these issues in courses: courses per scale or courses encompassing different scales (e.g. multiscale biomechanics, multiscale biophysics, …)

**Table 2. Module Biological engineering**

<table>
<thead>
<tr>
<th>Issues</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanobiophysics</td>
<td>Non-equilibrium thermodynamics, statistical physics</td>
</tr>
<tr>
<td>Molecular biophysics</td>
<td>Biopolymers, systems biology</td>
</tr>
<tr>
<td>Cellular biophysics</td>
<td>Computational cell biology</td>
</tr>
<tr>
<td>Tissue biophysics</td>
<td>Integrative systems physiology</td>
</tr>
</tbody>
</table>
3. Current situation of Biosystems Engineering in Flanders
The KULeuven is the only university in Flanders organizing an education in Biosystems engineering. The teaching and research staff consist of 9 professors and 14 postdoctoral research engineers represented by two divisions: MeBioS (Mechantronics, Bio-statistics and Sensors) and M3BIORES (Measure, Model & Manage Bioresponses), currently housing more than 80 researchers. Both divisions belong to the Department of Biosystems.
The curriculum Biosystems engineering delivers a master degree spread over two academic years. About 20 students are studying in the master. In 2014, according to a Flemish decree, this number should at least be 40, to prevent removal of the master.
The different courses directly related to the curriculum biosystems engineering are currently organized into 6 modules which are given in table 3.

Table 3. Modules and courses in the education biosystems engineering

<table>
<thead>
<tr>
<th>Modules</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanisms</td>
<td>Machine kinematics and dynamics (BSc)</td>
</tr>
<tr>
<td></td>
<td>Precision technology for crop production (MSc)</td>
</tr>
<tr>
<td></td>
<td>Mechanical unit operations (BSc)</td>
</tr>
<tr>
<td></td>
<td>Design and construction techniques incl. CAD/CAE (BSc)</td>
</tr>
<tr>
<td>Bio-environment</td>
<td>Sustainability in buildings for production (MSc)</td>
</tr>
<tr>
<td></td>
<td>Bio-environmental control (BSc)</td>
</tr>
<tr>
<td>Transport processes</td>
<td>Transport phenomena (BSc)</td>
</tr>
<tr>
<td></td>
<td>Multiscale transport phenomena in biosystems (MSc)</td>
</tr>
<tr>
<td></td>
<td>Physical processes inhandling biological products (MSc)</td>
</tr>
<tr>
<td>Systems analysis and design</td>
<td>Systems analysis (MSc)</td>
</tr>
<tr>
<td></td>
<td>Integration of biological responses in process management (MSc)</td>
</tr>
<tr>
<td></td>
<td>Mechatronic design of biotechnical processes (MSc)</td>
</tr>
<tr>
<td></td>
<td>Sensor technology and bio-electronics (MSc)</td>
</tr>
<tr>
<td></td>
<td>Electronic instrumentation (BSc)</td>
</tr>
<tr>
<td></td>
<td>Technology in human applications (BSc)</td>
</tr>
<tr>
<td>Applied physics and</td>
<td>Physical properties of biomaterials (BSc)</td>
</tr>
<tr>
<td>mathematics</td>
<td>Optics, lasers and acoustics (MSc)</td>
</tr>
<tr>
<td></td>
<td>Applied thermodynamics (MSc)</td>
</tr>
<tr>
<td></td>
<td>Strength of materials (BSc)</td>
</tr>
<tr>
<td></td>
<td>Applied mathematics (MSc)</td>
</tr>
<tr>
<td></td>
<td>Applied multivariate statistical analysis (MSs)</td>
</tr>
<tr>
<td>Management of bio- and agro-</td>
<td>Quality control and process and chain management (BSc)</td>
</tr>
<tr>
<td>systems</td>
<td></td>
</tr>
</tbody>
</table>

4. Impacts of transition in Biosystems Engineering
As mentioned higher, in 2014 the number of master students in Biosystems Engineering should, by Flemish decree, be minimum 40 (over two master years). The initiated transitions should be viewed in this framework. The institutional structure is not expected to change much in the near future. One of the aims of the reshaping of the study is to make the study more attractive to students with a more biological oriented background. Possibilities are recently being investigated if the masters in Biosystems Engineering could be organised in collaboration with other faculties/departments (engineering, biology, medicine). In this way it is aimed at making the study more attractive on a national as well as international scale.
5. Influence on transition by national level
A proposal is being worked out by the commission for rationalization of education to put a minimum level of 40 students for the master studies from 2014 on. This proposal is not yet approved by the Flemish parliament. This evolution puts pressure on the ongoing transition in biosystems engineering.

6. Influence on labour market
Although the study of Biosystems Engineering is still not well known and visible in Flanders, people find immediately work on the labour market after finishing their studies. Thanks to the polyvalent engineering studies, biosystems engineers are working in many different fields going from the ore classical agricultural engineering (companies such as Case New Holland, John Deere), automotive and space industry, government, environmental consultancy, up to financial institutions and high tech companies. In addition, the Flemish industry offers excellent opportunities for people who graduated in biosystems engineering: food-, textile- and leather-, wood- and paper-, chemical and polymer industry represent resp. 13%, 7%, 9% en 26% of the Flemish industry
It is expected that extending the study towards biological engineering will offer additional job opportunities in sectors such as pharmaceutical and medical engineering. The emergence of the knowledge intensive 'life science' industry (with e.g. the biomedical sector, the industrial biotech sector and the agro(food) biotech sector) are creating exceptional possibilities for the biosystems/biological engineers.
 DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE as seen by BEST

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1. What do you understand when you hear the term “Biosystems Engineering”?
Biosystems Engineering is a new applied science that deals with innovative and ecological projects, and aims to integrate biosystems in the engineering area.

2. Has your Association tackled or will tackle in the near future (Educational and Professional) issues related to Biosystems Engineering?
So far, some BEST local groups were organising courses in biosystems engineering. At the moment, BEST participates in ERABEE. This relation takes place in the European level, and is taken care by the Educational Committee of BEST. BEST wishes to create common activities with ERABEE, such as Events on Education, in order to gather student input to it in common fields of interest.

3. Envisage the potential employers for Biosystems Engineering graduates and try to identify areas where new job opportunities for Biosystems Engineers may arise in the labour market.
In most of the universities there is a degree or a specialisation in Biosystems Engineering. The number of students is increasing and there will be a bigger number of potential employers. The graduates would be employed in the following areas: chemistry, food engineering, biomedical engineering, paper engineering, environmental engineering, civil engineering, power engineering, microbiology, nanotechnology.

4. If a student had a 1st Cycle degree in Engineering (incl. Agricultural Engineering), would he/she be interested in following a 2nd Cycle in Biosystems Engineering?
Yes, because it is a growing field and it will give more opportunities to the graduates. Biosystems Engineering is ensuring a good quality of studies, compared to studies in Agricultural school.

5. Do you believe that Biosystems Engineering discipline is attractive with positive career opportunities?
A degree in Biosystems Engineering will offer more opportunities to the graduates, because this field is more practical and more applied than the classic Agricultural studies. It will probably become one of the most attractive fields to study in near future.

6. Free comments on Biosystems Engineering in Europe.
Biosystems Engineering is actually the evolution and the future of the current field of Agricultural science. It also has sustainability aspects, as it includes subjects related to bio-fuels or bio-waste in a future developing. A well developed Biosystems Engineering education will allow Europe to lead this field in a worldwide level.
CURRENT STATE AND PERSPECTIVE OF BIOSYSTEMS ENGINEERING IN BULGARIA

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Hristo Beloev, “Angel Kunchev” University of Rousse, Stoudentska St. 7017 Rousse
Georgy Kostadinov, Research Institute for Melioration and Mechanization, 3, Shosse Bankya St. 1000 Sofia,
Bulgaria

Introduction
The free market economy requires a new type of specialist for the restored agriculture and related industry in Bulgaria. For satisfying the arisen necessity of such specialist was established a new course on Agricultural Engineering at three Bulgarian universities in 2002 year. Today, Agricultural Engineering is one of the most attractive among agrarian subjects, especially at Agricultural University – Plovdiv.
The main task of the Bulgarian Agricultural Engineers is to design and introduce modern and effective technologies for producing and storage of agricultural, horticultural and livestock products. Nowadays, there is a new challenge for the Bulgarian higher education and research – transformation of the existing education on Agricultural Engineering to Biosystems Engineering.
The main aim of the report is to present the current state and perspective for higher education on Biosystems Engineering in Bulgaria.
To accomplish the aim above, the 1st ERABEE Project Newsletter was translated into Bulgarian language and was distributed together with a inquiry questionaire at three institutions, which are the most closely related to education and research in Agricultural Engineering in Bulgaria, namely “Angel Kunchev” University – Rousse, Agricultural University – Plovdiv and Research Institute for Melioration and Mechanization – Sofia.
An inquiry study with 63 participants was conducted, in this figure:
- 30 students on Agricultural Engineering,
- 18 lecturers and researches on engineering subjects in Agr. Eng. course,
- 15 lecturers on biological and agronomical subjects in the same course;

Inquiry results
They show that 90% of the participants are acquainted with the definition of Biosystems Engineering discipline from the 1st Project Newsletter for the first time. Only 3% of participants have information about recent developments in the area of Biosystems Engineering in Bulgaria, namely about equipment for producing oil from rape introduced by RIMEX Engineering company. No body expresses any wish for adding or summarizing definition of Biosystems Engineering in different way than in the Newsletter.
More than half of participants (67 %) envisage real revision necessity for the Agricultural Engineering core curriculum related its transform to Biosystems engineering. But they suggest adding to the core curriculum the following modules:
- Analysis and Design of equipment and technology for bio-fuel;
- Analysis and Design of equipment and technology for agricultural liquid and solid waste processing.
The relevant to Biosystems Engineering disciplines in Bulgaria are both Agricultural technique and technology and Agricultural Engineering. The first one is offered at the Rousse University since 1954. The second is offered at three Universities – the Rousse University, the Agricultural University – Plovdiv and the Thracian University – Stara Zagora since 2002. The popularity of Agricultural Engineering COURSE is going up each year, more over it is the most attractive among agrarian specialities at the Agricultural University – Plovdiv, according to number of candidate-students for one student place, besides that the Agricultural Engineering students graduate with highest grades.

Those are the main reasons way 72 % of inquiry participants consider, that the transition from existing Agricultural Engineering programme of study to the emerging discipline of Biosystems Engineering is not imperative at the moment in Bulgarian higher education.

The same percentage of participants is keen on expanding the existing Agricultural Engineering course by establishing master courses on new areas of biomaterials, bio-fuels, biomechatronics, etc. More over, Bulgarian low for higher education encourage and stimulate that.

Before the Newsletter and questionnaire dissemination, there was no real discussion or consideration about transition from Agricultural Engineering to Biosystems Engineering. Presumably, this is the reason why only 24 % of participants envisage this transition would become urgent after 5 years and the other 32 % - after 10 years.

The relevant activities that would change the present situation and create suitable surroundings in Bulgaria are:

- National popularisation and advertisement the main ERABEE idea.
- Discussion the future of Agricultural Engineering and necessity of transition or evolution to Biosystems Engineering.
- Establishing the more active collaboration of Bulgarian structures in the area of Agricultural Engineering with European structures.
- An article for the ERABEE TN and the core of Biosystems Engineering is under preparation. It will be based on the 1-st ERABEE Project Newsletter and the inquiry results.

The chart on figure 1 shows the inquiry participant opinions about the possible impact of the transition from the existing to expanded Agricultural Engineering or Biosystems Engineering in Bulgaria.

![Figure 1. Inquiry results for the impact of transition from existing to expanded Agricultural Engineering or Biosystems Engineering in Bulgaria.](chart.png)

More than half of the participants envisage positive impact on:

- Universities, offered Agricultural engineering, because this will arise a necessity of
new areas of teaching and research, together with new specialists and departments (according to 58 % of the participants);

- Student enrolment increase especially for the new study and research directions (75 % of the participants);
- Professional status of the graduates, due to more expanded qualifications and better possibility to apply the new professional knowledge (76 % of the participants);
- National attractiveness of the Universities, offered the extended Agricultural Engineering or Biosystems Engineering (71 % of the participants);
- The rest of participants are not tuned negatively - they have no opinion about the questions.

The social need of the transition from existing to expanded Agricultural or Biosystems Engineering has not identified at the national level. The only presented inquiry results are available in Bulgaria at the moment. They show that 58 % from the opinions envisage positive social effect on professional structures and industry in the mentioned area.

The main disproportion of the present Bulgarian labour market is “many unemployed and luck of professionals”. In this meaning, the transition mentioned above will influence positively on the labour market mainly through providing trained staff for the modern agriculture and new sectors of the related industry.

According the inquiry results, Biosystems Engineering holds out more job opportunities than the existing Agricultural Engineering not only in agriculture, but also in linked industrial sectors. The inquiry participants identify the following new job opportunities for the Biosystems engineers:

- Experts at companies dealing with design, development and introduction of innovative technologies for bio-materials, bio-fuels and environmentally friendly and sustainable systems, etc.
- Staff for maintenance and management of the mentioned equipment at companies & producers of bio-materials, bio-fuels, etc.
- Qualified personnel at extension service companies in the mentioned sectors.

The inquiry participants do not envisage any possible conflicts with other disciplines in Bulgaria, just the contrary. They notice an overlapping of the existing Agricultural engineering course with Agricultural technique and technology course about 50 % and with General Agronomy course about 25 %. Many people (66 %) think, that this fact leads to lack of enough own identification of the existing Agricultural Engineering. They also envisage a positive effect of expanding the existing Agricultural engineering with the new mentioned areas.

**Conclusion**

The expanding Agricultural Engineering and Biosystems Engineering disciplines are not popular in Bulgarian higher education and research at the moment. On other hand, there is a big interest and good prerequisites for expanding the existing Agricultural Engineering discipline with the new emerging areas for bio-materials, bio-fuels, biomechatronics, etc. The inquiry results show that the Agricultural Engineering transition to Biosystems Engineering would be suitable to perform in two stages. The first – expanding the existing Agricultural Engineering with master courses on bio-materials, bio-fuels, biomechatronics, etc., after 5 years and the second – evolution to Biosystems engineering – after 10 years.
1. Definition of the Biosystems Engineering discipline

The most common definition of Biosystems Engineering, which is also accepted in Czech Republic, is based on the principles described in the journal Biosystems Engineering, official journal of the Institution of Agricultural Engineers (I AgrE). It says: “Biosystems Engineering” is research in the physical sciences and engineering to understand, model, process or enhance biological systems for sustainable developments in agriculture, food, land use and the environment” [1]. This definition covers nine fields:

- **Automation and Emerging Technologies (AE)** - intelligent machines; automatic control; navigation systems; image analysis; biosensors; sensor fusion; engineering for biotechnology
- **Information Technology and the Human Interface (IT)** - communications and field bus protocols; ergonomics; geographical information systems; operational research; biosystem modelling and decision support; machinery management; risk and environmental assessment; operator health and safety; work science
- **Precision Agriculture (PA)** - agro-meteorology; food, fibre and forage crop production; extra-terrestrial bioproduction; yield, weed and soil mapping; geographical positioning systems; input reduction; integrated pest management
- **Power and Machinery (PM)** - tillage and earthmoving equipment; machines for the establishment, protection and harvesting of field, protected, and orchard crops; tractors and agricultural vehicles; dynamics, vibration and noise; forest engineering; hydraulics and turbomachinery; clean technology
- **Postharvest Technology (PH)** - properties of biomaterials; crop drying, processing and storage; opto-electronic size grading; ripeness, quality, damage and disease detection with optical reflectance, nuclear magnetic resonance and X-ray tomography; food packaging and processing; food chain integrity and foreign body detection
- **Structures and Environment (SE)** - design of buildings and control of their environment; livestock housing; dust and odour control; crop stores; horticultural glasshouses and plasticulture; composting and waste treatment; gaseous emissions
- **Animal Production Technology (AP)** - livestock welfare and ethology; health monitors; robotic milking and shearing; feed handling; animal draught; integrated stock management; stock handling, weighing, transport and slaughter; meat processing
- **Soil and Water (SW)** - soil structure and properties; soil dynamics in tillage, traction and compaction; soil erosion control; crop water requirements; infiltration and transport processes; irrigation and drainage; hydrology; water resource management; hydroponics and nutrient status

*Corresponding author: Prof. Ing. Pavel Kic, DrSc., Phone: + 420 224 383 141, e-mail: kic@tf.czu.cz*
- Rural Development (RD) - renewable energy; pollution control; protection of the rural environment; infrastructure and landscape; sustainability

Related field of science is defined as a “Bioengineering”. According to The American Heritage® Medical Dictionary, Bioengineering includes two branches:

- The application of engineering principles to the fields of biology and medicine, as in the development of aids or replacements for defective or missing body organs;
- Genetic engineering [2].

From Wikipedia, the free encyclopaedia, can be used also the word “Bionics” (also known as biomimetics, biognosis, biomimicry, or bionical creativity engineering), which is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology [3].

It seems, that these parts of science from the last two definitions are currently away of problems solved in the research and teaching activities of our Faculty of Engineering.

2. Possible revisions in the existing modules in reference to the core curriculum included in the FEANI Report Template and suggestion of new module(s) that might be included with regards to the Biosystems Engineering discipline

Study program of Agricultural Engineering and related fields (described in part 3) prepared and accredited at Faculty of Engineering of CULS Prague (the 1st and 2nd cycle) includes and covers all main courses corresponding with the courses from the FEANI report.

The partial difference is above all in the part Agricultural/Biological courses (core basis courses). There are possibilities for the students who are interested in those courses to follow it as facultative courses in the frame of study programs of the CULS Prague, prepared by the other Faculties. It can be expected more interest of the international students to follow the study programs in English. It is positive, that the current courses taught are based also on the students work in laboratory and on the research projects.

It can be expected that several specialised courses could be developed and prepared for the new curricula, which needs deep research and work on the special fields of science. The exact specification will depend on the general situation of the university and particular possibilities of the faculty.

3. Current situation of the Biosystems Engineering discipline

Education specialised to agricultural engineering has a long tradition in the Czech Republic. During the last decades, great changes of the economy and policy in the country resulted also in the changes of an educational system. Many universities decided to prepare new study programmes according to the priorities and interest of young generation. There are three following universities, where the university studies of Agricultural Engineering are in Czech Republic. The basic information about the differences can be described:

Faculty of Engineering (formerly Faculty of Mechanisation in Agriculture, later Technical Faculty) of the Czech University of Life Sciences Prague (formerly Czech University of Agriculture) was established as part of the University of Agriculture in 1952. Originally, the faculty’s objective was to educate engineers for mechanisation
in agriculture as well as for machinery and tractor stations and for heavy machinery centres.

Three-level studies have been gradually introduced in the faculty since 1998, in harmony with Law 111/1998 coll. The international commission from EU several times evaluated the educational system. The current educational system seems compatible to the European systems from different point of view (e.g. ECTS, duration, degrees etc.).

Currently, after the many changes provided during the nineties and first years of this century, the Faculty of Engineering educates graduates for the whole of the agri-food sector including designing of technological equipment of buildings in food industry and agriculture, for road automobile transport and for trade and business involving machinery. B.Sc. In:

- Agricultural Machinery
- Road Transportation and City Traffic
- Technological Equipment of Constructions
- Trade and Business Dealing with Machinery.

Faculty of Engineering covers by the courses and research activities practically main parts of all branches from the first definition of Biosystems Engineering. In the area of new emerging discipline we could include studies specialised to the technology for waste management, and also study of information and control technology in Agri-food Complex. Bc. in:

- Waste Disposal Technology
- Techniques Information and Control Technology in Agri-food Complex.

In the second part (2nd level = MSc.) of the curricula (two years) students have the opportunity to choose their study programme in accordance with the rules and regulations set by the faculty. The title of the MSc. study programmes is the same like the title of previous Bc. study programmes. Students are not restricted to take courses only in their specialisation, but they may choose courses also from other specialisations.

There is offered one MSc. study programme with all courses taught in English language:

- Technology and Environmental Engineering

Many foreign students, especially incoming students in the frame of Lifelong Learning Programme (Erasmus), choose the courses included in this programme. Graduates of the MSc. level can continue in doctoral study programmes (PhD.). The doctoral study programme takes three years, and is offered in 5 special branches related to agricultural engineering. PhD. in:

- Technology of Production Processes
- Machinery and Mechanisation in Agriculture
- Power Engineering
- Quality and Dependability of Machinery and Equipment
- Marketing and Management of Machinery and Production Systems.

The Faculty of Agronomy, Mendel University of Agriculture and Forestry in Brno organises bachelor, master and doctoral study programmes. There is one bachelor study programme (three years) offered by this faculty in the field of agricultural engineering called “Management of Agricultural Machinery”. Two years master study related to the agricultural engineering either “Technology Management” or
“Automobile transport” can be taken after first degree. The university offers also Doctoral study. The Faculty of Agriculture at the University of South Bohemia (USB) in Ceske Budejovice offers bachelor study programme (three years) in the field of agricultural engineering “Agricultural Machinery – Marketing and Services”. This university does not offer the Master nor Doctoral level study in the field of agricultural engineering.

The basic information about the study programmes can be described:

<table>
<thead>
<tr>
<th>University</th>
<th>Faculty</th>
<th>Bachelor degree</th>
<th>Master degree</th>
<th>Doctoral degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>CULS Prague, Faculty of Engineering</td>
<td>Bachelor degree (6 study programmes in Agricultural Engineering)</td>
<td>3 years</td>
<td>2 years</td>
<td>3 years</td>
</tr>
<tr>
<td>Mendel University of Agriculture and Forestry (MUAF) in Brno, Faculty of Agronomy</td>
<td>Bachelor degree (1 study programmes in Agricultural Engineering)</td>
<td>3 years</td>
<td>2 years</td>
<td>3 years</td>
</tr>
<tr>
<td>University of South Bohemia (USB) in Ceske Budejovice, Faculty of Agriculture</td>
<td>Bachelor degree (1 study programme in Agricultural Engineering)</td>
<td>3 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Impact of the transition of the discipline
The transition from the traditional study programmes to the new emerging discipline was based on the needs of the whole society in Czech Republic. The whole Czech University of Life Sciences Prague prepared and opened many study programmes, which were accredited by the state commissions. The whole structure of the University was strongly influenced by this process. The CULS Prague was created originally by 3 Faculties and about 3 500 students. Currently, it has 5 Faculties with more than 40 specialised study programmes in each level, available also in the combined (distance) form of study: Faculty of Engineering, Faculty of Economics and management, Faculty of Agrobiology, Food and Natural Resources, Faculty of Forestry and Wood Sciences, Faculty of Environmental Sciences. The number of students dramatically increased from 3500 to 20 000 students, who follow the Bachelor, Master or Doctoral study levels.

The quality of new study courses and study programs must be always assured by standardized accreditation procedure at the Faculty and University level. The curricula of the courses and programs are presented to the scientific board of the Faculty, and the special commission nominated by the Vice-rector also recognizes it. It assures not only the quality of the course but it also eliminates duplicity of the courses.

The accreditation process is mandatory and the rules are general for any type of study program accredited. Any new study program has to be accredited under the legislation rules. The accreditation commission by the Ministry of Education, Youth and Sports considers the accreditation application. In the application are presented the curricula of the program, characteristics of each course, personal data of each course guarantor, financial support for each program, library and information sources for student’s support etc. The application has the mandatory structure and the
accreditation commission is allowed to require additional materials and information for its evaluation. Usually the accreditation is permitted for Bc. for 4 years, MSc. and PhD for 8 or 10 years.
The foreign prestigious universities evaluated Czech University of Agriculture Prague several times. The group of specialist from the University of Wageningen (including the Rector and Heads of Departments) made the first evaluation in 1993, and the international commissions created from the representative persons of five EU Universities provided second evaluation in 1999. The last evaluation was at the Czech University of Agriculture Prague in the year 2006.

5. Has the societal need for such a transition been identified at a national level? If yes, was it based on pertaining questionnaires circulated to employers, professionals and professional bodies, alumni, etc. Has this societal need identified by any independent market analysis, or independent reports of the private/industrial or public sectors?
The profession “Engineering” has been one of the dominating branches in Czech Republic for approximately 100 years. The specialist for the traditional engineering professions e.g. machinery engineering, civil engineering, electro engineering etc. are educated at several technical faculties and universities in the Czech Republic. Alumni of engineering study programs have no limitations and restrictions in their job functions in general.
Currently, engineering is not a “regulated” profession in the Czech Republic. There are several societies, which represent scientific, and special interest of professional engineers for different branches, like Czech Scientific Technical Society and its parts, e.g. Czech Society for Quality, Society of Environmental Engineering, etc. There are also limitations/restrictions on the job functions, which are related to the designing process of either buildings or technological facilities. Persons, who want to be designers, must past the professional examination by Czech Commission of Chartered (Authorized) Engineers. The graduates from the Faculty of Engineering of CULS Prague can achieve the degree of “Chartered (Authorized) Engineer” after graduation of two study programs: “Technological Equipment of Constructions” and “Waste Disposal Technology”.
The Faculty has good relations with many graduates from the last years and quite interesting and helpful are also results of questioners, which our graduates fulfil after graduation and after many years of experience in practical life.
Problems, which are solved in the area of new emerging disciplines of Biosystems Engineering, like expanding new areas of biomaterials, bio-fuels and mechatronics, are studied at the Faculty of Engineering partly in the research; but more attention should be paid to it also in the courses for Bachelor and Master level. Especially during the last years, questions related to the food quality, safety and traceability are obviously very important for the Czech Republic. These problems are mentioned in some courses for students only informatively. The role of international cooperation, exchange of information and strongly oriented research in these branches, can be very important for the future development of curricula.
6. Influence of such a tradition on the labour market and on the employability of the Biosystems Engineering graduates.

The strategy in preparation of the study programs is based on the current and supposed future situation in the working place market. The number of economically active population working in agriculture is dramatically reduced (553 000 persons in 1990, 287 000 in 1994, 149 000 in 2000, and 122 000 in 2005) [4]. It resulted in very low needs of highly educated people for agriculture. The study of agricultural sciences lost its attractiveness. One the other hand, many young people, especially from the country, are interested in university studies in agri-business, commerce and technology. It was the main reason, why the Czech agricultural universities extended their study programs to the related fields and other similar branches during the last years.

The perspective development of agriculture, use of land, landscape planning etc. will probably follow general trends in European countries with similar climatic and economic conditions. On the one hand the higher pressure of market is on the improvement of food quality and all food recourses, on the other hand more intensive use of land for non agricultural production (raw materials, energetic purposes, improved landscape cultivation with esthetical aspects for agricultural tourism etc.) can be expected in the next years.

The new technology for quality management, e.g. food traceability systems, precision farming and precision livestock farming will be generally more in the use in agriculture. The whole agri-food complex is large part of economy and business, and new emerging technologies in the frame of Biosystems engineering will probably create an inseparable part of it. The research and study programs should follow these trends.

The possible conflicts with established disciplines are not expected, the main problems can create the persistence of some departments and persons to continue only in old traditional branches instead of participation on development and preparation of new study programs.

References:
1. Biosystems Engineering. Official Journal of the Institution of Agricultural Engineers (IAgrE)
2. The American Heritage® Medical Dictionary
4. Statistical Yearbooks of the Czech Republic
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN DENMARK

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1. Specify the main characteristics and give a definition of the Biosystems Engineering discipline based on your expertise and/or any recent developments in your country. Please justify the definition with adequate references.

In Denmark we agree to the following basic definition of Biosystems Engineering (BE) as various other educational institutions across the world: BE is a science-based engineering discipline that integrates engineering science and design with applied biological, environmental and agricultural sciences. Biosystems engineers apply engineering analysis and design to solve problems involving biological organisms and their natural or controlled environments.

2. In reference to the core curriculum included in the FEANI Report Template propose possible revisions in the existing modules, if needed, and/or suggest any new module(s) that might be included with regards to the Biosystems Engineering discipline.

We recognise a big overlap in themes and topics between the FEANI core curriculum and course and programmes offered in Denmark. Due to the current and unique situation in Denmark about merging of institutions and reorganisation of programmes and courses there will probably be more modifications to structure and content of programmes and courses the next years. The FEANI core curriculum will be the basis for the coming discussions.

3. Describe the current situation of the Biosystems Engineering discipline or any relevant to it discipline in your country. In case no such programme of studies exists please explain if the need for such a transition or evolution from the traditional Agricultural Engineering programme of studies to the new emerging discipline of Biosystems Engineering is under discussion, consideration or it is foreseen in the future, in any way. Please explain the relevant policy related channels for such a development in your country.

Denmark reorganized education and research at universities in 2006. Universities were merged and sector research institutions were integrated into universities. The political drivers behind it were aiming at to strengthen regional universities and to gain synergy effects in education, research and organisational issues. The merger between the former Royal Veterinary and Agricultural University (KVL), The Danish University of Pharmaceutical Sciences and the University of

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Copenhagen became reality in January 2007. As a consequence, KVL has changed its name to Faculty of Life Sciences. The University of Copenhagen is now the largest university in Scandinavia in number of researchers with more than 5,500 researchers and 37,000 students. The vision has been to create Denmark’s most prominent and internationally oriented university. The University of Copenhagen now consists of 8 faculties and at the same time comprises Europe’s largest university cluster within Health and Life Sciences. Health and Life Sciences is research into all that lives - plants, animals and humans - with a particular focus on the prevention and curing of diseases.

After merging with the University of Copenhagen the Faculty of Life Sciences’ research and education will maintain its present focus and we will continue to offer and develop our 25 university degree programmes. All that lives will remain at the centre of our efforts to establish a holistic and interdisciplinary approach to the entire chain ‘from farm to fork’. Our aim is to improve the health, welfare and quality of life of human beings, animals and nature and we plan to do so within the seven main areas where we already assume a significant position at home and abroad:

- biotechnology
- veterinary medicine and animal welfare
- energy and the environment
- food and health
- plants and natural resources
- economics, politics and developing countries
- forestry, landscape and urban development

The University of Aarhus ranks amongst the 200 best in the world, and has very strong academic environments within science, health sciences, social sciences, theology and the humanities. The study environment at the university is concentrated around an attractive campus in the centre of the city of Aarhus – with excellent opportunities for interdisciplinary collaboration and contact with all parts of the university. The university is internationally oriented and in a strong state of development, with an extensive academic scope that covers all aspects of the social sectors.

On 1 January 2007, the University of Aarhus merged with the Danish National Environmental Research Institute (NERI), the Danish Institute of Agricultural Sciences (DIAS) and the Aarhus School of Business (ASB). On 28 February 2007, this merger was extended to include the Danish University of Education (DPU). As a result of the merger, the University of Aarhus has considerably increased in size, and is the second-largest university in Denmark. The university has approximately 35,000 students and a staff of about 9,000 (full-time equivalent).

### 3.1 University of Copenhagen ([http://en.ijv.life.ku.dk/](http://en.ijv.life.ku.dk/))

In 2005 the old programme of agriculture was already revised into a BSc programme of Natural Resources and new MSc programmes of Agriculture, Forestry and several others. In the BSc programme students will have to attend more or less predetermined courses and modules, equivalent to a core curriculum. However, it is important to note that the core curricula focuses on the Natural Resources seen in a broad perspective, where the specialist areas, such as Biosystems Engineering, will
be taught in combination with other disciplines and in special course units, fitted into the core curriculum according to the specific student interests. This new core curriculum will strengthen the students’ common natural science skills, while also having an important economical incentive for the institution, as few courses with more students attending them equals earning money.

Within the MSc programme in Agronomy new specialisations have been defined in 2008. The preliminary theme titles are:

- Biological Processes and Crop Quality
- Crop Production and Environment
- Systems and sustainability

Some of the current courses related to BE are:

1. Environmental and Ecotechnology 7.5 ECTS
2. Bioresource Technology and Environment 7.5 ECTS
3. Life Cycle Assessment 7.5 ECTS
4. Biosystems Instrumentation 10 ECTS (3rd cycle)

A new MSc specialization in BE within KU-Life does not seem realistic in the near future as no priority is given to the area, and staff has been reduced during the later years.

However, there are possibilities within the “Nordic School of Biosystems Engineering” (NORBE), which is part of The Nordic Forestry, Veterinary and Agricultural University Network (NOVA, [http://www.nova-university.org/] that includes universities in Norway, Sweden, Finland and Denmark. In this school students can choose between single courses, semester packages and full MSc programmes with specializations in Farm Buildings, Agricultural Systems Engineering (from 2008), Machinery for Biosystems Environmental Engineering (from 2008) and Aquaculture Engineering.

Within the Copenhagen area students also have possibilities to supplement with courses at the Technical University of Denmark ([http://www.dtu.dk]), but no common BE programme is under way.

Remark: The Department of Agricultural Sciences at KU-LIFE will merge with the Department of Ecology starting 1st July 2008. The new department will be called Department of Agriculture and Ecology.

3.2. University of Aarhus ([http://www.agrsci.org/])

The Faculty of Agricultural Sciences within the University of Aarhus has research activities at centres in Foulum, Bygholm, Aarslev, Flakkebjerg, and Sorgenfri as well as at four experimental stations. Furthermore, a research group is located at the Faculty of Life Sciences, University of Copenhagen.

Besides the basic service and administrative functions, units in support of the research have been established performing tasks relating to farm management and animal research facilities, library and IT-functions as well as information and documentation activities. The Faculty of Agricultural Sciences thus has modern laboratories and experimental facilities, including barns, greenhouses, and semi-field facilities. To this may be added an area of approx. 1300 hectares for research, experiments, and feed production.

University of Aarhus starts a new MSc education in Biosystems Engineering in September 2008. The degree program is offered by the Faculty of Agricultural Sciences in collaboration with the Engineering College of Aarhus and Vitus Bering
Denmark. Bachelors from Denmark and abroad are targeted, who have taken a relevant degree in, for example, engineering. It is both user- and research-oriented and is primarily directed at industry.

The course programme gives the opportunity to specialise in one of two strands:

1. The Automation strand is based on a considerable amount of knowledge relating to the treatment and interpretation of sensor data from a biological environment and knowledge of how data can be utilised in the design and production of automation equipment. The strand is problem-solving and produces innovative environments for the agricultural automation equipment market, to the benefit of primary agriculture and export.

2. The Environmental technology strand focuses on the development of eco-technological solutions in agriculture that ensure the optimal utilisation of nutrients and the continued coexistence of town and country. It focuses on emissions and the measurement of low odour concentrations and how these can be reduced. Holistic solutions are emphasised, and life cycle analysis of energy and nutrient turnover is a core subject. There is the opportunity to specialise in production and utilisation of bioenergy.

The education lies at the interface between biology and technology and students may chose automation or environmental technology. Students specialising in engineering will at the completion of the study be able to integrate technical knowledge with production and eco-technological progress and to enhance a biological production in a modern society. Graduates with a biological background will be able to work as advisors in the technological development of biosystems and eco-technological solutions.

The studies are primarily project-oriented, where the students will solve actual problems in related research projects. The dissertation is carried out either in collaboration with scientists or with commercial entities and will be part of an actual development or research project. This will require creativity and dedication on the part of the students, and it will help them develop a constructive and critical approach towards their own and others’ work and to be able to rationalise their choices.

On completion of the degree students will have acquired skills in automation and environmental technology at the interface of biology and technology. They will be able to research, organise and control development and production and participate in processes relating to the development of automation and environmental technology, or they will be able to advise on new environmental technologies for the development of the best technological, economic and environmental solutions in agriculture.

3.3. Other educational institutions

Other courses and related study programmes are offered by the University of Southern Denmark (Institute of Chemical Engineering, Biotechnology and Environmental Technology (http://www.sdu.dk).

4. Will such a transition have an important impact on a) the Institutional structure, b) the students’ enrolment, c) the professional status and d) the national and international attractiveness and to which extent? (based on reported analyses, if any, or on your personal assessment as an expert).

Due to the current situation in Denmark it is very difficult to assess and foresee the impact of new study programmes on the institutional structure, on students’
enrolment, on the professional status and on the national and international attractiveness. A curiosity is that the University of Copenhagen decided to reduce and limit the activities in the BE area while at the same time the University of Aarhus started to offer a MSc programme in BE.

5. Has the societal need for such a transition been identified at a national level? If yes, was it based on pertaining questionnaires circulated to employers, professionals and professional bodies, alumni, etc.? Has this societal need identified by any independent market analysis, or independent reports of the private/industrial or public sectors? Please justify.

The societal need for Biosystems Engineering discipline has been confirmed and identified. But a clear increase in student enrolment is needed to keep the new established programmes and courses.

6. Envisage the influence such a transition may have in your country on the labour market (e.g. industries, companies, private and public sector, freelance work and self-employment) and on the employability of the Biosystems Engineering graduates based on your expertise. More specifically try to identify areas where new job opportunities for Biosystems Engineers may arise in the labour market in your country, especially with respect to the current situation of the Agricultural Engineers. Please identify and justify possible conflicts with other established disciplines.

The need for graduates with skills especially in problem solving by using the systems approach is obvious for some commercial companies. Companies need highly specialised as well as interdisciplinary oriented employees. Traditional Agricultural Engineers often lag non-agricultural problem solving competences which are abilities of Biosystems Engineers. The awareness will probably support the acceptance of the Biosystems Engineering discipline in the next years.

References:


DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN ESTONIA

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Estonian Association of Agricultural Engineers, Fr. R. Kreutzwaldi 56, 51014 Tartu, Estonia

Abstract
According to the definition in this paper the technologies of biotechnical systems represent an applied synergy of basic, natural and technical sciences, resulting in origination of bioenergy, biomatter, and biomaterial. Prerequisites for assignment of the agricultural engineer profession and the necessity of reshaping the basic university curricula creating a new one – a curriculum for biotechnical systems engineer are explained. The forms of 3+2 curricula of biotechnical systems and project subject programs are explained.

Keywords: technology of biotechnical systems, bioenergy, biomatter, biomaterial, agricultural engineer, biotechnical systems engineer

Introduction
Estonian University of Life Sciences is the only university in Estonia which study and research fields comprise the production and usage of life-essential agricultural products.

Former structural units of the Institute of Technology of Estonian University of Life Sciences – formation and chronological order of the subjects taught (Tables 1. and 2.)

Table 1. Chronology of units teaching agricultural machinery

<table>
<thead>
<tr>
<th>Period</th>
<th>Department (chair, institute, work group)</th>
<th>Subordination</th>
<th>Main groups of subjects taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>1919...1945</td>
<td>Chair of agricultural equipment and machinery</td>
<td>Tartu University, Faculty of agriculture</td>
<td>agricultural machinery mechanization of agriculture</td>
</tr>
<tr>
<td>1945...1951</td>
<td>Chair of agricultural mechanization</td>
<td></td>
<td>agricultural machinery</td>
</tr>
<tr>
<td>1951...1955</td>
<td>Chair of agricultural machinery</td>
<td>Estonian Academy of Agriculture, Faculty of agricultural mechanization</td>
<td>agricultural machinery, mechanization of cattle-breeding, electrification</td>
</tr>
<tr>
<td>1955...1957</td>
<td>Chair of agricultural machinery and electrification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1957...1971</td>
<td>Chair of exploitation of agricultural machinery</td>
<td>Faculty of agricultural mechanization</td>
<td>agricultural machinery, machinery usage, work safety</td>
</tr>
<tr>
<td>1971...1991</td>
<td>Chair of agricultural machinery</td>
<td></td>
<td>agricultural machinery, machinery usage, work safety</td>
</tr>
<tr>
<td>1991...1992</td>
<td>Chair of agricultural machinery</td>
<td></td>
<td>agricultural machinery, machinery usage,</td>
</tr>
<tr>
<td>Period</td>
<td>Department (chair, institute, work group)</td>
<td>Subordination</td>
<td>Main groups of subjects taught</td>
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<tr>
<td>1946...1951</td>
<td>Chair of transport equipment and machinery design</td>
<td>Tartu University</td>
<td>transport facilities (machinery), electrotechnics, hydraulics, heat engineering, machinery design</td>
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<tr>
<td></td>
<td></td>
<td>Faculty of agriculture</td>
<td></td>
</tr>
<tr>
<td>1951...1991</td>
<td>Chair of cars and tractors</td>
<td>Estonian Academy of Agriculture, Faculty of agricultural mechanization</td>
<td>cars and tractors, heat engineering, traffic and traffic safety</td>
</tr>
<tr>
<td></td>
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<tr>
<td>1991...1992</td>
<td>Chair of transport equipment</td>
<td>Estonian Agricultural University Institute of agricultural engineering</td>
<td>cars and tractors, traffic safety</td>
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<tr>
<td>1992...1994</td>
<td>Chair of agricultural machinery</td>
<td>Estonian Agricultural University Institute of agricultural engineering</td>
<td>agricultural machinery, machinery usage, cars and tractors, labour protection</td>
</tr>
<tr>
<td>1994</td>
<td>Institute of agricultural engineering</td>
<td>Estonian Agricultural University Institute of agricultural engineering</td>
<td>cars and tractors, hydro-drives</td>
</tr>
<tr>
<td>1994…</td>
<td>Institute of agricultural engineering</td>
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</tbody>
</table>
1. Definition of the Biosystems Engineering discipline
The technology of biotechnical systems is a joint application of fundamental (basic) sciences (mathematics, physics, chemistry, philosophy), natural sciences (anatomy, zoology, biology) with technical science (applied mathematics, technology, ergonomics, electrotechnics and energetics, agricultural machinery and technologies, animal breeding technologies, medicine) resulting in synergy of energy, substance, material and product.
The primary key word here is living nature, which lifelong evolution in the technological chain of biosystems is dictated by man, who by his daily consumership is (re)shaping the ambient world.
The object of the biotechnical systems technology as a new emerging discipline is to synthesize and produce alternative bioenergies, bioproducts and materials in concordance with the society’s overgrowing consumer demands.

2. Current situation of the Biosystems Engineering
Transition from the consumer-oriented society to life-sustainable and efficient consumership is realized on the principles of remodeling the surroundings, putting into practice biotechnical systems and technologies, essential and indispensable due to the global climatic changes.
Research and industry in Estonia have started their pace of development in the sphere of biotechnical systems due to the help of Western Europe: most of the machinery and technology used are of Western origin. As in the whole world, biofuel and biogas have been made more active use in Estonia recently; environmental impact assessment and waste management have found much consideration.
Demand for engineers qualifying in biotechnical systems is growing.

3. In reference to the core curriculum included in the FEANI Report Template propose possible revisions in the existing modules, if needed, and/or suggest any new module(s) that might be included with regards to the Biosystems Engineering discipline.
The curriculum of the Institute of Technology of the Estonian University of Life Sciences from 2005 in 3+2 system is technology-oriented, with specializations in production engineering, technotronics, ergonomics and energy usage. At present it is reasonable to remodel the curriculum into 3+2 years of biotechnical systems engineering, with specializations in biosystems technology, biosystems technotronics, biosystems ergonomics, energetics of biosystems.
The Institute of Technology of the Estonian University of Life Sciences approves most of the subjects in the curriculum of Biosystems Engineering Discipline introduced by FEANI and on the basis of it we have drawn up our own provisional curriculum, expectedly meeting the requirements of the institute.

4. Has the societal need for such a transition been identified at a national level? If yes, was it based on pertaining questionnaires circulated to employers, professionals and professional bodies, alumni, etc. Has this societal need identified by any independent market analysis, or independent reports of the private/industrial or public sectors? Please justify.
At present the Estonian University of Life Sciences lacks the curriculum of biotechnical systems engineering, but a curriculum of engineering exists, which rescheduling is a mutual concern both of the University and the employers. EU financial aid for agriculture has had a regenerative effect both for agricultural
production and to the firms producing, selling and maintaining the relevant machinery. Most of these firms employ specialists educated in the sphere of agriculture and technology. Efficient and environment-conscious agricultural business is inconceivable without modern machinery and people who can operate it. That is why, considering the standard of modern machinery, it is essential to maintain an uninterrupted schooling of highly qualified specialists. With this aim the previous technology-based training has to be developed to a wider basis. A discussion is on to reconsider the agricultural engineer qualification into biotechnical systems engineer qualification.

In Estonia the demand for biotechnical systems engineers has not been studied. The existing connections and cooperation with branches producing and processing agricultural products are signaling us of the need of this profession. 25% of land in Estonian is engaged in agricultural production. Industrial biotechnical systems in need of learned specialists can be accrued regionally. There is an obvious need for qualified personnel. The Estonian University of Life Sciences is the only university providing higher education in biotechnical systems in Estonia. The achieved economic level is due to qualified specialists, at the same time a need for skilled biotechnical systems specialists has arisen. The high level of technology has shifted the emphasis from theoretical technological treatment to the system Man-Machine-Environment.

Conclusions
Analyzing the present situation on Estonian labour market (with the discussion of the representative of Estonian agricultural engineers and employers in view) and the restructuring of the curricula of the Institute of Technology of the Estonian University of Life Sciences, the following conclusions can be made:

i. The Estonian Association of Agricultural Engineers at present recognizes the bachelor 3-year engineering curriculum and the master's 2-year production engineering curriculum (taught at the Institute of Technology of the Estonian University of Life Sciences) as the basic curricula for agricultural engineer profession.

ii. The Estonian Association of Agricultural Engineers and the Estonian Employers' Confederation recommend and support the rescheduling of the engineering curriculum taught in the Institute of Technology of the Estonian University of Life Sciences into the biotechnical systems technology curriculum.

iii. The Estonian Association of Agricultural Engineers and the Institute of Technology of the Estonian University of Life Sciences approve the biotechnical systems technology basic curricula presented by FEANI, a source document for compiling a new university curriculum, the realization of which will be a preliminary condition for getting engineer profession.

iv. The Estonian Association of Agricultural Engineers and the Estonian Employers' Confederation claim that a need for biotechnical systems technologists and engineers exists on Estonian labour market.

v. The Institute of Technology of the Estonian University of Life Sciences is ready for transition to biotechnical systems technology curriculum in system 3+2 and is willing to carry out the curricula-based study in keeping with EU Standard of Higher Education.
vi. The Institute of Technology of the Estonian University of Life Sciences holds the position that transition to biotechnical systems technology curriculum is necessary and timely and the intake number will not diminish.

vii. The present opinions are not questionnaire-based information but an analysis of the standpoints of the representatives of the Estonian Association of Agricultural Engineers, the Estonian Employers’ Confederation and the Institute of Technology.

References:
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<th>Field</th>
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<th>Module</th>
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<td>Mathematics (min 24 ECTS)</td>
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<td>Engineering Graphics and Design – CAD</td>
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<td>Strength of Materials</td>
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<td>General Course in Mechanics - Dynamics</td>
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<td>Heat Engineering - Thermodynamics</td>
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<td>General Course in Heat Transfer</td>
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<td>Plant Biology</td>
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<td>General Course in Soil Science</td>
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<td>Electric Circuits</td>
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<td>Instrumentation and Measurements</td>
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<td>Geodesy – Geoinfosystems (GIS)</td>
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<td>Crop Protection</td>
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<tr>
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<tr>
<td>Animal Sciences and Management</td>
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<tr>
<td>Environmental Impact Assessment</td>
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<tr>
<th>Subject</th>
<th>Credits</th>
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<tr>
<td>Energy Production and Supply</td>
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<tr>
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<td>3.3%</td>
</tr>
<tr>
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<td>3.3%</td>
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<tr>
<td>Electrotechnics</td>
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<td>6.6%</td>
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<tr>
<td>Instrumentation and Measurements Electronic</td>
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<td>6.6%</td>
</tr>
<tr>
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<td>3</td>
<td>3.3%</td>
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<tr>
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<tr>
<td>Animal Science and Management</td>
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<tr>
<td>Environmental Impact Assessment</td>
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<tr>
<td>Environmental Microbiology</td>
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<tr>
<td><strong>Energetics of Biosystems</strong></td>
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<tr>
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<tr>
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<tr>
<td>Animal Science and Management</td>
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<tr>
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<td>Physiology and Hygiene</td>
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<tr>
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<td>3.3%</td>
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<tr>
<td>Industrial and Agricultural Environment</td>
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<td>3.3%</td>
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<tr>
<td>Electrotechnics</td>
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<td>6.6%</td>
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<tr>
<td>Buildings Safety</td>
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<td>Safety of Workstation</td>
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<td>Electives subjects 16-20 ECTS: 8.9-11.1% of total 180 ECTS</td>
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### CURRICULUM – MASTER (2 YEARS)

#### Biosystems Engineering

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<td>Farmstead Equipment</td>
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<tr>
<td>Analysis and Design of Biomachinery</td>
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<tr>
<td>Techniques in Precision Agriculture</td>
</tr>
<tr>
<td>Automatics Control</td>
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<tr>
<td>Computer Control of Machines and Processes</td>
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<td>Design Methods for Machines for Biosystems</td>
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<td>Soil erosion</td>
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<tr>
<td>Landscape Planning</td>
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<td><strong>Free technical or Agricultural/Biological Elective</strong></td>
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#### Biosystems Technontrics

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<td>Electives subjects 16-20 ECTS: 8.9-11.1% of total 180 ECTS</td>
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<td>Animal Sciences and Management</td>
</tr>
<tr>
<td>Environmental Impact Assessment</td>
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<tr>
<td>Introduction to Food Sciences</td>
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</table>
DEFINITION OF THE EMERGING BIOSYSTEMS
ENGINEERING DISCIPLINE IN FINLAND

Ahokas Jukka
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Alakukku Laura
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Finland

Abstract
The employment of agricultural engineers in Finland is at the moment good. The
graduated students are not entitled to use the title of engineer but agronomist and
their education is more agronomic based than engineering based. The education
does not at the moment fully fulfil the USAEE requirements and it might be easier to
follow a biosystems engineering requirements because of the nature of studies. The
need for English language courses is at the moment increasing and also the need for
international recognition of degree is increasing. In this context the biosystems
engineering discipline may offer a possibility.

1. The discipline of Agricultural Engineering at the University of Helsinki
The University of Helsinki is the only university in Finland giving higher education in
agricultural engineering. The discipline of agricultural and environmental engineering
has two specialization lines, agricultural engineering and environmental engineering
in agriculture. The department has started recently the program of environmental
engineering in agriculture due to strong concern about agricultural emissions to lakes,
rivers and Baltic Sea. The education of the department is based on agronomic studies supplemented with technical subjects. The aim of the discipline is to educate agronomist who know the technical principles of agricultural production and machines. They are also educated to know the management principles used in the production and environmental questions related to the production. The university sets up the basic structure of the studies, ie there are regulations concerning the amount of credit points in different categories. In agricultural engineering program this leads to the structure shown in table 1. The program includes for instance quite large amount of language, ICT and elective studies.

Table 1. Study structure at the department of Agrotechnology

<table>
<thead>
<tr>
<th>Degree</th>
<th>Studies</th>
<th>ECTS</th>
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<td>Studies in the main subject</td>
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<tr>
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<td>Languages and ICT studies</td>
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<td></td>
<td>Secondary subject</td>
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<tr>
<td>MSc</td>
<td>General studies</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Studies in the main subject</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Languages and ICT studies</td>
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</tr>
<tr>
<td></td>
<td>Elective studies</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>SUM</td>
<td>120</td>
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</table>
The main subject courses have 87 ECTS in the bachelor degree and 95 ECTS in the master degree, the credit points include thesis, which in the master program forms a large part of the credit points. General studies are 39 ECTS in the bachelor degree and 7 ECTS in the master degree. General studies include basic science studies. In the bachelor degree 54 ECTS is left for languages, ICT, elective and secondary subject studies. In the master degree the corresponding amount is 25 ECTS. When language and ICT courses are not calculated, altogether 59 ECTS is not controlled by the study program but the student can choose these quite freely.

In categorizing the courses it must remembered that the subject is an applied subject and all the basic science courses are more or less applied or engineering courses. This means that the division of courses to different categories could also be done in different ways. In table 2 the HU (Helsinki University) courses are compared to the USAEE proposed agricultural engineering structure [1].

<table>
<thead>
<tr>
<th></th>
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<th>USAEE</th>
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<tr>
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<td>engineering fundamental core</td>
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<tr>
<td>basis</td>
<td>10</td>
<td>44-51</td>
</tr>
<tr>
<td>Agricultural/Biological part</td>
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<td>20-25</td>
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<td>Agricultural engineering</td>
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<td>professional studies</td>
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<td>Engineering part</td>
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<td>28-30</td>
</tr>
<tr>
<td>Agricultural/Biological part</td>
<td>50</td>
<td>16-20</td>
</tr>
</tbody>
</table>

* This line is closest to Mechanical systems and mechanism used in agricultural and bioprocessing engineering in USAEE report

When the HU subjects are compared to USAEE requirements, the fundamental engineering and agricultural part of the courses have the largest differences. The main emphasis in HU courses is in the professional studies, which include also fundamental core basis matters. The allocation of the courses into different categories is difficult because the courses can be built up in many different ways.

2. **Biosystems engineering subject in Finland**

The national needs for agricultural engineering subject are satisfied with the present education. The unemployment of the graduated students is very low and they can easily find jobs in Finland. The education content is revised regularly based on discussion at the department and with employers of the graduated students. At the moment there are no discussion going on in Finland to change the agricultural engineering course contents. The need is at the moment mainly in the international acceptance side of the education. By using internationally recognized structures the degrees can be widely recognized. This would have a positive impact on student’s enrollment both nationally or internationally.

Another reason for internationally recognized study structure discussions is the English language MSc course supply. The university of Helsinki and also ministry of education are promoting English MSc courses in order to enroll foreign students. For this reason biosystems engineering or agricultural engineering English course structure is in consideration at the department. The Scandinavian countries also have a strong collaboration in agricultural/biosystems engineering education (NORBE) and for this purpose English courses are also needed because the language in these courses is also English.
3. Biosystems/Agricultural engineering title
The direct translation of the agricultural engineering education subject from Finnish into English is ‘agricultural technology’. The engineering word is not used because the graduated students are not entitled to use the title of engineer. The education is more agronomist type of education than engineering type. It seems that change or modification of the course structure more or entirely to biosystems engineering side could be easier than change to agricultural engineering side according to the USAEE proposal [1]. Biosystems engineering is also more in the line with the department strategy. Biosystems engineering is not known nationally and there are some disciplines which are using the name of biotechnology. This courses conflicts because the bio prefix is ‘reserved’ for biosciences. With EU level of definition biosystems engineering name could be introduced at least in the English translation.

References

DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN FRANCE

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Introduction

This paper presents some evolvements concerning Agricultural Engineering courses in France. The structure of higher education in Agronomical sciences is now based on seven national pools of agronomical and bio sciences Institutes. Agricultural Engineering is generally considered as an optional. Biosystems Engineering is not, at the present time, a recognized label of qualification and professional field.

1. Specify the main characteristics and give a definition of the Biosystems Engineering discipline based on your expertise and/or any recent developments in your country. Please justify the definition with adequate references.

In France, Biosystems Engineering corresponds more to a concept than an official discipline as no specific course or accreditation is existing. This concept implies a generic and systemic approach and methodology to biological systems at different scales (from genes to cells, from cells to plants, from plants to crop and food/non-food bioproducts). In this context, Biosystems Engineering corresponds to Sciences and Technologies, which are involved to describe, understand, control and optimize such complex biological systems.

Smaller scales of biosystems involve Bioprocessing and Biotechnology (cells cultivation and vaccine production) as larger scales of Biosystems corresponds to agricultural production (precision agriculture), transformation (food and non-food processing) and global environment (environmental engineering).

Unfortunately Biosystems Engineering is not an accredited label for courses, diploma and professional skills and does not correspond to an official to graduates in Agricultural Sciences discipline. Nevertheless, depending on the specialization, most of this concept is taught.

All these systems can be modeled as complex system with inputs/outputs of biological material, energy and where energy and matter are transformed.

In France one must separate 2 acceptations of the term "Biosystems engineering". The first definition is found in Biotechnology and Biochemistry 2 (from the cell to the process) where several applications are under development:

Bio Refining: extractions from cereals, flex fuel production and biomass valorisation, green oils.

---

2 A research group was recently created in France in Biosystems Engineering: from the cell to the process. GDR 3071 CNRS - University of Toulouse - INRA.
Biosystems Engineering: from cell to process in food processing, pharmacy and cosmetics.
BioProduction: the plant-factory concept, target seeds, cell cultivation (for vaccine and therapy), cell therapy.
Some aspects of this approach of BSE are taught in Biological Engineering courses and introduced in a majority of Higher Education Institutions of Agronomy and Agricultural Sciences (extended to Horticulture, Forestry, Food Sciences, etc.)
The second acceptance of Biosystems Engineering concerns larger scales of study in Biological and Agricultural Sciences from cells to crops and prior/post Harvest processing. It is the way all disciplines of Agricultural Engineering are involved to understand and control Biosystems.
In this last case, a Biosystems is considered as analogous to a mechanical system by using functional analysis:
Functions related to the energy transformation in the (bio)system: system modelling, applied mechanics, CAD, hydraulics, electrotechnics, applied thermodynamics…
Functions related to Information and IT: energy transformation optimization, traceability of crops and products, electronics, sensors, automation, (remote or contact) control & survey, computer sciences, image analysis, etc.
In this last case, the object of study is focused on the sensor/actuator and its effects on the biosystem than the biosystem itself. Another example can be found in Precision Agriculture where technologies are used to characterize crop/soil variability and to optimize field inputs/outputs, and in Sustainable Agriculture.
In this case, all the technics (mechanics, electronics, computing, IT) allow a better understanding of the biological/agronomical processes for a better management of the natural resources, not only in the agronomical domain but also for horticulture, forestry, food sciences. The main objective is to combine energetical efficiency, economical constrains and environmental issues.

2. In reference to the core curriculum included in the FEANI Report Template propose possible revisions in the existing modules, if needed, and/or suggest any new module(s) that might be included with regards to the Biosystems Engineering discipline.
Potential development of Biosystems Engineering courses in France would need a greater amount of biological Sciences and biological systems. Compared to the current situation in France, HE courses in Agronomy do not integrate engineering but (mechanical) Engineering courses do not integrate enough biology/agronomy.

3. Describe the current situation of the Biosystems Engineering discipline or any relevant to it discipline in your country. Please explain the relevant policy related channels for such a development in your country.
As described above (§ 2.2. and 2.3) the term BSE is emerging in Institutions or Universities mainly in the domain Biotechnology and Bioprocessing. The merging of High Education Institutions in 6 national “green” pools is now achieved but strategic complementarities in terms of education and research are still not defined regarding the emergence of Biosystems Engineering recognition as a real discipline. But depending on the course specialization, a more or less important part of Biosystems Engineering can be identified as a part of competencies of graduates.
The lack of HE courses in Agricultural Engineering (3 Bachelor degrees, 1 Master with optional, 1 Master in France) compared to 2000 annual graduates in Agricultural Sciences and Agronomy, Food Science, Water and Forestry, Rural Engineering would facilitate the creation of BSE as a common approach of study for Agricultural Systems.

A common vision of the future from main French Research Centres in agronomy and agricultural/environmental engineering (INRA - Cemagref Strategic plans (2005 – 2009) reveals new deals for agriculture, industry, environment toward society needs and concerns.

a. Sustainable development is necessary to allow economical viability with respect to constrains between environment – society – economy balance.

b. Climate changes (global warming) that lead to manage natural resources and industrial activities (including agriculture).

c. Water management : Optimize a limited resource, how to manage flood and dryness

d. Multi-functionality of Agriculture: agriculture impact on rural areas development.

e. Toward a safe society : natural risks management, food safety, environmental impact of agriculture (pollutants management)

As a consequence, society needs have inflected the way research is oriented:

- introduction of (almost systematic) **human and social sciences** to deal with sustainability criteria : nature – society – economy. No scientific and/or technological progress will sustain without sociological acceptance.
- **modelling, methods and decision making tools for the environment** : development of a real discipline of Environmental Engineering.
limiting energetic dependence and development of biomass-based energies.

New approach of territories: Rural spaces (territories systems) and water management (water systems): a **coupled spatial and systemic approach**.

**Risk management:** machines safety, safe food technology and storage, emerging pollutions management (air pollution), agricultural pollutants, natural risks (flood/dryness, gravity risks in mountains, fires).

**Examples of practical applications:**

- New modelling approaches of agricultural systems: spatial characterization and site specific Inputs management (Precision agriculture), remote sensing aided decision making tools (relationships between wine and “terroir”)
- Another example is the FARMSTAR program. 300 000 ha are no subscribed in 2007 for Nitrogen management on winter wheat and rape seed, water management on corn using satellite imagery and ground based modelling.
- Development of inputs less sensitive cultivars and agricultural strategies (Nitrogen, fertilisers, water). Cultivar certification protocols are particularly envisaged.
- More integrative approaches including human and social sciences to understand conditions of acceptation/non acceptation of progress, models and new technologies.

The part of non-food valorisation of agricultural products is increasing to 30 % (all products) an up to 60 % for starch. New industrial outlets for agriculture involve new strategies of production and environmental impact.

4. Will such a transition have an important impact on a) the Institutional structure, b) the students’ enrolment, c) the professional status and d) the national and international attractiveness and to which extent? (reported analyses or on personal assessment).

The emergence of the concept of Biosystems engineering is not, at the present time, visible in France. Nevertheless, trends in students’ enrolment and professional positions show a constant increase in or attractiveness for international positions in companies. That’s why the APRODEMA Association (association of professionals from the branch of agricultural engineering in France) jointly with the Enesad Institute, are willing to set up a European Manager Diploma (Italy/France/Germany) to be proposed to young senior executives from Agroengineering Companies. Main topics would concern international marketing and sales management.

5. Has the societal need for such a transition been identified at a national level? If yes, was it based on pertaining questionnaires circulated to employers, professionals and professional bodies, alumni, etc. Has this societal need identified by any independent market analysis, or independent reports of the private/industrial or public sectors? Please justify.

Although BSE is not a recognised discipline in France due to academic and administrative limitations for accreditation, research needs and opportunities highlighted by the 2 main research centres in Agronomy and Agricultural Engineering are convergent.

Systemic approach of Agricultural Systems extended to human and social sciences is necessary. Technological progress is no more studied/proposed as a complete and self sufficient solution. More efforts are involved to study their impact on

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3 Typical word including cultivars, local soil(s), climate(s) and production strategie(s) that give wine its typicity.
agricultural systems at economical and social level. The consequence is that research teams are now multidisciplinary. The problem of water resource management concerns particularly different levels of biosystems:

- development of less sensitive cultivars (Biotechnology and Bio processing)
- new cultivation strategies with less inputs
- development of new outlets for agricultural products (Bio processing, agronomy, agricultural engineering).

6. Envisage the influence such a tradition may have in your country on the labour market (e.g. industries, companies, private and public sector, freelance work and self-employment) and on the employability of the Biosystems Engineering graduates based on your expertise. More specifically try to identify areas where new job opportunities for Biosystems Engineers may arise in the labour market in your country, especially with respect to the current situation of the Agricultural Engineers. Please identify and justify possible conflicts with other established disciplines

Historical fields of employment:

1 – Technical or commercial Executives in the field of:
- Agricultural engineering (Industry, Advisors, development, etc. ...)
- Environment engineering (Potable and waste water management, etc.)

2 – Interface Executive between industrial production and dealership:
- Sales manager, Sales Team manager
- Marketing management (machine specifications, marketing plan when launching new machines, etc.
- Interface executive between dealers and manufacturers.
- Economical and Technological survey
- Technical support for salesmen and final users

Example of primary job profiles after graduation (Bachelor & Master Level)

- Technical advisor for farmers Unions in Precision Agriculture (FNCUMA)
- Marketing manager (Gauvain, John Deere, Grégoire et Besson, SMA)
- Advisor for an agricultural Chamber for wine production waste water (CA Côte d’Or, Chaumont)
- After sales manager for manufacturers (AGCO Fendt)
- R&D (Kverneland, John Deere, Ateliers d’Occitanie, Satplan)
- Journalist or head of Press publication (La France Agricole, Réussir)
- Advisor for cattle management for an agricultural Chamber (CA Aveyron)
- Sales manager (CNH, AGCO Massey, Kuhn, dealers)
- Farmer, Teacher, Union representative (SNCVA)
- Technical Trainer (SDF)
- Product manager (AGCO Massey, Challenger, John Deere, Grégoire & Besson, Lely, CNH)
- Communication manager (SDF, Claas)
- Sales manager (John Deere)

The emergence of Biosystems Engineering in France is slowed down due to two convergent phenomena:
The absence of an official recognition of the discipline by the Ministry of Agriculture and Ministry of Education (no Ph D., no accreditation and no scientific representation in Ministry councils). Until now, BSE is a concept resulting from the aggregation of recognized disciplines, but the concept itself is still not recognized.

The lack of recognition from Ministries, BSE is used in Industry in different domains mostly in Biotechnology and Bioprocessing. The aggregation of Agricultural Engineering onto BSE is not, at the present time, achieved.

Nevertheless, professional positions can be found in new or in-development sectors (particularly at International levels):

- Precision Agriculture development and advising (ex: FARMSTAR program and satellite imagery applications in agriculture and environment)
- Biotechnology and Bioprocessing for non-food valorization of agricultural products (biofuel, flexfuel, green oils)
- Traceability of agricultural products (ex: development of RFID concept)
- Fleet control and management
- Food safety and quality control
- Sustainable agriculture and environment engineering (Characterization of agro- and eco- systems, reduction of agricultural pollutants, mobility and safety of machines, waste management)
- Multifunctional aspects of agriculture
- Water management and risk modeling
- Environmental expertise
- Renewable energies (biogaz, oil …)

NB: Some of these sectors are in emergence. It is not possible to give quantitative information about employment yet.

**Conclusion**

This paper introduces the problematic of Biosystems Engineering in France as a non recognized (accredited) engineering qualification for diploma and job profiles. Nevertheless, according to the development of a European market of business and higher education (Universities recruitment & professional employment), things may slightly evolve in the next future. Two main consortia of higher education Institutes in France (Dijon, Toulouse) are willing to develop specific courses in this field.
Annex 1: Definition of Biosystems Engineering in France

Multiscale concept of Biosystem Engineering

Multiscale Biological Models

- Gene
- Cell
- Plant
- Field
- Product
- Foo
- Non food
Annex 2. National consortia for Agronomical Sciences in France


2- Eastern (Dijon): Food science, Flavour, Agrosystems, Territory and rural development. Existing courses in Agricultural Engineering @ bachelor level (1) and (2) @ Master level.

3- Capital (Paris – Massy – Versailles): Crossing Biological, Engineering and Human Sciences, Natural resources & landscape management, Food Sciences & technology.

4- Western: (Angers - Nantes - Rennes): Animal Sciences & Production, Food and Nutrition, Environmental sciences, Crop and Horticulture Sciences, Bio Industries, Sea & seashore resources.

5- Southern East: (Montpellier) Agronomical Sciences, sustainable agriculture.

6- Central: (Clermont Ferrand – Lyon: Natural resources and territories dynamics. Crop & animal production in mountains conditions. Nutrition &animal products quality, Food technology, Genetics and cereal variability.

7- Southern West (Toulouse): Agronomical Sciences, agrosystems, Crop and animal production. Existing course in Agricultural Engineering (1) at bachelor level.
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN GERMANY

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Abstract
A description of the situation in the emerging Biosystems Engineering discipline in Germany is given. A definition of the terminology and focal points in educational training and research are compiled. Because the terminology of Biosystems Engineering has a strong relation to Biotechnology, in Germany the term Agrarsystems Engineering / Technology is used to emphasise the systems approach in research and education in the field of agricultural engineering and technologies.

1. Agricultural and Bio-/Agrarsystems engineering – Definition
Prof. Kromer published in 2001 an article to the above-mentioned topic with the title ‘Agricultural and biosystems engineering-what is it’? He was able to define Bio-/Agrarsystems engineering from an Agricultural Engineering point of view. In this article some parts of his publication, especially the definition of the item, will be introduced.

The term engineering is known – even although this suffers under an almost continual meaning change. It has become established that the optimising of process mechanisation can only be achieved through an exact process description, modelling and structuring. Methodically one speaks here of identification, decision, action and testing for which appropriate data, signals or information is required. These lead to the introduction of automation and instrumentation for the individual process. Should, however, an ordered, networked interaction of individual processes be required for a common target, the system description would then be introduced with necessary definitions of the system limits.

The achievement, transmission, storage and processing of this information as tools for achieving a defined target would in the same way be brought together under the descriptions information engineering and information technology. This necessarily demands, in an extension of traditional engineering sciences, the analysis, modelling and synthesis of systems then described under the collective name systems engineering.

This development was earlier known in electro-engineering and nowadays is increasingly introduced in engineering sciences, even as study course. The declared
aims here are expediting of hard and software development and improvements in the area of project management.

Agricultural and biosystems engineering thus describe the use of above-mentioned system engineering concept in that they are applied for process optimisation in land use with the aim of sustainable production of food and raw materials and thus serve the natural scientific fundamentals of the sciences physics, chemistry, biology, agriculture and the environment science. Following the representation of engineering sciences as the link between natural sciences and their practical application, agricultural biosystems engineering can be regarded as a special engineering science subject for the synthesis of interdisciplinary specialist knowledge, i.e. the networking of natural sciences, especially biology and physics, and their translation in instruments, machines, procedural techniques and production systems. With this it goes beyond the area of machinery systems engineering. Because individual terminologies such as agricultural physics, biotechnology or environmental engineering were no longer able to accurately describe the comprehensive concept, the terminology of agricultural and biological system technology has had to be expanded over the last two decades. [1]

2. Current Situation in Germany
In Germany the Federal Agricultural Research Centre (FAL) [2] has played a big role here in terminology identification and by establishing an Institute for Technology and Biosystems Engineering. The activities of the institute concentrate on the development, investigation and evaluation of production methods (especially new technologies) and engineering processes for:

- an environmentally acceptable agricultural production and
- the treatment, preparation and conversion of materials from agricultural production and processing of agricultural raw materials

Research topics of the Institute are:

i. Interactions agriculture and environment and environmental provision technologies
   - Trace gas emissions
     - animal breeding, storage of residues
     - biogas plants
   - Entrapment processes for biological pest control
     - Nematophagous fungi
     - Bacterial antagonists
   - Biosensors
     - milk quality in automatic milking systems
   - Drift-reduced application technology for pesticides

ii. Products and energy from renewable resources
   - (Bio)catalytic conversion for the production of intermediates and fine chemicals
     - ethanol, 1,3-propanediol, itaconic acid, DFA 3, erythrit, erythulose, threit, palatinose, methionin
   - Sugar surfactants, sugar acids
   - Screening of (bio)catalysts
   - Genetic engineering
   - Immobilization of (bio)catalysts
Synthesis of polymers and production of materials from renewable resources
- Biogas production from energy crops

iii. Waste utilization and elimination of pollutants
- Biogas production, processing and utilization (hydrogen production, fuel cell)
- Liquid manure processing
- Nutrient recovery and disinfection
- Composting of wastes
- Production of biofertilizer
- Nitrite/nitrate removal in waste and drinking water
- Waste air cleaning
  - biowasher
  - biofilter
- Anaerobic waste water treatment

iv. Information technology, especially sensor technology and signal processing
- Understanding animal vocalization
- Estimation of plant canopy properties by optical measurement techniques
- Measurement techniques for assessment of soil state
- Measurement techniques for assessment of basic plant processes
- Non contact measurement of soil moisture and crop density by radar
- Understanding Animal Vocalization

v. Computer aided food and non food production
- High precision control system for longitudinal distribution pattern during spreading of liquid manure
- Modelling and Control of Animal Cell Cultures
- Expansion of the functionality of the Agricultural Bus--binary unity system System (LBS)
- Computer aided control of climate and hydroponics in greenhouses
- Understanding Animal Vocalization

Biosystems Engineering Faculties with focus on agricultural topics do not exist. Biosystems Technology / Engineering in Germany is defined as combining biological and electronic components to create bio-hybrid systems solutions. Biosystems Technology solutions are more than merely learning from nature because they arise when biological molecules and cells, optimised by evolution, are merged with approved microelectronics and microsystems technology. There is actually no relation to agricultural engineering. As a solution to keep the systems approach, address agricultural engineering subjects and avoid conflicts with already existing biotechnology related the terminology of Agrarsystems Technology / Engineering was created.

At University of Technology Munich a Chair of Agrarsystems technology exists, which main focus in education and research are agricultural engineering process. A very important topic in research is Precision Engineering. For the optimisation of the whole agricultural production chain a systems approach is inevitable.

At University of Technology Dresden also exists a Chair of Agrarsystems technology, which belongs to the Faculty of mechanical engineering. In the educational training there are also no Modules in Agrarsystems Engineering existing, students are still
taught in agricultural engineering and machinery. The renaming was a strategic decision and emphasises the future development of the Chair in research and education. Really progress in that field of research can only be reached, if the whole agricultural systems will be taken into consideration and not only single machines or processes.

A third example is the Martin-Luther-University Halle-Wittenberg with an agricultural faculty. This faculty offers modules in Agrarsystems Engineering I and II. Learning Outcomes and content of the modules are depicted in the following composition.

**Agrarsystems Engineering I**

*Learning Outcomes:*
- Mastery the methods of process analysis, -modelling and –evaluation
- Ability for the development of simple simulation approaches for description of natural and technical systems
- Knowledge about classification, working and operational principals of agricultural machines and implements
- Knowledge about timekeeping systems
- Knowledge about basics for selection of machines and implements
- Mastery of ergonomical fundamentals in agricultural production
- Design of working procedures and processes (transport, handling, storage; assignment of tractors, tillage, seeding, fertilising, plant protection, crop harvest, animal husbandry)
- Abilities for determination of process costs and for realisation of process comparisons
- Detailed understanding of precision farming / precision livestock farming

*Contents:*
- Fundamentals for process evaluation
- Ergonomic, methods for timekeeping, assignment of tractors, tillage, seeding, fertilising, plant protection, agricultural machinery and processes
- Analytical and numerical approaches of simulation technology, process simulation
- Process costs, plant and building design
- Renewable Energy, Precision farming, precision livestock farming, comparison of processes in dependence of field size

**Agrarsystems Engineering II**

*Learning Outcomes:*
- Mastery of technical simulation systems
- Independent planning of machine and installation/plant systems
- Managing of automation tasks
- Planning of technical plants and buildings for animal husbandry
- Detailed knowledge in Precision Farming / Precision Livestock farming

*Contents:*
- Development of complex process simulation models
- Application of numerical solution processes in AgEng
- Technology of tractors
Planning machine and implement application for tillage, seeding, plant protection, crop harvest

Precision Farming

Five years ago at the Leibniz University of Hannover a new study (BSc and MSc) of “Plant Biotechnology” has been established. A small part of this study is modules offered by the “Horticultural and Biosystems Engineering” section of the institute of “Biological Production systems”. These modules are:

BSc
- Basics of measurements, control and analysis
- Process engineering in plant biotechnology

MSc
- Technical aspects of plant orientated solar architecture
- Analysis, simulation and optimisation of technical procedures

Possible subjects for MSc-thesis are:
- Bioreactors, development, design, control
- Photo-bioreactor (in greenhouses)
  - Production of proteins
  - Production of biomass
  - Production of biogas, etc

At the University of Hohenheim in Stuttgart since seven years the BSc and MSc studies for Agricultural Sciences are introduced. During the Bachelor studies of 6 semesters one of five major courses is Agricultural Engineering. Five specific modules of each 4 hours per week are compulsory in semester 5 and 6:
- Development and Design of Agricultural Machines
- Technology Assessment in Plant Production
- Technology Assessment in Special Crops and Agricultural Buildings
- Work Methods in Science and Industry
- Planning of Livestock Housing Systems

For the Master Program of 4 semester also one major course Agricultural Engineering is offered. There 10 modules are compulsory within the selected specialization and 5 modules have to be selected from a broad list. The compulsory modules with always 4 hours per week are:
- Energy Technology
- Planning of Experiments and Measurement Technique
- Preservation and Processing Technology
- Farm Tractors and Self propelled Agricultural Machines
- Technical Processes in Livestock Husbandry
- Building Physics, Indoor Climate and Emissions
- Energy from Biomass
- Static and Strength of Materials, Material Sciences
- Function and Management of Agricultural Machines in Plant Production
- Environmental Technology in Plant and Animal Production

Based on the first experiences the curricula have been adjusted to integrate more soft skills and project work.
At the University of Stuttgart still the diploma studies of mechanical engineering are offered. The change to the Bachelor and Master system will be done in 2009. As one of several specialisations for mechanical engineering, the main course “Agricultural Machines” is offered. For this specialization four modules of each 2 hours per week are offered:

- Agricultural Tractor
- Oil Hydraulic
- Design of Agricultural Machines I + II

These modules are provided by the one professor of the Institute of Agricultural Engineering from the University of Hohenheim, who is also member of the Faculty of Mechanical Engineering at the University of Stuttgart.

3. Outlook and Conclusion
The field of Agricultural Engineering and Technologies will more and more develop towards a technology within biological systems. Background for that is with a growing world population we are faced with the situation of not expandable farmland and a continuously raising demand for food and renewable primary products. New ambitious activities and challenges for people, working in the field of agricultural engineering and technologies, are the usage of biological, biotechnical and biophysical methods and experiences to develop advanced agricultural production processes. With that new approach we might be able to solve the above-mentioned topics [3].

References:
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN GREECE

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1. Specify the main characteristics and give a definition of the Biosystems Engineering discipline based on your expertise and/or any recent developments in your country.

The European Society of Agricultural Engineers (EurAgEng**) through its official journal (www.academicpress.com/bioeng) defines Biosystems Engineering as: “...research in the physical sciences and engineering to understand, model, process or enhance biological systems for sustainable developments in agriculture, food, land use and the environment”.

On top of this, the American Society of Agricultural and Biological Engineers (ASABE***) defines (http://www.asabe.org/membership/beengin.html) Biosystems Engineering as: “the application of engineering principles to any process associated with producing agriculturally based goods and management of our natural resources”. It furthermore states that: “Biological and Agricultural engineers ensure that we have the necessities of life: safe and plentiful food to eat, pure water to drink, clean fuel and energy sources, and a safe, healthy environment in which to live”. Finally, it concludes (http://www.asabe.org/about.html) that: “Agricultural, Food and Biological Engineers develop efficient and environmentally sensitive methods of producing food, fiber, timber, and renewable energy sources for an ever-increasing world population”.

In agreement to the above and following the developments taking place within the EU-US ATLANTIS project (http://www.pomsebes.aua.gr), Biosystems Engineering in Greece is defined as: “A science-based engineering discipline that integrates engineering science and design with applied biological, environmental and agricultural sciences”. It is considered to extend Agricultural Engineering as it extends the application of engineering sciences to all living organism applications, including traditional agriculture. Biosystems Engineering can tackle issues in the expanding new areas of bio-materials, bio-fuels, bio-mechatronics, etc., in the assessment of food traceability, quality and safety and in the design of environmentally friendly and sustainable systems. In contrast, Biosystems Engineering would not pertain to human medical applications.

The discipline of Biosystems Engineering is characterized by concrete knowledge on Basic Sciences (e.g. mathematics, physics, and informatics) along with a strong Engineering foundation (i.e. strength of materials, thermodynamics, heat-transfer, etc.) and broader Biological subjects (i.e. cell biology, ecology, etc.) in the place of very specific subjects of applied Agricultural Sciences.

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** http://www.eurageng.net/
*** http://www.asabe.org/
2. In reference to the core curriculum included in the FEANI Report Template propose possible revisions in the existing modules, if needed, and/or suggest any new module(s) that might be included with regards to the Biosystems Engineering discipline.

The modules to be included are individual program specific, namely they are based on local conditions, National needs, Institution specificities, etc. Moreover, new or revised modules should be established after the corresponding areas of expertise a Biosystems Engineer may enter have been defined in a coordinated way, preferably in harmonisation with the relevant International activities (e.g. through the activities of the ATLANTIS project). Such areas of expertise could include:

**Soil and Water Resources Engineering** (this area of expertise is covered by the learning outcomes of the ‘Water Resources Engineering’ module of the FEANI report; http://www.eurageng.net/files/usaee-corecurriculum.pdf): It is imperative that society protect the quality of its water and soil resources. This specialty uses environmental expertise to better understand the complex mechanics of these resources, and utilizes them efficiently and with minimum degradation. Determine crop water requirements and design irrigation and drainage systems. Apply hydrological and/or soil mechanics principles to controlling drainage, control soil erosion and reduce the environmental effects of sediment on stream quality. Design, build, operate and maintain water control structures for reservoirs, floodways and channels. It includes ecological engineering, protection of surface and ground water resources, developing soil-water relationships and design of systems for water treatment, wetlands development or preservation, and other water resources issues.

**Machine and Power Systems** (this area of expertise is covered by the learning outcomes of the ‘Mechanical Systems and Mechanisms in Biosystems Engineering’ module of the FEANI report; http://www.eurageng.net/files/usaee-corecurriculum.pdf): It concentrates on designing advanced equipment, making it more efficient and less demanding of our natural resources. Design machine and power systems for agricultural and biological production including tractors, tillage equipment, irrigation equipment, and harvest equipment. This also includes equipment for biomass processing, highly precise application of chemicals and nutrients to crops, agricultural commodity and waste transport, turf and landscape maintenance, construction equipment, as well as equipment for waste treatment and specialized tasks.

**Information and Automation Technologies** (this area of expertise is covered by the learning outcomes of the ‘Information Technology and Automation in Biosystems Engineering’ module of the FEANI report; http://www.eurageng.net/files/usaee-corecurriculum.pdf): Information and electrical technologies engineering is a specialty area that is applied to many Biosystems Engineering applications, including machinery systems and mechatronics, control of biological processes, control of micro-environments, etc. Design and utilization of Geographic Information Systems, Global Positioning Systems, machine instrumentation and controls, remote sensing, bio-informatics, bio-robotics, bio-sensors, machine vision, imaging products, spectroscopy, etc. Intelligent machine design includes robotics, operation automation, specialty sensors, and control systems.

**Structures and Environment** (this area of expertise is covered by the learning outcomes of the ‘Structural Systems and Materials in Biosystems Engineering’ and the ‘Waste Management in Biosystems Engineering’ modules of the FEANI report;
http://www.eurageng.net/files/usaee-corecurriculum.pdf): Design structural systems and facilities to create and maintain a healthy environment for plants, animals and their products and all biological organisms, and for protecting workers within the facilities. This must be done without diminishing natural resources, environmental quality and quality of life therefore it is imperative to have concrete knowledge of issues concerning materials, including biomaterials, and materials re-use and waste management. The Controlled Environment aspect of this area of expertise includes design of control systems for temperature, humidity, and ventilation in various Biosystems Engineering applications. Develop best management practices and systems for storing, recovering, reusing, and transporting agro-industrial waste products. Also, includes protecting air quality near production facility from gas, odour, and particulate emissions along with modelling impacts of emissions on surrounding regions. Design production systems for raising fish and shellfish, as well as ornamental and bait fish. Develop systems to maintain water quality and natural resources, and utilize the latest biotechnology, feeding systems, aeration systems, and water sanitation systems. Design systems to reduce pollution from aquacultural discharges, to reduce excess water use, and to reduce production costs. Develop aquatic animal harvesting, sorting, and processing facilities.

Bioprocess Engineering (this area of expertise is covered by the learning outcomes of the ‘Bioprocessing’ module of the FEANI report; http://www.eurageng.net/files/usaee-corecurriculum.pdf): The production of food, fibre, and timber has been expanded to include innovative food products and biodegradable packaging materials. Utilize microbiological processes to create useful products, and to improve food safety. Develop processes for pasteurization, sterilization, and irradiation, and for the packaging, transportation and storage of perishable products. Design and develop manufacturing methods and post-harvest processes and facilities to ensure economical and responsible processing solutions for industry, guarantee the safety and quality of biological materials, including crop drying, processing and storage.

Energy Systems Engineering (this area of expertise is covered by the learning outcomes of the ‘Energy Supply and Management in Biosystems Engineering’ module of the FEANI report; http://www.eurageng.net/files/usaee-corecurriculum.pdf): Develop energy management strategies to reduce costs and protect the environment, and design traditional and alternative energy systems that have optimum energy efficiency and meet the needs of biological and agricultural systems. Develop and apply alternative energy sources that are renewable and sustainable, and create few undesirable by-products (possible energy sources include: biomass, bio-fuels, solar, and wind).

Biomaterials (this area of expertise could probably be covered by the learning outcomes of a new module entitled ‘Bio-materials in Biosystems Engineering’): An emerging horizontal area of expertise on science and technology of bioplastics and biodegradable plastics (i.e. bio-degradable agricultural films, bio-packaging, composite materials, etc.) currently under development.

All the above clearly show that almost all expertise areas of a prospective Biosystems Engineer are well supported by a corresponding FEANI module, thus effort must be put in implementing, evaluating and revising them after they have been tested for some time.
3. Describe the current situation of the Biosystems Engineering discipline or any relevant to it discipline in your country. In case no such programme of studies exists please explain if the need for such a transition or evolution from the traditional Agricultural Engineering programme of studies to the new emerging discipline of Biosystems Engineering is under discussion, consideration or it is foreseen in the future, in any way. Please explain the relevant policy related channels for such a development in your country.

At present no Biosystems Engineering discipline is established in Greece. On the contrary, there are three traditional Agricultural Engineering programs of study, i.e.:

a. Natural Resources Management and Agricultural Engineering Department (Agricultural University of Athens - AUA)

b. Faculty of Agriculture (Aristotle University of Thessaloniki - AUTh)

c. Department of Agriculture Crop Production and Rural Environment (University of Thessaly - UTh)

Very few members from the discipline-specific academic community and professional bodies follow the international developments concerning the transition from the traditional Agricultural Engineering to the Biosystems Engineering discipline. Traditionally, many academics in the Agricultural Engineering programs of study, with diverse educational backgrounds (e.g. agricultural sciences, physics, chemistry), support the idea that Agricultural Engineering should be based on strong Agronomy core curriculum and offered only as a technological specialisation without a sound Engineering background.

Currently (from the three related programs of study) only at AUA, discussions have been re-initiated and indicate that the development of a new Biosystems Engineering program of studies could be considered as a possibility in the future. Such a development, however, has to undergo serious debates and restructuring, which for the time being is not clear whether they have more support and momentum than during the previous years. The pressure for a major restructuring of the Higher Education, the renewal of the faculty staff and the elucidation of various points which can arise (e.g. professional rights already awarded to classical engineers) may eventually open the way for the development of the first program of studies in Biosystems Engineering in Greece.

4. Will such a transition have an important impact on a) the Institutional structure, b) the students’ enrolment, c) the professional status and d) the national and international attractiveness and to which extent? (based on reported analyses, if any, or on your personal assessment as an expert).

**Institutional structure**

The transition from Agricultural Engineering to Biosystems Engineering seems to be a giant step forward under the current Higher Education and professional conditions of agronomists and engineers in Greece. For the specific case of AUA, where already an Agricultural Engineering Department exists, it could have a major impact on its structure as it may require that the University modifies its Agricultural orientation to a broader one. Such a decision could only be taken by the senate of the University after extensive (most probably endless) discussion within the Departments; a decision which under the current circumstances (i.e. faculty disagreements, student reactions, etc.) seems very unlikely to be made in the immediate future.
**Students’ enrolment**

In case the abovementioned institutional structural changes will be realised, it seems rather logical to presume that prospective students would be more interested to enter such Departments because their future job opportunities will be better, considering that they will be offered a much wider range of professional possibilities and be well equipped with a structured sound engineering and scientific background that does not limit their learning outcomes to the Agricultural applications neither it wastes the efforts of the students to a very diverse range of weak learning outcomes of almost all scientific disciplines.

**Professional status**

The graduates of such a Department will be able to register as licensed engineers following the corresponding professional procedure (a licensed engineer is a profession which nowadays in Greece is more attractive rather than that of the Agronomist). The award of the status of licensed engineers to the graduates is based on the expected registration of the new Biosystems Engineering program of studies in the FEANI index.

**National and International attractiveness**

The transition from an Agricultural Engineering Department to a Biosystems Engineering Department awarding an engineering degree (prerequisite to become a licensed engineer in Greece) will most probably improve its attractiveness at National level. This is related to the fact that most prospective students seek entrance at a Department considering, among others, the future employment opportunities. At an International level many more things apart from a transition in program of studies have to take place. Among these are: improvement of infrastructures, internal and external evaluation of all education, research and administrative issues, opening to international cooperation (i.e. student mobility, researchers exchanges, participation to partnerships seeking international funds, etc.), ways to enhance the visibility and attractiveness of the profession with regard to the related target groups, i.e. relevant labour market, professional societies, students and parents, etc.

A key element for the enhancement of the national and international attractiveness of the new program of studies in Biosystems Engineering should be based on the possibilities offered through the implementation of the core curricula described in the approved by the FEANi document. The award of the label “recognized” program of studies in ‘Biosystems Engineering’ by EurAgEng through the recognition process developed by USAEE-TN in synergy with EurAgEng is the first step in this direction. The next step is to obtain the EURACE label, when the program of studies is labeled as an Engineering program of studies at the European and International level and is also automatically registered with the FEANI index.

5. Has the societal need for such a transition been identified at a national level? If yes, was it based on pertaining questionnaires circulated to employers, professionals and professional bodies, alumni, etc.? Has this societal need identified by any independent market analysis, or independent reports of the private/industry or public sectors? Please justify.

The societal need for such a transition has not been identified at a National level yet by any of the above mentioned ways. Such surveys could be initiated in the future by the Universities which are interested in this possibility through the public relation or career offices and have the support of the corresponding Departments so as to have better access and communication with employers, professionals and professional bodies, alumni, etc.
Despite the lack of such an analysis, there is a widely acknowledged societal need for better and more efficient technical support of the Agricultural sector but also of emerging fields of Biosystems Engineering in areas such as:

- Bioenergy, biomaterials, bioprocessing
- Water resources engineering (installation of efficient irrigation and drainage systems to save water)
- Agro-hydrology and agro-environmental hydraulics
- Irrigation and drainage engineering
- Design of agricultural structures, control of the environment and material technology
- Agro-industrial and livestock waste treatment, management and use
- Design and management of farm machinery
- Post-harvest engineering
- Energy saving using renewable energy resources
- Modern techniques and automation systems for Precision Agriculture and Precision Livestock Farming

It is therefore believed that better educated Biosystems Engineers with related professional rights could play a vital and supportive role towards covering the emerging needs of the wide field of Biosystems Engineering.

2. Envisage the influence such a transition may have in your country on the labour market (e.g. industries, companies, private and public sector, freelance work and self-employment) and on the employability of the Biosystems Engineering graduates based on your expertise. More specifically try to identify areas where new job opportunities for Biosystems Engineers may arise in the labour market in your country, especially with respect to the current situation of the Agricultural Engineers. Please identify and justify possible conflicts with other established disciplines.

As it has already been pointed out (http://www.eurageng.net/files/usaeeshop7-procs.pdf), restructuring the Agricultural Engineering program of studies to a Biosystems Engineering program of studies can offer better employability chances as the last will abide to the FEANI criteria and most probably the graduates will be considered as chartered engineers in Greece and FEANI Engineers or EURACE labelled engineers in Europe.

Current employment and career opportunities for Agricultural Engineering graduates in Greece are far beyond their orientation. They usually work as Agronomists for commercial or productive enterprises (e.g. sales, agricultural machinery, greenhouses, livestock units, soil analysis laboratories, fertilizers / pesticides / insecticides companies, food conservation establishments), as civil servants (Ministry of Agriculture, prefectures with tasks that may vary from animal science to plant protection and environmental impact studies) and as private professionals (i.e. commercial activities - sales, landscape architecture, garden design, planning of agro-industries, consulting in animal housing and greenhouse design, environmental studies, etc.). An appreciable percentage of these graduates find a job that has nothing to do with the Agricultural sector (i.e. banks, consulting technical companies, etc.).

The primary agricultural sector in Greece accounts for the 5.2% of the GDP, the 22.9% of all exports and employees 12.6% of the total working force, whereas the secondary food sector accounts for the 2.5% of the GDP, 16.9% of all exports and
employees 3.2% of the total working force. Despite their minor contribution there are some aspects that have lately gained importance like:

- Environmental protection and wastes exploitation
- Biofuels
- Biomaterials
- Bioprocessing and innovative food products with certified quality
- Food quality, security and safety
- Biosensing and bio-instrumentation
- Product traceability
- Rural sustainable development
- Innovative systems of renewable energy production
- Livestock well-being in relation to housing

These developments mean that new job opportunities will be most probably be available for future Biosystems Engineering graduates well educated in the above mentioned topics.
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN HUNGARY

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Abstract
The main characteristics of biosystems engineering discipline in Hungary show typical features. So far it has not been figured it out a good name for such education replacing the original agricultural engineering term. The developed biosystems engineering curriculum however is still fairly applicable including the teaching modules. The main institution to educate students in biosystems engineering, named specifically agricultural and food processing engineering in Hungary is the Faculty of Mechanical Engineering, Szent István University, Gödöllő. It has been elaborating a national wide common BSc and a second level MSc education as a joint effort of additional participating institutions and, it was accepted by the Hungarian Accreditation Committee in 2006. The biosystems engineering transitions definitely have important impacts on institutional structure, student’s enrolment and, attractiveness. It is also proved a societal need for transition and, a strong influence on labour market is predicted.

1. Main characteristics and definition
To give a right definition for the “Biosystems Engineering” seems to be a rather difficult job. In the last two decades a lot changing happened in connection to this issue all through the word including us, Canada and Japan, as well. In the before period mostly “agricultural engineering” term was used commonly. The department’s and institute’s names of such started to be not that much attractive for the students. At the same time the agricultural engineering field has changed in its content, as well, as the used technologies, machineries, etc. Among the new names appeared like “biomechanical systems”, “bio-engineering”, “bio-process engineering” and a lot more.

The situation in Hungary has also changed following the international trend. As a matter of fact, it has been drastically dropped the number of the students interested in agricultural engineering discipline in the 90’s. In answering to such achievements, for example, the university and the faculty have changed their names first.

Gödöllő University of agricultural sciences has changed for “Szent István University”. However, the main education was based on agriculture, but the word of “agriculture” was moved away from the name. Concerning to the faculty of agricultural engineering it was even bigger changing. To substitute the lost agricultural engineering students a new study line of pure “mechanical engineering” was introduced competing of course with some other universities in the country educating mechanical engineers. The new name of the faculty changed for “faculty of mechanical engineering”. The same thing happened, e.g. The word “agricultural” disappeared from the name of the faculty.

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Before 2000 still it was enrolled about 100 agricultural engineering students to the faculty yearly, which was a great number. After the modifications the “agricultural engineering” discipline has remained only as a study line within the faculty. The quota of 100 students subsidized by the government remained, but within that, recently there are only 15-20 agricultural engineering and food processing students. Concerning to the name of the revised education in the direction of biosystems engineering studies surely has been started. However, still there is a real problem with the selection of most appropriate name of such education. The main problem is that the formal translation of the term of “biosystems engineering” into the hungarian language would sound very strange in a sense of engineering discipline. It is rather than would express the strong relation to biology and not to engineering. It is absolutely misleading, so it is no way to use this term. A lot of discussions are still going on to figure it out a good, expressing, attractive term which would be equivalent to biosystems engineering. The give this answer will take more time, so there is no solution at the moment. Temporarily, “agricultural engineering and food processing” term is used.

2. Revision of core curriculum
The developed core curriculum with regards to the Biosystems Engineering discipline is still valid under the recent conditions. It may include the issues as:
- the ratio of the basic sciences and electives,
- engineering part of core curricula,
- agricultural /biological sciences part of core curricula,
- optional courses,
- modules in connection specifically to the biosystems engineering.

3. Current situation of Biosystems Engineering disciplines
In the newly started biosystems engineering (specifically named agricultural engineering and food processing) study line more institutions take part in just to fulfil the conditions. Due to the Bologna process requirements new BSc and MSc systems were developed in the field. The Faculty of Mechanical Engineering, Szent István University, Gödöllő takes the lead and, the following institutions take part in the program:
- Faculty of Mechanical Engineering, Szent István University, Gödöllő,
- Agricultural Faculty of the Tessedik Sámuel High School in Mezőtúr,
- Mechanical and Agricultural Faculty of the High School of Nyíregyháza,
- Food Processing Industrial High School Faculty of the University of Szeged.

The biggest action was elaborating a national wide common BSc and a second level MSc curricula for agricultural engineering and food processing, as a joint effort of the participating institutions listed before, was accepted by the Hungarian Accreditation Committee in 2006. Since that time the BSc education in such field has already been started with about 35-40 students/semester at Gödöllő. It is considered as a really good start of this kind of education.

The BSc course is composed of six semesters meanwhile the MSc courses last four semesters. The education takes place mainly at the campus of the Szent István University Gödöllő, Hungary. The laboratory facilities at the Hungarian Institute of Agricultural Engineering are also used during the courses. As a practical placement site, biosystems engineering enterprises are also involved in the education including a 4 week industrial period in relation with the thesis work.
The Natural Sciences subject group includes Mathematics, Physics, Mechanics, Flow theory, Heat flow, Material Science, Computer simulation. The Economical and Human Sciences subject group includes Ethics, Economics, Managements and Ergonomics. The Core Module includes Modelling Theory, Electronics, Measuring Theory, Control Theory, Mass and Energy Transfer, Machine Design, Integrated Manufacturing Systems. The Specialization Module relates to the selected study line. The Free Elective subjects could be selected from the list of all available subjects at the campus. Finalizing the entire training period a Master Thesis is to be performed and defended. This work is expected to be deal with the technical realization of a selected problem. During the study the following specializations via module subjects are recently available:

- agricultural informatics,
- environmental technology,
- food process engineering,
- food quality assurance,
- machinery maintenance,
- machinery production technology,
- renewable energy resources.

4. Impacts of transition
The biosystems engineering transitions definitely have important impacts on several view points, as on the:

i) Institutional structure
Restructuring the Faculty has already been started. Instead of the former departments an institute based structure is going to be developed. The new institutes are going to be established according to the relevant new modules. In such a way the institutes will have more responsibilities for education issues.

ii) Student's enrolment
The transition will have influence on student's enrolment in a SENSE OF:
- it is already observable the increasing demand for biosystems engineers,
- it is expected to increase the number of students in the field of biosystems engineering.

iii) Professional status
As a matter of fact, in the field of biosystems engineering education recently there are quite big differences in European institutes. The common European market conditions along with the Bologna process conditions, no doubt, will require narrowing the gap between the different institutions. The developed common curricula will be applied in more and more extent, and that will lead also to the comparability of the recognition process across Europe.

iv) The national and international attractiveness
The transition will have national and international influences on the following fields:
- the education of biosystems engineering will be more attractive for the students,
- provides courses for Erasmus students,
- extends the number of students outside from EU,
- introduces BSc courses also in English beside the local, national language,
- extends co-operation with other universities, for example double-degree programs.
5. Societal need for transitions
In Hungary, several studies and investigations have been carried out at national level in order to justify the needs of transition in higher education. It has been clearly identified by several governmental, non-governmental, professional, industrial, market participants and civil organizations that the restructuring is a must. It will have definitely an effect on the biosystems engineering, as well.
Based on the questionnaire fulfilled concerning to the employability issues different competences were considered to be useful as to enter a new job graduated under the conditions of the recently running program of studies. The impact of the restructuring and the newly introduced study programs requires needs as:
- Generally saying, the society requires more and more highly qualified people;
- Due to the fast changing technical development, it is expected a strong subject knowledge and technical abilities;
- The knowledge achieved should be easily converted according to the companies’ request;
- As because the majority of the BSc graduates will not continue with MSc education, they try to find job immediately. It implies that the practical skills have a greater significance.

6. Influence on labour market
It is beneficial for the agricultural engineering and food industry graduates that under the recent regulations, they can easily get jobs initially offered for mechanical engineers. At the same time, the studying period for agricultural engineering requires less effort.
The application of the developed common curricula will have a sensible influence on the employability. The recognition process applied will help to the agricultural engineering and food industry graduates to enter to the labour market. Moreover, the widely educated agricultural engineers have a more generic competence in a sense of find appropriate job.
Typical occupations of the graduates in the subject area of agricultural engineering and food industry:
- 1st cycle: Operational engineer, maintenance manager, machinery production engineer,
- 2nd cycle: Developing engineer, food process engineer,
- 3rd cycle: scientific fellow.
Taking account the statistics on the number of graduates educated originally as agricultural engineering and food industry field, it can be concluded that a great portion of them will find a job later in another field, for example, advisory companies, insurance institutions. Therefore the general transferable skills have also an importance.
At the same time the public sector requires agricultural engineering and food industry graduates in relatively greater extent. On their courses followed the environmental subjects are to be mentioned.
The forecast of the nation-wide demand for BSc degree specialists is very difficult. In one side it is clear that the enterprise form and the property size change, and the other side it should be take into account that the management of the small and medium-sized enterprises could be carried out by specialists graduating from as agricultural engineering and food process field.
If it is assumed 1300 cooperatives of about 300 hectares average plant size along with 7000 agriculture related companies, then about 300 enterprises can be potential workplace for such graduates.

Besides the 20 state financed students per year nation-wide, there will be enrolled another 20 students in self-financed way. Taking into account the normal dropouts, yearly 30-35 graduated students assure the reinforcement of the experts in the agricultural engineering and food technology areas.

References:


On the establishing the BSc education in the field of Agricultural engineering and food processing, Recommendation of the Ministry of Education, Budapest, Hungary, 2004 (In Hungarian).

Appendix / Web-sites:

Szent István University Gödöllő, Hungary
http://www.szie.hu

Faculty of Mechanical Engineering, Szent István University Gödöllő, Hungary
http://www.gek.szie.hu

Department of Physics and Process Control, Szent István University Gödöllő, Hungary
http://fft.szie.hu
THE BIOSYSTEMS ENGINEERING DISCIPLINE IN IRELAND

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Abstract
Biosystems Engineering in Ireland has undergone a period of rapid transformation in recent years. University College Dublin’s degree programme in Agricultural and Food Engineering was replaced in 2004 by a significantly revised curriculum in Biosystems Engineering. The new Biosystems Engineering programme has been accredited by Engineers Ireland (EI), a chartered body that addresses the needs of the engineering profession. The curricula are recognised by FEANI as acceptable engineering programmes. The curriculum for the four-year degree in Biosystems Engineering has also changed from a year-by-year curriculum to a modular, semesterised curriculum. These changes have also coincided with major restructuring within University College Dublin. Twelve Faculties and ninety-five Departments have been replaced by five Colleges and thirty-five Schools. Biosystems Engineering has now become part of the UCD School of Agriculture, Food Science and Veterinary Medicine. This has lead to a broadening of and multidisciplinary approach to activities within Biosystems Engineering which now looks to address the agri-food chain from farm-to-fork.

1. Characteristics of the Biosystems Engineering discipline in Ireland
University College Dublin’s (UCD) Biosystems Engineering programme is the engineering discipline based on the science of biology, analogous to the relationship between Chemical Engineering and chemistry. Students in Biosystems Engineering learn both engineering and biological principles and how to apply these to produce, manufacture and process biological materials, as well as to achieve sustainable development and environmental protection in the bioresource industries.

2. Current situation of the Biosystems Engineering discipline in Ireland
As noted previously [1] in 2004 UCD accelerated its efforts to “modularise” its course structures (separate them into semester-long units) and adhere more closely to the ECTS guidelines for assigning credits to courses. Since then the curriculum for the four-year degree in Biosystems Engineering has changed from a year-by-year curriculum to a modular, semesterised curriculum. The new semester system is compatible with best international practice and facilitates international mobility while the introduction of a modular curriculum has facilitated a broader educational experience. The new Biosystems Engineering curriculum which began accepting students in September 2004 received accreditation [2] from The Institution of Engineers of Ireland (Engineers Ireland, EI) and is consequently recognition by FEANI.

The four-year Biosystems Engineering programme progresses from the biological and engineering sciences of Biosystems, Thermodynamics and Computer Science in

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earlier stages to Food and Bioprocess Engineering, Mechanisation and Renewable Energy Systems and Environmental Engineering later in the programme. In the later stages, students may diversify their areas of interest. A significant component of Stages 2, 3 and 4 is the requirement to carry out project work that is typically experimental, design or computer based. The programme being taught in 2007/2008 is detailed below (Table 1 - 4).

**Table 1: UCD’s Biosystems Engineering curriculum, Stage 1 (50 Programme Credits, 10 Elective Credits)**

<table>
<thead>
<tr>
<th>Core</th>
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</thead>
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<tr>
<td></td>
<td>BSEN10010</td>
<td>Biosystems Engineering Design Challenge</td>
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<tr>
<td></td>
<td>CHEM10030</td>
<td>Chemistry for Engineers</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>EEEN10010</td>
<td>Electronic and Electrical Engineering I</td>
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</tr>
<tr>
<td></td>
<td>MATH10150</td>
<td>Mathematics for Engineers I</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>MATH10160</td>
<td>Mathematics for Engineers II</td>
<td>5</td>
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<tr>
<td></td>
<td>MATH10170</td>
<td>Mathematics for Engineers III</td>
<td>5</td>
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<tr>
<td></td>
<td>MEEN10030</td>
<td>Mechanics for Engineers</td>
<td>5</td>
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<tr>
<td></td>
<td>MEEN10010</td>
<td>Engineering Thermodynamics and Fluid Mechanics</td>
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<tr>
<td></td>
<td>PHYC10150</td>
<td>Physics for Engineers I</td>
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<tr>
<td></td>
<td>PHYC10160</td>
<td>Physics for Engineers II</td>
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**Table 2: UCD’s Biosystems Engineering curriculum, Stage 2 (50 Programme Credits, 10 Elective Credits)**

<table>
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<td></td>
<td>BSEN20060</td>
<td>Food Physics</td>
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<td></td>
<td>BSEN20040</td>
<td>Literature Research Project</td>
<td>5</td>
</tr>
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<td></td>
<td>MATH20240</td>
<td>Mathematics for Engineers : Calculus of Several Variables</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>MEEN20010</td>
<td>Mechanics of Fluids I</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>MEEN20040</td>
<td>Mechanics of Solids I</td>
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</tr>
<tr>
<td></td>
<td>STAT20060</td>
<td>Mathematics for Engineers V</td>
<td>5</td>
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<thead>
<tr>
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<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC20030</td>
<td>Principles of Animal Science</td>
<td>5</td>
<td></td>
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<tr>
<td>BSEN20050</td>
<td>Computer and Manufacturing Technology</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>CPSC20030</td>
<td>Principles of Crop Science</td>
<td>5</td>
<td></td>
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<tr>
<td>EEEN20020</td>
<td>Electrical and Electronic Circuits</td>
<td>5</td>
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<tr>
<td>FDISC20010</td>
<td>Agricultural Chemistry I</td>
<td>5</td>
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<tr>
<td>INDM20010</td>
<td>Agricultural Microbiology</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>MEEN20030</td>
<td>Applied Dynamics I</td>
<td>5</td>
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</table>
### Table 3: UCD’s Biosystems Engineering curriculum Stage 3, (55 Programme Credits, 5 Elective Credits)

<table>
<thead>
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<tbody>
<tr>
<td>BSEN30010</td>
<td>Bioprocess Engineering Principles</td>
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<tr>
<td>BSEN30250</td>
<td>Biosystems Engineering Design Project</td>
<td>10</td>
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<tr>
<td>EEN30110</td>
<td>Signals and Systems</td>
<td>5</td>
</tr>
<tr>
<td>EEME30040</td>
<td>Professional Engineering (Finance)</td>
<td>5</td>
</tr>
<tr>
<td>MAPH30170</td>
<td>Numerical Methods for Engineers</td>
<td>5</td>
</tr>
<tr>
<td>MEEN30100</td>
<td>Engineering Thermodynamics II</td>
<td>5</td>
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<tr>
<th>Options Code</th>
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<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>BSEN30240</td>
<td>Waste Management</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30310</td>
<td>Biofuels &amp; Renewable Energies</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30190</td>
<td>Power and Machinery Systems</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30220</td>
<td>Soil Engineering</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30230</td>
<td>Unit Operations in Bioprocess Engineering</td>
<td>5</td>
</tr>
<tr>
<td>CVEN30040</td>
<td>Design of Structures</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 4: UCD’s Biosystems Engineering curriculum Stage 4, (55 Programme Credits, 5 Elective Credits)

<table>
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<th>Core Code</th>
<th>Title</th>
<th>Credit</th>
</tr>
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<tbody>
<tr>
<td>BSEN30270</td>
<td>Biosystems Engineering Major Project</td>
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<tr>
<td>EEME40260</td>
<td>Professional Engineering (Management)</td>
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<th>Title</th>
<th>Credit</th>
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<tbody>
<tr>
<td>BSEN30090</td>
<td>Food Refrigeration Systems</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30120</td>
<td>Food Quality and Safety Assurance</td>
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</tr>
<tr>
<td>BSEN30180</td>
<td>Power and Machinery - Control</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30210</td>
<td>Precision Agriculture</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30280</td>
<td>Environmental Engineering</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30020</td>
<td>Buildings Design and Construction</td>
<td>5</td>
</tr>
<tr>
<td>BSEN30030</td>
<td>Buildings Environmental Control</td>
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</tr>
</tbody>
</table>

The UCD Biosystems Engineering programme currently has less than 10 undergraduate students in any given year, while Biosystems engineering graduate student programmes usually have upwards of 70 students enrolled. Figure 1 shows the number of graduate students enrolled in UCD’s Biosystems Engineering programmes in 2005 in comparison to Biosystems Engineering programmes in the USA.

In the near future, UCD’s current 4 year degree programme in Biosystems Engineering will be modified to offer a Bologna-style “3+2” or “4+1” programme. The exact format has yet to be determined.
3. Transition from Agricultural and Food Engineering to Biosystems Engineering

In 1960 Agriculture accounted for 20% of Ireland's GNP, but by 2006 this had dropped to 3.5%. Indeed by 2006 the Agriculture sector accounted for just 5.4% of employment in Ireland, a drop of 31.6% from 1960. This movement has resulted in Biosystems Engineering widening its focus to include other areas beyond the farm such as the processing sector. This was reflected in a change in name from Agricultural and Food Engineering to Biosystems Engineering in 2004. This period of change also coincided with a major restructuring within UCD. Over the past four years UCD has undergone major restructuring. These changes have been driven by a University Strategic Plan aimed at making UCD one of Europe's leading universities. The University Strategic Plan also complements national planning which centres on the Strategy for Science, Technology and Innovation (SSTI). Within UCD, Faculties have been replaced with a more integrated structure. The original twelve Faculties and ninety-five Departments have been replaced by five Colleges and thirty-five Schools. The Colleges are logical groupings of Schools which provide the Schools with administrative and functional support. Within UCD the unit of operation is now the School and it is responsible for delivering the Education and Research programmes for the University. The rationale for this restructuring was to break down barriers, create larger units with critical mass, integrate complementary disciplines and groups, to facilitate collaboration between groups, foster interdisciplinary research, to facilitate research along the complete value chain and to move from the situation of the individual researcher to thematic research programmes.

Biosystems Engineering has now become part of the UCD School of Agriculture, Food Science and Veterinary Medicine (SAFSVM). The SAFSVM comprises most of the old Faculty of Agriculture, Food Science, Biosystems Engineering and Veterinary Medicine making it the largest School in the University. The SAFSVM is multidisciplinary incorporating Agriculture, Veterinary Medicine, Food Science and Engineering. This multidisciplinary approach has become incorporated into Biosystems Engineering allowing it to address the agri-food chain, from farm-to-fork.

Figure 1: Biosystems Engineering Graduate Programs in USA and Ireland.
In terms of the SAFSVM, it can address the farm-to-fork continuum, comprising: sustainable agricultural systems, veterinary medicine (and downstream public health), biosciences, food quality and safety, human nutrition, and sustainable bioresource utilisation.

On a national level the SSTI is addressing the issue that the development of the knowledge economy is one of the key challenges and opportunities facing Ireland. The SSTI measures success through transformational change in the quantity and quality of research, an increase in the number of PhD graduates and trans-national research activity, enhanced contribution of research to economic development, an international profile for Ireland, coherence and exploitation of synergies, nationally and internationally, and knowledge transfer from universities into the market place. The SSTI also identified the agri-food sector as one of the key areas with great potential to lead economic and social progress it stated that “Agriculture and food, health, environment, marine and energy are sectors which have the potential to yield innovations which make tangible improvements in the quality of life” [3]. The SSTI’s has highlighted key research area including Sustainable Agricultural Production, Rural economy, Food & Health, Product innovation, and Bio- and nano-technologies (the Bio-Economy). UCD has responded to this by creating an Institute of Food & Health focusing on new food products and bio-products, a Biosciences Nano group, as well as a Chair in Sustainable Agriculture. This has been carried out in conjunction with additional emphasis on extra-disciplinary collaboration, which has been facilitated by the University’s restructuring programme.

4. Conclusions
The structure of Biosystems Engineering in Ireland is still under going change. There is a trend towards increased postgraduate activities including taught Masters programmes and research studies (Masters and PhD).

5. References
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN EUROPE: THE CURRENT SITUATION IN ITALY

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G. Scarascia Mugnozza
Università di Bari, Dipartimento PRO.GE.S.A., Via Amendola, 165, 70126, Italy

1. Main characteristics and definition of the Biosystems Engineering discipline

The Italian Association of Agricultural Engineers (A.I.I.A.), having competences about Biosystems Engineering in Italy, has recently specified the following main characteristics of the Biosystems Engineering discipline: (1) development and application of techniques for analysis, control and assessment of risk and vulnerability of local resources and land potential; (2) application of precision agriculture for chemical reduction in crop production; (3) enhancement and exploitation of renewable energy resources; (4) improvement of irrigation efficiency, using also waste water; (5) control and reduction of soil erosion for soil and water preservation; (6) intervention for restoring historical rural buildings; (7) design and planning of modern rural buildings for crop and animal production, food processing, landscape and environment protection; (8) design of plants, tools and agricultural machinery, taking into account human health, safety and environmental protection; (9) reduction of costs and increase of quality of raw agricultural products (from crop and animal production).

Based more on our expertise than on recent limited developments in Italy, Biosystems Engineering can be defined as the engineering discipline related to the overall agricultural activity, such as production, processing, storage and distribution of agricultural (food and non-food) products (e.g. structures, equipment and machines for crop and animal production, livestock buildings, environmental control for animal health and welfare, structures, machines and plants for agricultural, forestry and food production, post harvest technology, process engineering, ergonomics and safety, safe food production), the protection of the natural environment and the preservation of the natural resources (e.g. land planning, soil conservation, rational water management, air pollution control, waste management, preservation of natural habitats) [1].

2. Possible revisions in the existing modules of the core curriculum included in the FEANI Report Template and new modules with regards to the Biosystems Engineering discipline

In Italy, in the framework of Bologna process, which started in the academic year 2000-2001, the 3+2 years University study programmes were updated by the D.M. (Law) of the Ministry of Education, University and Research n. 270 of the 22nd October 2004. This law established new degree study programmes, which can be offered from the academic year 2008-2009: these educational programmes are constituted by a methodological-educational and job-oriented three-year 1st cycle study programme (180 University credits or CFU), for achieving the degree title called “Laurea”, corresponding to the Bachelor of Science degree, and a two-year
2nd cycle study programme (120 CFU), for achieving the degree title called “Laurea Magistrale”, corresponding to the Master of Science degree. In order to enter a “Laurea Magistrale” study programme, a three-year degree or another recognised degree, previously achieved abroad, is required [2]. From the academic year 2008-2009 and however within the academic year 2009-2010 all the current study programmes [3] will not be offered anymore. In Italy the above law is being implemented by most of Universities (e.g. Palermo and Bari), which designed new degree study programmes, which have to be approved by the Ministry of Education, University and Research, in order to be offered from the academic year 2008-2009. Moreover, according to the D.M. of the 16th March 2007 of the Ministry of Education, University and Research, in order to be accredited, the three-year study programmes must include a maximum of 20 courses, one of which is optional [4]. According to the D.M. of the 16th March 2007 of the Ministry of Education, University and Research, in order to be accredited, the two-year study programmes must include a maximum of 12 courses, one of which is optional [5]. Therefore, nowadays updated news about the above new study programmes are not available. However we don’t propose any possible revision in the existing modules of the core curriculum included in the FEANI Report Template neither new modules with regards to the Biosystems Engineering discipline.

3. Current situation of the Biosystems Engineering discipline

In Italy the recently established laws of the Ministry of Education, University and Research of the 16th March 2007 have determined the reduction of the amount of degree study programmes, including also Agricultural Engineering ones, and also the number of courses per each study programme. Therefore, in Italy no study programme in the Biosystems Engineering discipline exists and in the next future the offer of 1st and 2nd cycle degree study programmes in this discipline is unlikely, while that of a higher amount of 3rd cycle study programmes (Ph.D.), which will be more different among each other than nowadays, is foreseen. Moreover, the need for the transition from the traditional study programmes in Agricultural Engineering to the new ones in the emerging discipline of Biosystems Engineering is not under discussion neither consideration nor foreseen in the future. In Italy the relevant policy related channels, which are interested in the transition from the traditional Agricultural Engineering study programmes to the new Biosystems Engineering ones are: the Ministry of Agricultural, Food and Forestry Policies (through the strategies of food processing and storage, safe food production such as H.A.C.C.P., food traceability, energy crops, biomaterials, green areas and parks, etc.); the Ministry of Environment; the Regional administrations (through the funds for land planning, rural economics and environmental impact assessment concerning the Biosystems Engineering, e.g. the Regional Development Plan or P.S.R. 2007-2013 and the Regional Energetic and Environmental Plan or P.E.A.R.); the Italian association of agronomists; the National Association of Agricultural Machinery Manufacturers or U.NA.CO.M.A.; etc.
4. Impact of the transition from the Agricultural Engineering study programmes to the Biosystems Engineering ones on the institutional structure, the students' enrolment, the professional status and the national and international attractiveness

As the need for the transition from the traditional study programmes in Agricultural Engineering to the new ones in the emerging discipline of Biosystems Engineering is not under discussion neither consideration nor foreseen in the future, it is not possible to foresee the impact that such a transition will have on the institutional structure, the students' enrolment, the professional status and the national and international attractiveness.

However we think that grammes to the Biosystems Engineering ones and to disseminate in Italy the it is fundamental to promote the transition from the Agricultural Engineering study pro impact of this transition on the institutional structure, the students' enrolment, the professional status and the national and international attractiveness obtained in other countries, by means of joint Ph.D. study programmes and European and international research projects, under the umbrella of the 7th Framework Programme, Atlantis, etc.

5. Identification of the societal need for the transition from the Agricultural Engineering study programmes to the Biosystems Engineering ones

Until now in Italy the societal need for the transition from the traditional study programmes in Agricultural Engineering to the new ones in the emerging discipline of Biosystems Engineering has not been identified.

However, as a consequence of the above promotion of such a transition, in the future also in Italy the public opinion will probably identify this transition itself as a societal need.

6. Envisaged influence of the transition from the Agricultural Engineering study programmes to the Biosystems Engineering ones on the labour market and on the employability of the Biosystems Engineering graduates

In Italy the reform of Agricultural Engineering degree study programmes is in effect after the beginning of Bologna process. Therefore, the Agricultural Engineering study programmes were recently established, so that the sample of the related graduates is too small to be significant.

In fact, until now only six 1st cycle study programmes and five 2nd cycle study programmes in Agricultural Engineering are offered by 10 of the 23 Italian University Faculties of Agriculture [6]. These 1st and 2nd cycle degree study programmes are those included in the USAEE-TN database, shown on USAEE-TN Web-site (URL:http://sunfire.aua.gr:8080/ects/Welcome.do?jsessionid=07E88E7976BA082F0FEE1E0955203E2).

However on average the Agricultural Engineering graduates of the 1st cycle study programmes offered by Italian University Faculties after Bologna process are inadequately educated as Agricultural Engineers in order to enter the relevant labour market, because of the limited amount of engineering learning outcomes.

The only significant available data are about agronomists. In fact, the graduates of five-year study programmes offered by Faculties of Agriculture before Bologna process who have successfully passed the professional examination for becoming agronomists have competences about Agricultural Engineering. Therefore, historically industries, companies, private and public sectors, besides freelance
professional activity, have contracted them.
Nowadays the employers that contract the above agronomists are industries (of tractors and agricultural machines), companies (e.g. for the commercialisation of structures, irrigation plants and equipment in rural areas), private (e.g. agricultural farms and food processing industries) and public (Regional departments of environment, agriculture and public works, e.g. for the management of agricultural and livestock wastes, planning and management of green areas and parks) sectors, Universities (for research and teaching) [7], high schools (for teaching), internal job position or external consultancy for the growth of developing countries, within international bodies (e.g. EU, FAO), besides freelance professional activity (consultancy about irrigation plants, land planning and management, rural buildings, agricultural mechanisation, etc.).
However, because from the academic year 2008-2009 and however within the academic year 2009-2010 all the current study programmes will not be offered anymore and will be replaced by new ones, fitting with the above established laws, these changes will probably produce other ones also in the labour market for the new Biosystems Engineering graduates.
Yet, it is difficult to envisage, relying on our expertise, the influence of the transition from the traditional Agricultural Engineering study programmes to the new Biosystems Engineering ones on the labour market (e.g. industries, companies, private and public sectors, freelance work and self-employment) and on the employability of the eventual Biosystems Engineering graduates in Italy.
The areas where new job opportunities for Biosystems Engineers may arise in the labour market in Italy, especially with respect to the current situation of the above agronomists having competences about Agricultural Engineering, are the following:

- environmental impact assessment;
- risk analysis, ergonomics, health and safety;
- control environmental agriculture, including phyto-depuration;
- post harvest technology;
- product quality;
- product traceability;
- soil erosion and compaction;
- rural development;
- alternative and renewable energy sources, including energy crops;
- biomaterials

The eventual Biosystems Engineering graduates can enter in competition and conflict with other established disciplines and, therefore, with the following corresponding professional categories:

- agronomists;
- environmental engineers;
- hydraulic engineers;
- architects;
- etc.
References:


Abstract
There is no one study programme on Biosystems Engineering in Latvia today. The Faculty of Engineering of Latvia University of Agriculture (LLU) is only higher education institution in Latvia that offers study programmes in Agricultural Engineering which is quite similar to core curricula of Biosystems Engineering found in FIANI Report. Transition from Agricultural Engineering to Biosystems Engineering study programmes will not create substantial impact to the Institutional structure, but would have number of positive aspects.

1. Definition of Biosystems Engineering
Apprising and analyzing current situation in Latvia, it should be recognized, that term “Biosystems engineering” is not known and used in Latvia today. In relation to biosystems, there are number of terms and definitions found in Latvian cyclopedia [1]: bioinformatics, biochemistry, biology, biomedicine, biomechanics, biometrics, biopolymers, biopsy, biosphere, biosynthesis, biotechnology and biotops, but there is not term “biosystem” in Latvian. There is not also term and definition of engineering in relation with biosystems. Term of engineering is used in relation with other fields: genetic engineering, protein engineering, environmental engineering, system engineering, software engineering, test engineering, biomedicine engineering, cellular engineering and structural engineering [2].

There is no also official term and definition of Biosystems Engineering in internet in English, but more widespread term is Bioengineering [3]. In the area of health, the US National Institute of Health formed a Bioengineering Definition Committee that released the following preamble and definition on July 24, 1997 [4]:
“Preamble. Bioengineering is rooted in physics, mathematics, chemistry, biology, and the life sciences. It is the application of a systematic, quantitative, and integrative way of thinking about and approaching the solutions of problems important to biology, medical research, clinical proactive, and population studies. The NIH Bioengineering Consortium agreed on the following definition for bioengineering research on biology, medicine, behaviour, or health recognizing that no definition could completely eliminate overlap with other research disciplines or preclude variations in interpretation by different individuals and organizations.

Definition. Bioengineering integrates physical, chemical, or mathematical sciences and engineering principles for the study of biology, medicine, behaviour, or health. It advances fundamental concepts, creates knowledge for the molecular to the organ systems levels, and develops innovative biologics, materials, processes, implants, devices, and informatics approaches for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health.

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If we ignore the obvious health focus in the NIH definition, it is clear that bioengineering is concerned with applying an engineering approach (systematic, quantitative, and integrative) and an engineering focus (the solutions of problems) to biological problems. BIOENGINEERING is the application of engineering design and technology to living systems. Any living system.

2. Curriculum of Biosystems Engineering

In our opinion the core curriculum included in the FEANI Report Template set the basic requirements to Biosystems Engineering study programmes according to today's understanding of education of Biosystems engineers. Core curriculum included in the FEANI Report Template is comparable with curriculum in existing study programme in Latvia. There is academic study programme Agricultural Engineering in Faculty of Engineering, Latvia University of Agriculture that covers four sub-programmes: Agricultural Machinery, Automobile Transport, Food Engineering and Entrepreneurship in Agroservice [6]. Sub-programme Agricultural Machinery to a great extent is similar to Draft Core Curricula Overview of Agricultural / Biosystems Engineering that is developed in the frame of ERASMUS thematic network “USAEE” [7, 8]. In this programme Basic Sciences (mathematics, informatics, physics and chemistry) compose 36.5 ECTS (in the Draft – 36-45), courses mentioned in the list of optional courses compose 21.75 ECTS (in the Draft – 18-27 ECTS). The total sum of courses mentioned in the list of Agricultural Engineering fundamental core basis courses is 49.5 ECTS (in the Draft – 44-51 ECTS). The greatest difference is in Agricultural/Biological sciences, the courses in this section compose only 9.75 ECTS (in the Draft – 20-25 ECTS). In this section possible revisions could take a place. Generally, there would be possibility to create other modules or sub-programmes, as Waste Management in Agricultural and Bioproces engineering, perhaps also Energy Supply and Management in Agricultural and Bioprocess Engineering, although the professional bachelor study programme Agricultural Power Engineering is realized in the Faculty of Engineering without any Biological Science part.

3. Transition to Biosystems Engineering

There is no one study programme on Biosystems Engineering in Latvia today. Beside of agricultural engineering study programmes in the Faculty of Engineering there is some other study programmes in Latvia University of Agriculture which are related with this direction: in the Faculty of Rural Engineering there is academic bachelor study programme “Environmental Science” and professional bachelor study programme “Environment and Water Management”. Faculty of Food Technology have the bachelor study programme „Food Science”, Faculty of Agriculture have the bachelor and professional study programmes „Agriculture” and Faculty of Forestry have the Professional bachelor study program „Forest Engineering“. At this moment there is no specific plan for introduction of Biosystems Engineering study programme. Certain discussion takes a place within the Faculty of Engineering due to very small interest to Agricultural Engineering. This type of study programme can introduce only university or faculty which has particular interest to do this, because there is not defined priority or specific support to the Biosystem Engineering study direction in the level of education policy in Latvia.
4. Impact of transition

Transition from Agricultural Engineering to Biosystems Engineering study programmes will not create substantial impact to the institutional structure. Additional courses which could be necessary for modifying existing Agricultural Engineering study programmes to Biosystems engineering, could be provided by the staff of other faculties, for example, Faculty of Agriculture, Faculty of Rural Engineering, Faculty of Food Technology. Possibly transition to Biosystems Engineering study programmes could rise the students’ enrolment, but not substantially. We guess that kind of transition will change the professional status of graduates, by extending it, as well as it could have positive influence to the national and international attractiveness of students and graduates.

5. Societal need for transition

There is no clear societal need for transition to Biosystems Engineering identified at a national level. But in principle in some extend there could be societal necessity to such transition in national level in Latvia. But this estimation is not based on questionnaires circulated to employers, professionals and professional bodies or on independent labour market analysis or on reports of private, industrial or public sector. Estimation is based on expert assessment of academic and administrative staff of Faculty of Engineering.

6. Influence of transition to Biosystems Engineering

From our point of view such transition could positively influence labour market and the specialists in Biosystems Engineering could find their own niche in the labour market. One of the aspects that determine this estimation could be that the agricultural production more and more becomes large scale production – become more concentrated and specialized. But at the same time many branches with biological character are developing where the engineering is needed. Here we can mention different kind of waste management and bioenergetics where the biological and technical (engineering) aspects have very tight relation. Currently these both wide branches are developing very fast.

References:
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN LITHUANIA

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Abstract
Evolution of the discipline of Biosystems Engineering in Lithuania is related with changes and developments in agriculture. Each period of developments created individual characteristics for the discipline of Agricultural/Biosystems Engineering. The main goal nowadays for Agricultural / Biosystems Engineering is sustainability. It means that every technology or engineering system used in agriculture must correspond to requirements of sustainability of the environment - land, nature, water and air. An understanding of the discipline of Agricultural Engineering in Lithuania is slightly related with a qualification that graduates are qualified in Mechanical and Energy Engineering. There is no clear definition of the discipline of the Biosystems Engineering in Lithuania.

1. The main characteristics and definition of the Biosystems Engineering discipline in Lithuania
The introductory course Mechanics and Agricultural Machinery, which commenced at the newly established Lithuanian Academy of Agriculture in 1924, can be considered as the beginning of higher study of agricultural engineering in Lithuania. The first department of agricultural engineering was established in 1928, and the Faculties of Agricultural Mechanisation and Hydromelioration and Land Management were established in 1946. The Faculty of Hydromelioration and Land Management changed its name to the Faculty of Water and Land Management in 1990. The Faculty of Agricultural Mechanisation in 1994 was reorganised to the Faculty of Agricultural Engineering.
About 15,000 students graduated from the institution with the qualification of engineer between the years 1946 and 2007. Two thirds were graduates from the faculty of Agricultural Engineering and one third – from the faculty of Water and Land Management. The historical development of both faculties is closely linked to the economic and political changes that have taken place in Lithuanian agriculture. Many changes to agriculture were introduced in Lithuania with the reform of agriculture, which commenced in 1992. Although these changes have proven to be painful for the faculties due to a decreased demand for agricultural engineers, and hence for the number of students enrolling for study, exciting new opportunities have opened up at the same time. Each stage of developments in agriculture had individual tasks for agricultural engineering therefore characteristics of the discipline of Agricultural/Biosystems Engineering for each period were different. At the beginning replacement of man and animal power was main task of engineering. The first agricultural machinery and electric power were used in agriculture and food processing. After the Second World War in Lithuania have been active structural changes of agriculture. Big farms and processing industries appeared to supply with food of big market of Soviet Union.

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Those changes were leading with inefficient use of resources, fuels and energy, big demand of all resources, high pollution of environment. Rapid grow of demand of electric power, big quantities of machinery, high consumption of fuels were common for the period of 1945-1990. Changes in Lithuanian agriculture after 1990 have induced new tasks for agricultural engineering: modernisation of agricultural machinery, reorganisation of the processing industry of agricultural products, electrification of private farms, creation of industrial and communal services in rural areas, energy saving, application of renewable energy resources and information systems, conservation of the environment. It is obvious that modernisation of agricultural machinery is vital, particularly as the use of powerful machinery is not profitable due to significant increases in the cost of energy. Even agricultural co-operatives with several hundred hectares of land find this to be the case. The objective to reduce energy consumption also stimulates the modernisation of machinery and technology. A new branch of agricultural energetics is in the process of formation, namely renewable energy sources. This is a very real issue for Lithuania as she is seeking to reduce the imports of primary energy resources and to achieve energy independence. At present only pilot enterprises are underway in Lithuania however; nevertheless this field of agricultural engineering has great prospects.

**Figure 1.** Evolution of Agricultural/Biosystems Engineering discipline in Lithuania
Information technologies can be considered to be an absolutely new tool of agricultural engineering. There is nevertheless a big market for the application of these systems in modern agricultural production. The application of information systems and computers through the modernisation of machinery and technologies is now a very real aspect of the control and assurance of food quality of agricultural products.

The nowadays Agricultural / Biosystems Engineering has a main goal – sustainability. It means that every technology or engineering system used in agriculture must correspond to requirements of sustainability of environment - land, nature, water and air. Engineering systems that are designed and used in agriculture or food processing must be with high efficiency and low pollution. Also Biosystems Engineering is responsible to serve biologist to develop new plants to supply growing demand for bioresources not only for food and forage, but also for bioenergy and biofuels. Biomass conversion to bioenergy and biofuels also belongs to Biosystems Engineering interests. Intensive farming and concentrated processing industries creates environmental problems that can be solved by engineering systems implemented into farming or processing technologies - efficient use of bioresources, by-products and waste utilisation etc.

An understanding of the discipline of Agricultural Engineering in Lithuania is slightly related with a qualification that graduates are qualified. There is not professional qualification of Biosystems Engineering in Lithuania. All programmes at the faculty of Agricultural Engineering qualify graduates in Mechanical and Energy Engineering. However it is popular to use the name of Biosystems Engineering for research and study areas that combines Biological and Engineering Sciences (Medicine and Electronics, Microbiology and Control Engineering, Biology (Agronomy) and Mechanical Engineering, Plant Biology and Energy Engineering, Plant Biology and Chemistry.

2. The possible revisions of the existing modules in reference to the core curriculum included in the FEANI Report Template.

Course of Biofuels and Biolubricants might be included into curricula of module Mechanical systems and mechanisms used in agricultural and bioprocess engineering. Biofuels and Biolubricants can replace mineral oils and lubricants for agricultural machinery and engines. Biofuels and Biolubricants are environmental friendly and will have more priorities in the future.

Course of Biomass Engineering that contains Biomass processing, conversion to Bioenergy, Biomaterials and Biofuels might be incorporated into module Bioprocessing. There are some specialities of biomass for non-food applications. There are special species of plants, harvesting and post harvesting technologies, logistics, processing, conversion to biofuels and bioenergy.

Course of Biomaterials might be included into module of Structural systems and materials in agricultural and bioprocess engineering. Biomaterials can replace plastics and metals, might be used for construction buildings, machines and equipment.

Course Biowaste Treatment and Bioconversion might replace course Manure Treatment and Bioconversion in the module Waste management in agricultural and bioprocess engineering. This course would contain understanding about wastes from agriculture and processing, treatment, bioconversion and refinery.
Module of Bioresources Engineering might be included to the Biosystems Engineering discipline. This module can contain courses:

- Biodiversity
- Landscape planning
- Management of water resources
- Biomass engineering
- Biomaterials and Biofuels
- Bioconversion and Biorefinery
- Biomass Systems and Integration
- Management of Bioengineering
- Integrated Biomass Systems

Agricultural Engineers in Lithuania are qualified as Bachelors and Masters at the faculty of Agricultural Engineering of the Lithuanian University of Agriculture. Under the national system graduates of the faculty receives qualification in Mechanical Engineering or Energetics with several specializations: Agricultural Machinery, Management of Agricultural Engineering, Engineering of Agricultural Production Technologies, Engineering of Agricultural Products’ Storage and Processing Technologies and Agricultural Energetics.
Graduates of the faculty of Agricultural Engineering are occupied on different enterprises (manufacture, service and trade of agricultural machinery, food processing), consultancy, education, technical supervision, energy generation and supply companies. Part of graduates established private companies for technical services and trade. Small part of graduates works in other fields of economy. Graduates with qualifications in Engineering are enough successful in labour market of Lithuania, because growing economy provides new workplaces.
The new module of Biomass Engineering has been developed during 2006 – 2008 on a basis of EU - National project “Development of Research and Studies of Management of Biomass Resources and Bioconversion”. This module already have been suggested for Master students of the faculty of Agricultural Engineering. This module contains four courses:

- Renewable Energy Technologies;
- Biomass Engineering;
- Liquid Biofuels and Biolubricants;
- Solid Biofuels and Biogas.

Six departments of the faculty of Agricultural Engineering and partners from three Lithuanian research institutions executed core curricula for this module, course descriptions, and educational books. In addition module have been supported by laboratory means and instrumentation.

4. Impact of transition on the Institutional structure, the students’ enrolment and professional status.
No significant changes made into institutional structure. However some expert’s groups were established for implementation new courses and improvement of laboratories. It was a good opportunity to concentrate attempts of several groups of researchers for the creation of common curricula, to find unity in form and content. On a basis of these developments a new Bioenergy research centre will be established.
We have no data about enrolment because we will start to register students for this specialisation from the fall semester. There is some interest from companies because biofuels biomass resources market is fast growing. This year we have an external quality assessment of six study programmes at the faculty of Agricultural Engineering. A new module will be evaluated during this assessment.

5. The societal need for such a transition.
As it was mentioned above the new module implementation was performed on a basis of EU-National project. On a stage of application, tenders and expertises many groups of interests were involved to evaluate necessity of such specialisation, content of curricula and courses, competence of researchers involved in this project, institutional resources etc. During each stage of the project there were different expertises on a quality of results from external experts.

6. The influence such a tradition on the labour market and on the employability of the Biosystems Engineering graduates.
We expect growing labour market in the area of new bioresources for biomaterials, biofuels and bioenergy. Graduates of specialisation Biomass Engineering can apply job positions on consultancy, biomass logistics and processing, biofuels production and application, biowaste treatment and bioenergy industries. Also there is a wide space for bioproducts delivery and sale market. There is a growing interest for our graduates from the research institutions working on National and International projects related with Biomass Assessments, Bioconversion, Biofuel technologies etc. This module might be suggested for long life learning students - graduates of Agricultural Engineering and other institutions, interested to improve knowledge in this topic.

Present situation shows that graduates of Agricultural Engineering can easily find job positions in a labour market. Additional specialisation might improve value of the graduates.

References:
DEFINITION OF THE EMERGING BIO-SYSTEMS ENGINEERING DISCIPLINES IN MALTA

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Abstract
Malta’s entry into the EU, with its associated opportunities for funding, has provided close to €140,000,000 for Rural Development measures as from 2004 to 2013, and their focus on investments, agri-environmental and quality of life improvements in rural areas should help attain desired sustainability. Successful implementation of this development programme lies on the degree of uptake and hence participation of the rural community and on the effective and efficient processing of applications by the Managing Authority. Presently the University of Malta does not offer degrees in Agriculture Engineering. Nonetheless the capacity does exist to organise such courses. There is a severe shortage of experts to support the rural community. Ultimately, however, the resultant transformations in the rural sector shall but reflect the overall supporting framework and associated efforts to promote development in this area.

1. Engineering at the University of Malta
Malta has only one University tracing its origins to the founding of the Collegium Melitense which was set up through direct papal intervention in 1592. The foundation deed specified that philosophy, theology and other subjects such as grammar and the humanities should be taught. In 1675 a ‘lettore’ in anatomy and surgery was appointed at the Sacra, establishing the beginning of the medical school. In 1769, the ‘Pubblica Università di Studi Generali’ was established. Two years later the Collegio Medico was set up as one of the Faculties making up the University. The Evans Laboratories were opened in 1959 to accommodate the Faculty of Science and a new Medical School was opened in 1968. The Faculty of Mechanical and Electrical Engineering became part of the University when the former Polytechnic was incorporated within the University. During the British period the University experienced a series of changes in its statutes and regulations bringing it in line with universities in the United Kingdom. The present University structure was established by the 1988 Education Act.

Engineering sciences taught at the University of Malta can be termed as traditional. Mechanical and Electrical Engineering are offered by the Faculty of Engineering and Civil Engineering is available within the Faculty of Architecture & Civil Engineering. The following courses are accredited by the Fédération Européenne d'Associations Nationales d'Ingénieurs (FEANI):
• B.E. & A. in the Area of Civil Engineering since 1992 and
• B.Sc. (Hons) IT in Computer Systems Engineering since 2004
This year a new Faculty of Information and Communication Technology was established. As from this year, the four year course B.Sc. IT (Hons) is being replaced
by a 3-year B.Sc.(Hons) ICT course. No degrees in Agriculture Engineering are presently available at the University of Malta.

2. Challenges in Agriculture
Malta is handicapped by a number of structural constraints limiting its competitiveness in agriculture and agro-industry. The most obvious is the opportunity cost of land due to land scarcity. This issue is further compounded by fragmentation, tenure issues and poor soil quality. The other major constraint is the lack of fresh water reserves, resulting in the farming community tapping all water aquifers for irrigation. In view of these limitations, Maltese agriculture has to develop and adopt ingenious systems to attain competitive productivity standards. Although the agricultural sector accounts for only 2.4% of the total GVA generated by the Maltese economy, the role of agriculture goes far beyond that captured in figures. Agriculture has been particularly important in shaping the rural landscape and the environmental character of the islands. Agricultural and rural areas constitute a green lung and a venue of recreation to many. Today agriculture remains a major contributor in maintaining the quality of the landscape. It is also an integral component of the cultural heritage and a crucial backdrop to the tourism industry. In short, agriculture exhibits multiple functions and values beyond its economic contribution. The Rural Development Plans for 2004-2006 and 2007-2013 have been strategically compiled in such a way so as to encourage the multifunctional dimension of Maltese agriculture coupled with quality production and sector sustainability.

3. Maltese Rural Development Plan
Malta became a full member state within the European Union in May 2004. On the 23rd June 2004, the first Rural Development Plan for Malta was approved. This plan was designed to establish a concrete base platform through which the Maltese agriculture sector could evolve and develop. The plan provided for the growth and development of the sector in a sustainable manner applying guidelines and procedures common to the rest of the other European Member States. It recommended that the overall strategy for Maltese agriculture should focus on the development and specialisation of agricultural niche quality products that are best suited for the Maltese agro-ecosystems. The 2004-2006 Rural Development Plan was the first ever serious attempt to put together a series of measures capable of acting and reacting in synchronisation to achieve measurable results. The second Rural Development Plan 2007-2013 aspires to implement a follow-up strategy that builds upon the achievements and milestones of first Rural Development Plan. It seeks to offer a more deliverable programme that is well aware of the strengths of the rural sector while at the same time addressing relevant weaknesses in order to attain a more sustainable development of agriculture. The inclusion of past as well as recent experiences both from a technical and administrative point of view will strengthen the commitment in focusing on present and future needs of all stakeholders as well on current European and world trends.

The 2007-2013 Rural Development Plan has the following core objectives:

a. Farm modernisation with emphasis on increasing value added and quality plus cooperation between producers, and collaboration with the Agro industry sector, further supported by education and provision of qualified advise to the farming community

b. Agro-environmental measures with respect to sustainable environmental management
c. Improvement in the quality of life in rural areas. These initiatives are spread over the various measures and are nested within the different axes that make up the programme. Achievement of these objectives lies on the extent of uptake and hence participation of the rural community and on the effective and efficient processing of applications by the Managing Authority. This Rural Development Plan has to be seen as a link within a larger complex that contributes to the gradual evolution of the rural community in line with other European rural communities. There is an obvious “catch up” factor as compared to the rest of the European member states that the rural community has to go through to develop and mature in mentality, organisation and implementation. The expectations from the plan have to be realistic and not confounded. Success depends on leadership and followers. There is a desperate need for homebred leadership to spearhead and manage projects aimed at the development of appropriate innovation, to implement new infrastructure, to modernise facilities, and to the adoption of strong agro-environmental ethics. In the recent Lisbon Review of 2006, Malta ranked rather low in innovation and knowledge transfer scale. The National Strategic Plan for Research and Innovation for 2007-2010 outlines national priorities and courses of action that should lead to significant improvements in the innovative capacity of the country. For the past fifty years, Maltese agricultural had few incentives to rationalize production through the upgrading of plant and produce.

4. Definition of Agricultural Engineering in Malta
Malta requires Agriculture Engineers who are able to apply knowledge of engineering technology, biological/environmental science and project management to agriculture. Specialised expertise is required to design machinery, equipment and structures as they relate to agriculture, food technology and bioprocess. Engineers will be expected to improve crop production system, design animal facilities, analyze food production systems, or test machinery in the process of applying with the measures of AXIS 1 (farm modernisation) of the Rural Development Plan. Expertise in the agro environmental field is also in high demand to coordinate projects under the AXIS 2 of the Rural Development Plan that deals with the wellbeing of soil and water resources. They may participate in legal or financial consulting regarding agricultural processes, equipment, or issues. They must therefore be in possession of strong analytical stills and be detail oriented. In addition, they must work well in team situations as they would be called upon to work in a group setting with other engineers and others to solve problems and develop solutions custom fitted to our local situations. In addition to the Engineering / Agricultural core component, our Engineers would have to have project management and leadership skills and a good understand of the content and procedures of the local Rural Development Plan. They will spearhead the implementation of the Rural Development Plan by compiling and placing applications and overseeing the actual completion of the funded projects.

5. Institute of Agriculture
The Institute of Agriculture of the University of Malta was established in 1993 to set up courses at tertiary level in agriculture. Along the years courses were initially developed to improve basic knowledge among those working in the sector, future generations of agriculturalists, and soon after to enlighten agriculture students through more complex science based graduate training. However, it is felt that the available formal training is not thoroughly addressing the actual and emerging needs of the sector. Food security and safety and their relationship to sustainable
agriculture and rural development have become matters of concern. Economic perspectives in the new EU realities within the larger framework of World Trade Organisation compliance are undergoing a constant process of dynamic development. In this rapidly changing social and natural environment, the Institute of Agriculture has a critical role to play and needs to closely mirror, if not anticipate the requirements of such a changing playing field.

The Institute of Agriculture is actively striving to enhance the varied facets of the local agricultural knowledge base. These include animal and crop husbandry, food science, environment, and rural development among others. An enhanced and up-to-date knowledge base can only be achieved by offering courses and striving to fill in any remaining lacunae through the development of new programmes. Agricultural engineering is one such lacuna. Hybrid professionals who have a solid agricultural (including food science and safety) and engineering base together with knowledge of environmental science are lacking in Malta. A preliminary search to identify engineering, agriculture, food safety and other related topics currently offered to students by various faculties of the University of Malta has been carried out. A USAEE working document that presented a model for an Agriculture Engineering degree curriculum that is intended to meet FEANI standards was also scrutinized. A comparison of both information sets revealed that the Institute of Agriculture, Institute of Health Care, Faculty of Engineering, Faculty of Architecture and Civil Engineering, Faculty of Science, and Department of Geography offer modules proposed by the USAEE/FEANI working document.

Master of Agriculture Engineering (M.Agr.Eng.) 90 ECTS (60 taught + 30 thesis)

Discussions with the Faculty of Engineering to collaborate in offering an Agricultural Engineering stream are underway. The Faculty of Engineering is presently restructuring its undergraduate study programmes to comply with the 3 year norm. The understanding is that the Agricultural Engineering will be offered as a 2nd Cycle degree to graduates in engineering. The Institute of Agriculture plans to propose and produce professional Agriculture Engineering courses at Masters Level that conform to expected European standards and which therefore merit international recognition and accreditation from FEANI. The Master of Agriculture Engineering degree is designed for those wishing to pursue a professional degree in Agriculture at the Masters level as their educational objective. It will prepare students for a proactive role in addressing and responding to personal, professional, and societal problems and challenges in agriculture and food systems. Individuals will enrol in the program for a variety of reasons: career advancement, professional development, personal interests.

The General Regulations for University Postgraduate Awards, 2007 make the following allowances:

a) Professional Master's degree obtained on successful completion of a Programme of Study that builds upon a first cycle professional degree in the same area of study and intended to develop further profession-related skills and knowledge, normally in an area of specialisation, and usually designated as Master of (subject); and

b) Conversion Master's degree obtained on successful completion of a Programme of Study that, whilst necessitating the broad academic preparation of a suitable first cycle degree, does not build upon a specific body of knowledge obtained in any particular first cycle degree course, designated as Master of (subject).
Furthermore, the regulations permit students to be admitted into a Preparatory Programme and they shall become eligible to join the appropriate Master’s course on completion of the Preparatory Programme. The preparatory course will have 30 ECTS consisting of the following study units:

1) Maltese Agricultural Production Systems.
2) Anatomy and Physiology of Maltese Agricultural Crops.
3) Anatomy and Physiology of Farm Animals.
4) Soil Science and Nutrient Budgets.
5) Understanding Agro – Environmental Systems.

In Malta there are two main professional engineering organisations. The Engineering Board advises Government on the issue of the title “ING” and the Chamber of Engineers that is officially recognised by Government as representing the Engineering Profession in Malta and is the Maltese member of FEANI. Graduates in Agricultural Engineering will have to establish there identity and recognition within these organisation.

7. The Workplace / Career Path
Job opportunities for Agriculture Engineers will certainly be available in the implementation of the Maltese Rural Development Plan. Potential employers are those entities that will be involved in the execution of the Rural Development Plan and the rural society at large. The formation of Farm Advisory Services as stipulated in the recent Rural Development Plan, is an ideal employer of such graduates who will be responsible to carry out holistic farm analyse and cross compliance studies. The Ministry responsible for agriculture would also recruit a substantial amount of experts to implement its regulatory role. The financial component, whether it’s the Paying Agency or any other financial institutions such as banks, will need to take on Agriculture Engineers as consultants. Finally the rural society will need the services of free lance Agriculture Engineers to put together an application and to ultimately execute the project.

8. Conclusions
This proposed degree programme is currently just a concept. The potential to run it exists and the capacity to organise it is already present at the University of Malta. Societal needs should dictate which of the specialisations should eventually be given precedence, should the course be offered.

References:


University Studies of Agricultural Engineering in Europe (USAEE) Thematic Network website location: http://www.eurageng.net/usaee-tn.htm
THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN EUROPE – SITUATION IN THE NETHERLANDS

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Abstract
A Biosystems Engineering programme does not exist at this moment in the Netherlands. There are some study programmes that may be seen as biosystems engineering programmes. These programmes have however a strong focus on small organisms or biomedicine and not on systems for biological production. A good definition may be: “Biosystems Engineering is a discipline that uses engineering knowledge and skills to understand, improve, design, or model biological systems for the production of food, and renewable resources and energy, explicitly taking into account environmental and societal demands.”. In the near future such a programme may be needed because of a growing interest – at least in the Netherlands – in topics related to a bio-based society and economy. Future job positions of graduates are expected to be more in the line of biosystems engineering than in agricultural engineering.
The current agricultural and bioresource engineering programmes on BSc and MSc level may develop into biosystems engineering programmes. Discussions about this will take place in 2008. Such a transition will have a large impact on the content of the programme since there will be put more focus on the biological sciences than is the case in existing BSc and MSc programmes. There are however also some risks, especially in relation to the attractiveness of the name since in Dutch no good equivalents exist.

1. Main characteristics and definition
The main characteristic of the biosystems engineering discipline is that it in this discipline life sciences and engineering meet each other. This can be rather broad and may also include for example biomedical engineering.
The Journal of Biosystems Engineering mentions on their website that the remit is: “research in the physical sciences and engineering to understand, model, process or enhance biological systems for sustainable development in agriculture, food, land use and the environment”. The American Society of Agricultural and Biological Engineering characterises themselves as an educational and scientific organisation dedicated to the advancement of engineering applicable to agriculture, food, and biological systems. Agricultural, Food and Biological Engineers develop efficient and environmentally sensitive methods of producing food, fibre, timber, and renewable energy resources for an ever increasing world population (Source: website of ASABE).
Several biosystems engineering programmes exist in the USA. Most of the mission statements of these programmes have in common that engineering science is integrated with and/or applied to biological systems. These programmes all have their basis in engineering.

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A good definition of the biosystems discipline may be: “Biosystems Engineering is a discipline that uses engineering knowledge and skills to understand, improve, design, or model biological systems for the production of food, and renewable resources and energy, explicitly taking into account environmental and societal demands”.

2. Revision core curriculum
The core curriculum in the FEANI report is very much focused on (agricultural) engineering at one side and agricultural/biological sciences at the other side. In Biosystems Engineering the interaction between engineering and biological systems is the main characteristic of the programme. In the fundamental part of the core curriculum some space should be made available for course units that pay explicitly attention to biosystems engineering. It will not be sufficient to have only courses on (agricultural) engineering and biological sciences. There need to be some courses on the system level. It may be good to have besides the (agricultural) engineering part and the agricultural/biological sciences part a third part that is explicitly on biological systems engineering. The required space can be found by for example reducing both the engineering and agricultural/biological sciences part of the core with one course unit.
For Biosystems engineering it may also be necessary to change the focus of the core curriculum as presented in the FEANI report from the more classical agricultural engineering to a more systems oriented approach for both the engineering and the biological part. The course units offered in the core curriculum have to reflect this change of focus too.

3. Situation in the Netherlands
The Netherlands has at this moment no specific biosystems engineering programme. However, there are several universities that offer study programmes that could be seen as – depending on the broadness of the definition – Biosystems Engineering. Examples are 'Life Science and Technology' offered by the Technical University Delft, Leiden University or University of Groningen and several programmes of Wageningen University (Biotechnology, Food Sciences, Environmental Sciences, and Agricultural and Bioresource Engineering). Many of these programmes have a strong focus on small organisms (virus, bacteria, algae or have a strong medical orientation). None of these programmes (except Agricultural and Bioresource Engineering) deals with engineering in relation to plant and animal production. Wageningen University characterises itself as University for Life Sciences and the different chair groups offer a broad range of knowledge and courses in the area of life sciences. Within the current study programme Agricultural and Bioresource Engineering a discussion will start whether the content of the programme has to move more towards life sciences, and thus becoming more a biosystems engineering programme. In addition to this, within the university a discussion is started on how the educational programmes should like in 2012. One of the proposals under discussion is the introduction of a broad BSc Life Sciences. Biosystems Engineering then could be a major within such a programme. Such a transition will be a major transition for the current Agricultural and Bioresource Engineering BSc and MSc programmes since the existing programmes have only a few courses on biological/agricultural sciences and the corresponding basic courses in chemistry and biology.
4. Internal impact of transition to Biosystems Engineering
A transition to biosystems engineering will not have an impact on the institutional structure. Wageningen University has a matrix structure and study programmes are independent of departments. Departments (i.e. chair groups) offer courses and study programmes ‘buy’ courses. Programme committees, consisting of students and representative of chair groups, decide about the courses that are part of a study programme (with a financial framework). A Biosystems Engineering programme will fit in the current university matrix structure. The specific structure around the programme will depend on whether it will become for example a major within a broad BSc or an independent programme.
The students’ enrolment of such a programme may be a point of great concern, not because of the content of such a programme but mainly because of the name. The content of such a programme may have a positive influence on the enrolment since it will be more close to major issues in the society at this moment. The name of such a programme is even more important because the name is the first selection criterion for a potential student. If the name does not directly give a clear and positive association, the student will look for the next programme. The main problems is that there is in Dutch no good equivalent word for ‘biosystems engineering’, at least no attractive word. An alternative may be an English name for the study programme, even if it is a Dutch programme. The current programme faced a lot of problems with enrolment a few years ago because of some name changes. Students could not ‘find’ the programme and it took a long way to recover. Name changes have to be considered very carefully.
The professional status is not the first point of concern. The Netherlands has no specific engineering accreditation (except for Architecture), as is the case in some other European countries. Employers look more at the institution, the specific content of the programme, and the competences of the student. Foreseen job positions for current and future graduates are more in the line of biosystems engineering than the classic agricultural engineering. In most job positions graduates have to deal with the interaction between living systems and technology.
The national attractiveness of such a programme firstly depends on the name of the programme used in campaigns and secondly on the content.

5. Societal needs for transition
There is not directly a societal need for such a transition. The current graduates are able to fulfil the job positions. It is more the need and the responsibility of the programme to keep up with (inter)national developments in the discipline and consider what is needed over five to ten years. The transition to biosystems engineering will be discussed explicitly with representatives from the employers, professional bodies, and alumni. Their comments on this transition will play an important role in the further discussions and steps that will be taken.
On the other hand we see in the Netherlands a growing interest in topics as bio-based society and bio-based economy. In this society biological systems play a more prominent role than agriculture did since these systems are not only needed for producing food (which was plentifully available) but also for producing energy and raw materials for the industry. A study programme that is clearly focused on the systems needed for a bio-based society may be necessary in the near future.
6. External impact of transition to Biosystems Engineering

It is expected that such a transition will not have a negative impact on the labour market for graduates in the Netherlands. Moreover, such a transition may have a positive influence on the labour market for graduates. The society will move in the near future more towards a bio-based society. Biological materials will more and more be needed as resource for the industry or energy to replace current fossil based resources, such as oil, coal and natural gas. Biosystems engineers are expected to be very well equipped to deal with these complex systems.

In the field of agriculture we see that advanced technology is more and more needed for agricultural production. Precision farming requires dedicated sensors to monitor the crop or plant status or the health status of animals, decision systems to process the information from the sensors and all other available information from a wide range of sources, and finally specific measures have to be taken to execute the decisions. In all three main steps knowledge about the living system and about engineering are necessary and especially important is that there are persons that understand both domains and are able to integrate them.

A broad definition of biosystems engineering may also include food technology, biotechnology, environmental technology, and technology related to land use. Within Wageningen University, and also within some other universities, there exist study programmes for these areas. There maybe some conflicts with these programmes but as long as the biosystems engineering programme keeps close to engineering in relation to plants and animals, such conflicts are not expected. The current plant sciences and animal sciences programmes within Wageningen University have no engineering focus.
1. Definition of Biosystems Engineering
In Portugal the designation "Biosystems Engineering" is commonly confused with the applied sciences that study all biological systems. It is common to associate this designation, for example, with the soil-water-plant system and to other agriculture-livestock production sub-systems. In a recent discussion developed in the Scientific Council of the Agrarian Sciences of the University of Évora, the designation "Biosystems" was mentioned several times, as a designation that could embrace almost everything within biological systems. This means that there is still a clear confusion in peoples mind between the designations "Biosystems" and "Biosystems Engineering."

In a recent research done with "Google" in the Portuguese Internet WEB pages it was possible to verify that the designation "Biosystems" can be found 1170 times. These 1170 references are mainly associated with Medicine and Biology Sciences, more specifically Biomedical Engineering. Some examples where the designation “Biosistemas", the portuguese word for Biosystems, can be found associated with Medicine Sciences, are presented in the following WEB pages:

a) [http://www-lip.fis.uc.pt/~jcarlos/aulas07/09.biosistemas.pdf], A PDF document where the designation biosystems is connected with the Biomedical Engineering;
b) [http://www.academicos.ubi.pt/home/menu1/licenciaturas/pe_info.asp?pe=7594&curso=816]. An undergraduate course from the University of Beira Interior: “Control de Biosistemas” or “Biosystems Control” in English, and associated with the Biomedical Sciences.

The same WEB search using the designation "Biosystems Engineering" just found one WEB page: [http://tux.utad.pt/citab/? q=node/54]. CITAB (Research Center for Agriculture-Environmental and Biological Technologies) belonging to the University of Trás-os-Montes e Alto Douro. This University has a Research Center on Biosystems Engineering.

The existing Rural Engineering Department of the University of Évora proposed to change its present name to Civil and Biosystems Engineering Department. This changing was approved at two different levels in the University: a) in the Scientific Council of the Rural Engineering Department and b) in the Scientific Council of the Agrarian Sciences of the University of Évora.

From what was stated before it is clear that in Portugal the name Biosystems Engineering is still much associated with Biomedical Engineering. Biosystems Engineering applied to Agricultural or Rural Sciences, is only used within one Research Center at the University of Trás-os-Montes e Alto Douro, and now as a proposal designation for a Department name at the University of Évora.

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To us "Biosystems Engineering" can be defined as the study of physical and engineering sciences, with the objective of understanding, model, process or develop biological systems, auto-sustained. Not being the common definition for the designation "Biosystems Engineering" used in Portugal, as we verified in our WEB search, we can foresee that it will not be easy or quickly the implementation of the designation "Biosystems Engineering" with this definition.

2. Possible revisions of the core curriculum presented in the FEANI report
Today, we all fell that any engineer graduation should have some background on energy efficiency. On general, any engineer should be capable of: simulate energy processes, prioritize energy-saving measures based on cost-effectiveness; evaluate the performance and energy-efficiency of any equipment; design and install permanent or temporary monitoring equipment, considering some premises to help make adequate energy choices; analyse energy usage on a farm, system or process level.

Considering this current gap in the education of engineers we believe that all modules (pages 16-27; http://www.eurageng.net/usaeetn.htm), on different scales, should develop their capacity to assess and implement energy saving opportunities.

3. Current situation of Biosystems Engineering in Portugal
In Portugal there is no Biosystem Engineering curriculum tradition. The University of Évora, in the early 80’s of the last century started an Agricultural Engineering curriculum that was different from the existent Agronomy curricula. This agricultural engineering curriculum contained a relatively high number of courses associated with Engineering, such as: Technical Drawing; Surveying and Terrain organization; Hydraulics; Irrigation and drainage; Soil Conservation; Farm Structures and Environment; etc. This curriculum had also a solid formation in fundamental or basic sciences such as: Mathematics, Physics, Chemistry, etc. The higher exigence in Mathematics, Physics and Chemistry of this curriculum, lead to the desertion of students from this type of agricultural graduation. Students tend to choose agricultural graduation with lesser exigencies on these basic sciences. The trend has been to choose Agronomy graduations instead of Agricultural Engineering ones. With this trend and the changes in the educational curricula and teaching processes introduced by the Bologna Declaration we now have, in Portugal, a 1st cycle of studies centred exclusively in Agronomy or Animal Sciences graduations and only in the 2nd cycle of studies we see graduations in Agricultural Engineering.

From our point of view, this trend of 1st cycles of studies exclusively in Agronomy or Animal Sciences should be inverted in Portugal because there is a huge technological evolution at the agricultural and animal production levels. Nowadays, being an expert at any production system of agribusiness is determined not only by the natural ability of a certain region, but, mainly, by aggregating technology on production. Designations as precision agriculture or precision livestock farming, which were only shimmered until the last century, are now a reality in the European agricultural scenario.

This trend asks for an expert with a solid profile on technology, a good knowledge in agribusiness and a consistent point of view from production chains that make part of used production systems. The only initiatives that intend to produce this type of experts are at the 2nd cycle level. Concrete examples exist in the University of Évora with the 2nd cycle in Agricultural Engineering.
Since the Bologna process is not finished in Portugal we ignore how will be the evolution of the curricula in other Portuguese Universities, however we believe that the trend will be similar.

We feel that, the implementation of the Bologna process in Portugal is leading at this time to a paradox with a difficult solution. The 1st cycle should promote a solid preparation in fundamental sciences towards the specialization in the 2nd cycle. However, in Portugal the government policy, concerning the implementation of the Bologna declaration, stimulates the creation of 1st cycles with a clear job orientation, that can allow graduate students to immediately get a job. In most cases we now see that the Bologna 1st cycle graduate students are not prepared for a qualified job. What is truly happening at a national level is that the 1st cycle is seen as a vocational cycle; therefore, the basic sciences are sacrificed by application sciences. Students that choose to do the 2nd cycle of studies will have some difficulties due to the lack of some basic sciences. The answer for that is, in many cases, to add basic science courses in the 2nd cycle curriculum. However, to us, this does not make much sense. The introduction of basics sciences courses at this level drives away many students that look to the 2nd cycle graduations as a chance to specialize their knowledge in a certain area. Also, since there are a limit credits to the 2nd cycle graduation, to use part of them with basic sciences reduces the opportunity to introduce knew knowledge or diversity at this level. Nowadays, students in Portugal are having a technical graduation in the 1st cycle of studies and a University graduation in the 2nd cycle of studies (in many cases without having a solid background in basic or fundamental sciences).

For these reasons, the suggestion, made by some people, that it is possible to develop a 2nd cycle of studies in "Biosystems Engineering" is in our opinion jeopardize. We think that a good Biosystems Engineer will need a 1st cycle of studies different from what is currently offered in Portugal, followed by a 2nd cycle of studies that could allow to complete the formation of this type of professional.

Professional associations are also confused with all these Bologna changes and until now they didn't arrive to a consensus, nationally or at a European level, regarding the Engineering graduations in general and in particularly in the Biosystems Engineering area.

4. The impacts of the transition to Biosystems Engineering

As we can see it, the transition for a Biosystems Engineering graduation, will have immediate consequences at the Institution structure level. Usually Agronomy graduations do not have strong links, at an institutional level, with technological areas such as electronics, information systems, etc. Considering that these technological areas will be fundamental in the curriculum of a Biosystems Engineering graduation any institution that teaches Biosystems Engineering should promote some internal reorganizations in its structure in order to improve or facilitate the cooperation between current areas of knowledge and these new areas.

We think that a Biosystems Engineering graduation can have a good acceptation from high school students. Young people have nowadays an insatiable appetite for everything that deals with technology. And this can be a key to capture young people for this area of knowledge.

Regarding the professional status of these new professionals, what was stated previously can be also applied here. In other words, the technological aspects of the Biosystems Engineering graduations, promotes a larger visibility and increases the students status.
We also believe that the Biosystems Engineering graduate will have a good acceptance in the labour market, in some cases better than an Agronomy or Animal Science graduate. The major problem, however, can be the fact that the society has still some difficulty in identifying what a Biosystems Engineering graduate will be able to do. That will be the biggest difficulty to overcome. If there is still much lack of knowledge about the activities that could be performed by a Biosystems Engineer at an Academic level, it is to be expected that these doubts will be greater to the possible employers of the future graduates.

5. The need for a transition to Biosystems Engineering
We don’t know any studies developed at national level that indicate or identify this transition need. However, as university teachers in this area, we are constantly confronted with situations, sometimes even grotesque ones, where students show their evident lack of technological formation and knowledge. The industrialization of agriculture requires that present technicians have certain type of knowledge that they don’t have, showing that industry advances with a higher speed than the educational institutions, namely Universities. For example, it is common nowadays in Portugal the commercialisation of agricultural machinery equipped with global positioning systems (GPS). However, many potential buyers, some of them technicians with a higher education in the field, are unfamiliar with these systems and the way that they could be used. Moreover, most agricultural engineering students are only know starting to be introduced to this type of equipment and systems.

6. Opportunities to the Biosystems Engineer in the labour market
With the agriculture industrialization and with a larger environmental regulation, new job opportunities will come up and future graduates in “Biosystems Engineering” areas will play a decisive role. Some examples can be: a) Precision Agriculture; b) Agriculture water efficiency usage; c) Agriculture environmental impacts; and d) Energy efficiency of agricultural activities and bio-fuels production.
THE EMERGING OF BIOSYSTEMS ENGINEERING DISCIPLINE IN ROMANIA

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Abstract
The Biosystems Engineering discipline represents a real challenge for height educational process. As a result of the demands which envisage the sustainable development of industrial and agricultural process, Biosystems Engineering can be defined as a new approach of the engineering skills in accordance with the biological systems demands, referring to all the input points: chemistry, physics, agricultural, energy, environment and human health, applied engineering etc.

The Romanian educational context regarding the syllabus and the societal needs of this transition from the so called “physic” (classical or conventional) agricultural engineering to the Biosystems Engineering are presented in this paper, referring to our educational experience in Technical University of Cluj-Napoca, Faculty of Mechanics.

Our point of view regarding the definition of Biosystems Engineering is also presented, with references in our educational curricula, within national legislation engineering specialization, and last issues according with European Union demands. Based on FEANI report and the thematic Network for Agricultural (Farm Machinery) Engineering studies, the paper refers to the European present stage and our national needs in this field.

As a national stage report the paper presents some remarks regarding the emergence of this discipline in order to ensure the same approach in different European countries, with the benefit in fast and unitary development.

1. Main characteristics of the Biosystems Engineering
The present demands regarding the quality of life impose to know, to govern and to run the mechanisms that characterize the biochemical environmental process. The control and the management of these mechanisms may be ensured by implementation of engineering principles in biology. In this respect the biochemistry is the field which develops the environmental processes, and engineering must develop the mechanisms and technologies according with the environmental demands.

At the same time the engineering must ensure the quality and quantitative evaluation of the biological processes and products characteristics, using methods and techniques already employed in the same time with the new ones, which are developed according with the new approach in Biosystems engineering filed.

The involvement of the bioengineer as the common engineer involvement has the same level (here the same importance) and difficulty, and that implies a continuous information exchange in order to control the products and the processes, for a continuous evaluation of the risks factors in the Biosystems Engineering (Figure 1).

We cannot reduce the Biosystems Engineering to the agricultural and environmental field because in the present the discussed topic approach covers a

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Indeed, Biosystems Engineering is a new discipline which grows very fast through the diverse approaches and various examples offered every day. In fact, the Biosystems Engineering represents a new orientation and a new perspective field because in the present the discussed topic approach covers a wide range of human, industrial and social activities, which are related to the natural resources: air, water and soil. In fact, all are related to human life. Indeed, Biosystems Engineering is a new discipline which grows very fast through the diverse approaches and various examples offered every day. In fact, the Biosystems Engineering represents a new orientation and a new perspective available for the science in order to contribute to the human life. The Biosystems Engineering consists in analysis of the biological systems and understanding of the biological phenomena, to integrate the engineering principles in accordance with sustainable needs of the soil. The communication and the information exchange stage actually represent the symbiotic engagement of those three sciences mentioned above, in order to ensure sustainable products. In this respect the engineering has an interactive role for design the product with life cycle considering the environmental risks and special demands regarding the risk reduction (Figure 2).

![Figure 1. The links and steps of Biosystems Engineering approach.](image1)

F(\text{a}_i, \text{b}_j, \text{c}_q)

![Figure 2. Inputs and Outputs of the Biosystems Engineering](image2)
Considering the approach in this field offered by USAEE, FEANI reports and others contributors, the main characteristics of the emergence communication process can be detailed as [1], [2], [3]:

- main inputs $a_1, ..., a_i, b_1, ..., b_j$ - basics of biology, agricultural and engineering as an involvement of the basic sciences such as mathematics, physics, chemistry, mechanics etc.;
- output results $F(a_i, b_j, c_q)$ - enhance the state of animals, plants, and biosphere by identifying sustainable environmentally sound solutions that minimize waste and continually recycle materials, with reduced risk;
- interactions factors $c_1, ..., c_q$, related to competences and any random influences (including environmental risk), consist in unexpected or expected models as a result of complex algorithms.

2. **Present state of Biosystems Engineering related to the syllabus of the discipline in Romania**

A first remark is that the Biosystems Engineering consists in a new approach in our country, and at the transition from conventional disciplines of engineering and agriculture to bio disciplines is in progress. In fact the process is slow because it is required a small steps policy from conventional stage to the new one. Something must happen in the attitude of the society related to the new discipline, and a continuous development of this issue (topic) must progress in accordance with a small steps policy.

The engineer specializations and the engineering fields are stipulated by Govern Act no. 676/28.06.2007. According to this act, the Biosystems Engineering is a part of Applied Mechanics field. This classification is actually in accordance with the previous definition. But in the same time the specialization of Agricultural (Farm Machinery) Engineering is known as a part of mechanical engineering. It is this good or bad? We can accept the fact that for the moment this situation represents an opportunity to let new biosystems disciplines to grow up with the possibilities to achieve good results in different activities: medicine equipments, environment, bioenergy, energy supply, agriculture etc. At the same time, the conventional engineer education enrols by master studies, and the graduate students have the opportunity to specialize themselves in Biosystems Engineering.

Our university develops a new orientation of Biosystems Engineering within an existing specialization: Machines and Equipments for Agriculture and Food Industry. In this respect new disciplines were introduced in syllabus, disciplines corresponding to the new approach in Biosystems Engineering. This is a complex line of study belonging to the larger field of mechanical engineering, training bachelor engineers in design and use of machines, tools and equipment from agriculture and food industry. The subjects we offer are: post harvesting processing technology of agricultural products, engines for tractors and automotive, agricultural machines, tractors, automotives and propulsion systems, renewable energy sources, repairing and manufacturing, CAD, quality engineering, management and marketing, environment engineering.

At the same time more changes appear in the syllabus, with indubitable references, especially at the elective courses in Biosystems Engineering, such as Renewable Energy Sources, Agricultural Waste Recycling and Basics of GIS – GPS systems. Orientation toward Biosystems Engineering is ensured by two ways, consisting in one hand in development of own researches in the field and on the other hand in
previous experience by participation to an educational master program, during 2002 – 2006, supported by DAAD [4].

The own researches development was possible by international and national grants participation, in the following fields: biofuels, renewable energy sources, development of equipment for precision farming and increasing of urban mobility referring to GPS – GIS survey [5].

The benefits of the carried out grants consist in development of material basis and certain specialized laboratories, where the students can attend the applicative courses according to syllabus (Figure 3).

![The laboratory of Cogeneration Energy Based on Solid Biomass; a – solid biomass heating system; b – air – water heating system; c – data acquisition system for biomass heating system.](image)

The involvement to master program “Promotion of post graduated education in Agricultural Engineering in South – East European countries” offered new experience to involved teaching staff regarding technical disciplines belonging to Biosystems Engineering.

All the new approaches are based on our educational experience regarding the Biosystems Engineering gained from a master program mentioned above (South East European Countries with the DAAD support in 2002 – 2006).
As an approach of educational development in Biosystems Engineering through certain master programs will allow to evaluate the impact and to feed back in an appropriate manner.

Aside our academic center there are two other centers where Biosystems Engineering is part of academic development. One is University “Politehnica” of Bucharest where Faculty of Biotechnical Engineering Systems was established. Within this faculty master program courses are taught in Biomedical Engineering, Bioinformatics, Biomaterials and Biotechnologies. In these fields Ph. D. students' courses are also held. The second is University “Transilvania” of Brașov, where within Food and Tourism Faculty (established 2007), Food Products Engineering is developed, having a marked orientation in promoting food biotechnologies.

3. Employability of the Biosystems Engineering graduate students

In this period universities train engineers in conventional fields, having bioengineering competences. So we cannot speak about engineers specialized in biosystems. Still, they can find where to labor, existing an encouraging attitude of the employers, related to their competences in measurement and instrumentation activity along with technological processes management. There is also an increasing demand of engineers with biocompetences, considering the biofuels production at national level along with bioenergetic crops production (rape, sunflower and soy) [6].

Another targeted field where bioengineer can find labor is the solid biofuels production (pellets, briquettes etc.). In present, within lumbering factories waste wood recycling stations have developed, which produce pellets and briquettes. However considering that bioenergy education just begins, the most part of graduate engineers will find a job within educational system as future forming staff. We consider the possibility offered to continue their specialization by master and doctoral programs, thus contributing to present or future bio research centers.

4. Final remarks

Biosystems Engineering is a challenge for Romanian education, transition from conventional approach to bioengineering must be done according to small steps policy, but in the same time with increasing of economic environment demand related to this new specialization. There still is a perception problem of bioengineer that is why the promotion of this new discipline must intensify. The argument in this respect is the decreased interest of the candidate students to conventional farm machinery engineering.

References:


DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN SLOVAK REPUBLIC

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Abstract
At the Faculty of Agricultural Engineering of the Slovak University of Agriculture in Nitra, the study programme Agricultural engineering has been established in 1964. The basic aim of the establishing of this study programme was to educate the specialists at the university level for the needs of the Slovak agriculture based on large-scale principles. In the 1989 there was 360 700 employees in the Slovak agriculture.

Until the year 1989 in the resort of the Slovak agriculture the cooperative farms and state-owned farms were prevailing. Each farm was managed by a group of managers with university-level education (chairman, economist, engineer, zootechnician, specialist for special crops, etc.). The state agricultural policy required a large number of specialists with a university-level education. At the Faculty of Agricultural Engineering of the Slovak University if Agriculture in Nitra each year graduated about 170-180 graduates of the study programme Agricultural engineering and a large number of them were able to find their job on agricultural farms (85-92 % of graduates).

In above mentioned conditions the Faculty of Agricultural Engineering of the Slovak University if Agriculture has educated the students to be able after graduation:

- to manage and organize the mechanized production processes in agricultural farms,
- to design mechanized production processes,
- to insure reliable operation of the production equipments and maintain qualitative parameters of the field machines on required level during their operation,
- to create and manage the system of field machinery life renovation and maintain power systems of the production units,
- to design and manage technical innovations of the production units by using electronics, computers and information technologies,
- to work in agricultural machinery design, in manufacturing, and machinery testing, in science and research where there is a need to synthesize the knowledge of agricultural machinery designer, production and technologist.

The graduates of a 5 year study at the Faculty of Agricultural Engineering of the Slovak University if Agriculture were able to find their jobs first of all in agriculture and food industry, but also in other industries at different positions. It is due to the structure of the study courses they have passed during their study. This structure was based on a courses of basic sciences, engineering courses and agricultural/biological courses (core basis courses).

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The analysis has confirmed that the graduate of the Faculty of Agricultural Engineering of the Slovak University in Agriculture could work in the following positions:

- technical manager or operational engineer controlling production processes in agriculture, in food industry, in civil engineering, in transport and in technical municipal services,
- technical manager in companies providing machinery service and repairs,
- machinery dealer or seller in trade companies,
- designer –technologist in specialized designing offices,
- specialist in research and development institutions focused on agricultural mechanization,
- teacher of study subjects related to agricultural mechanization at the secondary schools,
- engineer in the municipal offices and agrotouristic centres responsible for operation and maintaining of various technical equipments, etc.

In relation to the changes which have occurred in the resort of Slovak agriculture, at the Faculty of Agricultural Engineering of the Slovak University of Agriculture in Nitra, the analysis of the employability of the graduates has been done. According to the results obtained it is possible to state that 10.2 % of graduates were able to find their job in companies related to agricultural production, 5.1 % of graduates are employed in food industry. 21.4 % of graduates are employed in the companies providing service for the farms on the base of contracts of which 18.4 % is technical and trade service and 3.0 % is the share of other type of services. 40.8 % of graduates are employed in limited liability companies, 33.8 % of graduates are employed in joint stock companies, 11.2 % in state-owned companies and 7.1 % in cooperative farms.

The adaptation of agriculture to new conditions in the post-accession period called for formulation of new priorities in the agrarian and food policy. The aim is to increase the performance, productivity and competitiveness in a highly competitive environment within EU Single Market, as well as to define framework measures in order to enforce these priorities within EU Common Agricultural Policy. For this purpose it was prepared the Development Concept for Farming Sector in 2007-2013, within the aim to accept long-term strategy for development of farming sectors in the years to come. The concept for agriculture and food industry has defined the key strategic objective – preserve fully functional rural areas, by maintaining agriculture under all production conditions in Slovakia, to the extent justified by the ability to produce competitive products and the need for effective utilisation, protection, regeneration and permanent reproduction of natural resources, including preservation of cultural landscape and rural settlement. The Concept was approved by the Government of the Slovak Republic in their Decision No. 216/2007 dated 7th March. The Concept of Farming Sector in 2007 -2013 consists of two separate sections: 1. Agriculture and Food Industry, 2. Forestry. The part of the Concept which applies to agriculture and food industry defines the key strategic objectives – to strengthen functionality and stability of rural areas through development of agriculture in all production conditions of Slovakia, alongside rational use, preservation of natural resources, cultural landscape and rural settlement. This objective then translates into additional policy objectives:

a) Competitive agriculture and development of viable rural areas and employment in rural areas.
b) Production of safe foodstuffs.
c) Improved condition of environment and agricultural landscape.

1. Specification of the main characteristics and a definition of the Biosystems Engineering discipline based on expertise and recent developments in Slovakia

Since 1969, the Faculty of Agricultural Engineering has been the only faculty providing engineering solutions to agricultural problems in Slovakia. The faculty’s original mission was to mechanize agriculture. Now we are sure that mission should evolve to encompass a new view of the entire food and biorenewables production system - the wise management of natural resources in the production, processing, storage, handling and use of food fibre and other biological products. Taking into account this evolution the following definition of the Biosystems engineering discipline can be formulated:

Biosystems engineering discipline should be considered as a science-based engineering discipline that integrates engineering science and design with applied biological, environmental and agricultural sciences.

Biosystems engineers should apply engineering analysis and design to solve problems involving biological organisms and their natural or controlled environments. With regard to the Concept of Farming Sector in 2007 - 2013 the resort of the Slovak agriculture and food industry needs the new sort of specialists - Agricultural and biosystems engineers who will be uniquely qualified to use their knowledge of mathematics, biological and physical sciences, and engineering principles to solve problems relating to the production, handling, and processing of biological materials for food, feed, fibre and fuel, the preservation of natural resources and environment quality, and the design and production of machine systems.

In the process of Biosystems engineering discipline establishing there should be done several steps. As a first step which should be done is to prepare the basic philosophy of the a new study programme.

The overall purpose of the Biosystems engineering undergraduate programme: to prepare graduates who will integrate and apply principles of engineering and biology to a wide variety of socially important problems. To achieve that purpose, the primary objectives of the biosystems engineering programme will to prepare graduates to:

• identify and solve problems at the interface of biology and engineering, using modern engineering techniques and the systems approach,

• analyze, design, and control components, systems, and processes that involve critical biological components.

Additionally, the biosystems engineering program should be designed to help graduates succeed in diverse careers by developing a professional foundation that includes vision, adaptability, a practical mindset, effective communication skills, the ability to work in cross-disciplinary teams, an appreciation for global, economic, and societal issues, and a commitment to continuing professional growth and ethical conduct.

A major in agricultural and biosystems engineering could serve a broad range of career interests and could provide sufficient career opportunities for men and women from diverse backgrounds.

2. Proposal of a new module

In reference to the core curriculum included in the FEANI Report Template (pages 16-27; http://www.eurageng.net/usaee-tn.htm) it is possible to suggest the new
module that might be included with regards to the Biosystems Engineering discipline. The module should consist of the following study subjects:

i. **Study subject: Introduction to Biosystems Engineering**
   Content: Overview of topics and engineering application areas that comprise the Biosystems Engineering profession. Also significant emphasis given to development of oral & written communication skills needed by the engineering professional, introduction to design methodology, and application of engineering fundamentals to biological systems.

ii. **Study subject: Fundamentals of Biosystems Engineering**
    Content: Introduction to fundamental concepts in biosystems engineering, including mass, energy, and momentum balances; mass, heat, and momentum transfer; biological response to environmental variables, biological materials, biological kinetics, and techniques of measurement and analysis of engineering and biological data. Laboratory includes hand-on exercises, problem solving and computer sessions, and oral presentations.

iii. **Study subject: Geomeasurements**
     Content: Fundamentals of land measurement and traverse calculations. Levelling, earthwork, area, and topographic measurements using levels, total stations, and GPS. Application of mapping via GIS.

iv. **Study subject: Biological Kinetics and Reactor Modelling**
    Content: Fundamentals of microbial and biochemical kinetics used in analysis and design of biological systems. Topics include mathematical and computer modelling of biological kinetics and systems, estimating model coefficients, and development of microbial kinetic models as basis for batch and continuous reactor design.

v. **Study subject: Biosystems Engineering Mechanical Design**
   Content: Basic mechanical design of biosystems; introduction to biomechanics and biomaterial properties; applications of machine components and their selection related to specific types of biosystems; team design project.

vi. **Study subject: Heat and Mass Transport in Biosystems Engineering**
    Content: Fundamentals of heat and mass transport used in engineering design and analysis of biological systems; principles of steady state and transient energy and mass balances including chemical and biological generation terms.

v.ii. **Study subject: Instrumentation and Control for Biosystems Engineers**
     Content: Overview of modern instrumentation techniques and digital electronic components and subsystems to integrate them into digital data acquisition and control systems for bio systems. Laboratory use of equipment is emphasized. Topics include characteristics of instruments, signal conditioning, transducer theory and applications, programmable logic controllers, and digital data acquisition & control.

v.iii.. **Study subject: Engineering Systems for Soil Water Management**
Content: Fundamentals of design related to drainage of lands, irrigation, and modification of the microenvironment for optimum productivity are presented.

i.x.. **Study subject: Biochemical Engineering**
Content: Use of microorganisms and enzymes for the production of chemical feedstocks, single-cell protein, antibiotics, and other fermentation products. Topics include kinetics and energetics of microbial metabolism, design and analysis of
reactors for microbial growth and enzyme-catalyzed reactions, and considerations of scale-up, mass transfer, and sterilization during reactor design.

x. Study subject: Applications in Bio-technology Engineering
Content: Bioengineering principles applied to the expanding fields of agricultural biotechnology, ecotechnology, and biomedical technology. Specific applications include waste treatment and ecological engineering, bioreactor propagation of plant and animal cells and tissues, applied genomics and synthetic seed production, biosensors and biomonitoring, biological implants and materials biocompatibility.

x.i. Study subject: Bioprocess Engineering Design
Content: Design and analysis of systems for processing biological materials. Topics include biotechnology, thermodynamics, transport processes, and biological properties related to bioprocess design and computational simulation. Unit operations include basic bioreactor operation, bio-separations, and preservation techniques.

The Biosystems Engineering undergraduate programme should be designed so that graduates should be able to:
  i. apply knowledge of math, science, engineering,
  ii. design and conduct experiments, analyze data,
  iii. design a system, component, or process,
  iv. function on multidisciplinary teams,
  v. identify, formulate and solve engineering problems,
  vi. understand professional and ethical responsibility,
  vii. communicate effectively,
  viii. understand global and societal impacts,
  ix. engage in life-long learning,
  x. know contemporary issues,
  xi. use modern engineering techniques, skills, and tools,
  xii. understand the interface between biology and engineering,
  xiii. apply systems concepts and develop models.

3. Conditions for transition or evolution from the traditional Agricultural Engineering programme of studies to the new emerging discipline of Biosystems Engineering
For the current situation at the Slovak University of Agriculture it is very typical that each faculty has its own direction and this direction is reflected by the structure of study programmes. The deeper cross connection of study programmes and disciplines is missing. As the Biosystems engineering discipline integrates engineering science and design with applied biological, environmental and agricultural sciences, for the future, it will be very important to overcome faculty borders and establish new level of contacts with new potential partner. The Faculty of Biotechnology and Food Sciences can be considered as a best partner for Faculty of Agricultural Engineering to establish the new emerging discipline of Biosystems Engineering.

The Faculty of biotechnology and food sciences is one of the six faculties of the Slovak University of Agriculture in Nitra. Faculty was established in the year 2002 and its mission is to educate highly professionals able to apply knowledge in the areas of biology, chemistry, technology and economic sciences, oriented in modern procedures of production, evaluation and processing of food as well as specific biotechnology products.

The study at the Faculty of biotechnology and food sciences consists of three study
levels (Bachelor’s, Engineer’s and PhD.).
The Faculty of biotechnology and food sciences has accredited the following study programmes:

**Bachelor’s study level:**
- Applied biology,
- Agribiotechnology
- Agrifood technology,
- Food safety and control

**Engineer’s level:**
- Applied biology,
- Biotechnology,
- Food technology with specializations: Plant foodstuffs and Animal foodstuffs

**PhD. level:**
- Molecular biology,
- Biotechnology,
- Food technology.

The graduates of Agrifood sciences and food technology programme are prepared for work in the positions of technologists in agricultural, processing and food industry companies, market chains, catering services for agriculture and food industry, inspection institutions, in agricultural and food research and education.

The curriculum of the Biotechnology programme is designed to prepare graduates for work in biotechnological companies, biochemical and biotechnological laboratories, in companies of biological services and also in science, research and education.

The graduates of Applied biology programme can be employed in seed and breeding companies in research institutes and in testing institutions.

The establishing of a new Biosystems Engineering undergraduate programme will require very close cooperation between both faculties with the aim to integrate selected study subjects to one unit, which will reflect the mission of the new programme – to educate new sort of specialists.

It will not be simple process as the current system of financial resource allocation do not creates conditions for establishing inter-faculty study disciplines.

Such transition will have a positive impact on the structure of university, on the students’ enrolment and of course, also on the professional status.

4. Identification of areas where new job opportunities for Biosystems Engineers may arise in the labour market in Slovakia

At a national level it has been identified the increased interest of foreign investors to employ new sort of experts and specialists. New companies built by foreign investors and equipped with new technologies create new job offers. Graduates of a traditional study programmes have small chances to be successful on a job market.

Unfortunately, neither Slovak government nor Slovak agricultural and food chamber did not formulate official societal need for transition from the Agricultural engineering study programme to Biosystems engineering. We are sure that the transition to Agricultural and Biological Engineering should be considered as rational step, which will positively effect the employability of the graduates of our university. It is possible to estimate that Graduate students in Biosystems Engineering will be able to find research opportunities in the areas of water quality, bioprocessing, non-point source pollution, instrumentation and control, bioseparations, and machine design for
biosystems engineering.
For the graduates of Biosystems engineering discipline the following job titles can be formulated:

• production engineer,
• natural resource engineer,
• waste management engineer,
• material recycling engineer,
• director, food quality control,
• systems analyst,
• irrigation engineer,
• project engineer,
• food processing engineer,
• design engineer.

5. Conclusions
Due to the significant changes in Slovak agriculture which have occurred in last years, the transition of the study programme Agricultural engineering to the Biosystems engineering discipline should open new possibilities. On the labour market there is a lack of Biosystems Engineers who are able to identify and solve problems at the interface of biology and engineering, using modern engineering techniques and the systems approach. Both Faculty of Agricultural Engineering and Faculty of Biotechnology and Food Sciences have sufficient potential to create the solid platform for Biosystems Engineering Discipline. To be successful in the process of creating of such discipline it will be very important to overcome the current faculty borders. The higher employability of the graduates will be the main benefit.

References:
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN SLOVENIA

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Abstract
The Paper describes generally the reconstruction of Agricultural Engineering studies and emerging of the Biosystems Engineering (BE) discipline in Slovenia. The possibilities of Biosystems Engineering study in Slovenia are described. Paper deals also with the definition of the Biosystems Engineering discipline. In reference to the core curriculum included in the FEANI Report template the possible revisions are proposed. In following of the introduction of Biosystems Engineering study the impacts of the Institutional Structure, the student’s enrolment, the professional status and the national and international attractiveness, based on the personal assessment and two years experiences after introduction, are described. At the end the areas where new job opportunities for Biosystems Engineers may arise in the labour market, especially with the respect to the current situation of Agriculture Engineers, are identified.

1. Introduction and situation of higher education in Slovenia
Tertiary education in Slovenia is divided into traditional higher education (ISCED 5A-6) and the newly developed higher vocational education sector (ISCED 5B). The field of higher vocational education is administered by the Ministry of Education and Sport and regulated by the Higher Vocational Education Act (2004). Courses are delivered by vocational colleges. In 2005 the newly established Ministry for Higher Education, Science and Technology took over responsibilities for the universities and professional colleges.

In the National Classification system of education and training activities and outcomes (KLASIOUS, 2006), which is one of the formal bases for building a Slovenian eight-level qualification framework, the levels of tertiary education are arranged as follows:

<table>
<thead>
<tr>
<th>Level</th>
<th>Bologna cycle</th>
<th>Post 2004-2006 reform programmes</th>
<th>Pre-reform programmes and/or qualifications (prior to 2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Short cycle</td>
<td>Higher vocational programmes</td>
<td>Post-secondary vocational sub-degree programmes and qualifications</td>
</tr>
<tr>
<td>6.2</td>
<td>First cycle</td>
<td>Professional/academic programmes, equivalent to Bachelor</td>
<td>Undergraduate professionally oriented programmes</td>
</tr>
<tr>
<td>7</td>
<td>Second cycle</td>
<td>Professional magisterij programmes, equivalent to Masters</td>
<td>Undergraduate academically oriented programmes</td>
</tr>
<tr>
<td>8.1</td>
<td>Third cycle</td>
<td>Postgraduate academic specialization</td>
<td>Postgraduate professional specialization</td>
</tr>
<tr>
<td>8.2</td>
<td>Doctorate programmes</td>
<td>Research based magisterij of science/art</td>
<td>Doctorate of science</td>
</tr>
</tbody>
</table>

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There were two Bologna reform packages, one in 2004 and the second one in 2006. The table below illustrates the main differences among the three periods:
the pre-Bologna-reform period from 1993 to 2004
  - the very short first-Bologna-reform period 2004-2006 which resulted in very few reformed studies, and
  - the second-Bologna-reform period in 2006.

**Higher education legislation 1993-2003**
The structure is clearly binary, ISCED 5A and 5B. Non-direct transition from professional to academic track is possible, but rare. The post-graduate ISCED 5A studies lead either directly to ISCED 6 doctorate which is considered as an advanced research title. Usually, it is divided into two stages. The research *magisterij* (ISCED 5A- research diploma) is considered as the first stage of doctorate. The ISCED 5B path may begin with the professional degree study or vocational non-degree study. Both options enable students to go to the labour market or to continue up the »green line« to the level of specialist. The title of a specialist is considered equivalent to Magister as regards the level of qualification. All HE programmes lead to a first HE degree (professional or academic), regardless their duration. Long higher education programmes are no exception. Programmes of 5 or 6 years duration, like medicine or pharmacy, do not lead to a master degree, but the first-degree. Accreditations are the responsibility of the Council for Higher Education (CHE). Internal evaluations are the responsibility of HEIs, assisted by the National Higher Education Quality Assessment Commission. External evaluations are random, organized by HEIs themselves.

**Revised higher education legislation in 2004**
Theoretically, the structure has become more unitary. Direct transition from the professional to academic path is within the same area of study, otherwise conditioned by pre-determined bridging courses. Each first-cycle study should lead to at least one second-cycle option and up to a doctoral level after that. Transitional provisions for those who have completed pre-reform programmes:
First-degree professional graduates are equivalent to the Bologna first-cycle graduates and may normally continue to the second-cycle study. First-degree graduates of academically oriented studies are recognised a certain surplus of ECTS. In most cases, they would enter the second Year of a Master study. An accumulation of at least 300 ECTS can be recognised also in combination of the first academic degree with documented research or professional achievements (validated with 60 ECTS) and this makes possible to embark on a doctorate directly. Studies for the professions, regulated by EU directives (medicine, pharmacy, etc) may lead directly to a Master degree.
Accreditations and reaccreditations (every 7 years) are the responsibility of the Council for Higher Education (CHE). Internal evaluations are the responsibility of HEIs. HEIs should be assisted by an independent public agency for quality assurance and by a separate council for evaluations. For various reasons, these two bodies were not established. Instead, the National Higher Education Quality Assessment Commission has been carrying out some of their duties. NHQA is a member of the CEE and participates in sessions of ENQA. The 2004 Act stipulated that a public agency for quality assurance and a council for evaluations should be established, but it did not happen. In October 2004, the NHQA issued Rules on External Evaluation Criteria in order to establish a national system of regular external evaluations. In practice HEIs together with the NHQA have begun to organize external evaluations according to the above mentioned Rules.
Revised higher education legislation in 2006

The structure is more or less unitary (with the exception of short vocational programmes).

Transitional provisions for those who have completed pre-reform programmes:

First-degree professional graduates are equivalent to the Bologna first-cycle graduates and may normally continue to the second-cycle study. First-degree graduates of academically oriented studies are equivalent to the Bologna second-cycle graduates and may normally continue to the third cycle study. They may embark on a doctorate directly, without recognition of extra professional or research achievements. Long HE programmes leading directly to a Master are possible in cases of (1) professions, regulated by EU directives, and (2) if it is required by the national regulations of that particular professional field. Currently, no such national regulations exist.

According to the 2006 Act, the responsibilities of the CHE are extended to include several roles: counselling to the Government, accrediting of programmes and institutions, assuring quality (including responsibilities for internal and external evaluations), regulating and running the procedures of election of the HEIs' teaching staff. The CHE as an independent (sui generis) body has created three Senates that guide accreditation, evaluation and habilitation procedures. A special independent unit within the ministry of higher education provides technical assistance to the CHE.

According to the Decision of the Constitutional Court, issued in February 2008, the establishment of a new body for professional support to the CHE is required instead of the current ministry's administration.

2. Revision of the existing modules

In reference to the core curriculum included in the FEANI Report Template no revisions of the existing modules or new modules are needed from the viewpoint of Slovenia.

3. Current situation of BE in Slovenia

The academic study of Agriculture general is in Slovenia possible on the Biotechnical Faculty on the University of Ljubljana, the University of Nova Gorica and on the University of Maribor on the Faculty of Agriculture. The study of Biosystems Engineering is provided only on the Faculty of Agriculture in Maribor in the shape of professional agricultural study programme of the Agricultural Engineering program and last three years. In year 2006/2007 the new 1st degree study of Biosystems Engineering, with possibilities to continue the study in the 2nd and 3rd degree is started on Faculty of Agriculture in Maribor.

In Slovenia the study programs are moved from old system (1st USAEE meeting in Madrid) to new “Bologna” study system. Both systems of study programs are at this moment financed according to the old rules from year 2000. The new funding system will be adopted in at the end of this year and the first Slovenian Bologna students will be in this year finished the 1st degree, this way the positive and/or negative effects on the coherence of the study program and the quality of studies cannot be described yet at this moment (April 2008). There are no changes since the last USAEE workshops in ECTS credit system using in Slovenia. There are no adjustments, alterations or differences concerning the quality assurance scheme used in Slovenia since the 5th USAEE Workshop in Dresden.

The study program Biosystems Engineering is a first level study program and it takes three years and has started in year 2006. The contents and comparison with FEANI
was presented on the workshop in Budapest and in this period only small changes were adopted on the program. The Biosystems Engineering program provides an interdisciplinary education and comprises important branches of mechanical engineering, biology, agriculture, genetics, mathematic, electronics and process automation. Students can continue their study at the postgraduate level program. The admission requirement for Biosystems Engineering study program is a matura examination, vocational matura examination or final examination after the completion of four-year secondary education program or its equivalent. Faculty of Agriculture admit each year 40 full-time students.

4. Impacts of transition
With the transition from Agricultural Engineering study to the Biosystems Engineering study not only the name has changed. Many new contents are involved in the study process, e.g. Precision Farming, Electronic systems in Agriculture, Microbiology... From year to year the structure of enrolled students is better and better. About professional status is too early to write discussions about impacts, because the study program is going now for the first two years. Generally, on the personal assessment of authors, there are only positive impacts of transition on the Faculty of Agriculture in Maribor.

5. Identification at a national level
On the national level no analysis were madden, because the study of BE is offered only on our Faculty

6. Job opportunities for BE
Upon completion of the Biosystems Engineering study program, a graduate will be practical specialist qualified for leadership of market orientated family farms or estates. Areas of work include: trade organizations and cooperatives, technological and development branches of agricultural mechanization, advice services and agricultural educational schools. The objective of the study program is to educate experts capable of independent, practical and theoretical work in the field of: environmental, production, storage, processing and recycling of biological materials. During this two years period introduction of Biosystems Engineering study many events are organised with the goal to promote Biosystems engineering, as new termin, to the community.
For these activities the mobilisation of all human resources is necessary, what is in many times not possible.

7. Conclusions
The transition from Agriculture Engineering to Biosystems Engineering was on the University of Maribor, Faculty of Agriculture very successful. The structure of enrolled students is from year to year better. Not only the name was changed but also many contents were modernised and adopted to the current situation in our community. All that effort many energy from human resources and can be successful only as a systematic everyday work over many years.
THE FUTURE OF BIOSYSTEMS ENGINEERING
IN SPAIN

F. Ayuga*¹, P. Aguado²

1. Definition of Biosystems Engineering
The name of Biosystems Engineering is completely new for the Spanish culture. Traditionally (starting in 1855) there have been two official degrees in relation with Agricultural Engineering in Spain. The first one is called Ingeniero Agrónomo (Agricultural Engineer) and the second one is Ingeniero Técnico Agrícola (Technical Agricultural Engineer). The Technical Agricultural Engineer degree is obtained after three years of university studies. The Agricultural Engineer degree has change duration along the years, from 5 years (1855 to 1984) to 6 years (1884 to 1892) again to 5 years (1892 to 1957) then to 7 years (1957 to 1964), 5 years again (1964 to 1974) then to 6 years (1974 to 1990) and finally 5 years in 1990. Studies on Agronomy or on Agricultural Sciences do not exist in Spain and never existed. So, competences and professional jobs in Agronomy were shared between Agricultural Engineers, Biologists, Chemists and other degrees. Agricultural Engineers in Spain usually work for companies (agricultural machinery, irrigation equipment, phytosanitary, electronics and computers, rural construction and infrastructures, livestock), as public workers (in rural development, irrigation and drainage, research, agricultural economics and policy, livestock) and as professionals, mainly in the project and consultancy of agro-industries and animal housing. [Ayuga 2003]
During the past twenty years, environmental studies and all kind of interventions to protect, preserve and manage the environment have employed Agricultural Engineers as well as other kind of Engineers. Even new degrees (but not Engineering degrees) have been proposed to cover the new needs. More recently other tasks have been assumed by Agricultural Engineers not clearly in relation with Agriculture, such as quality management, occupational safety and health, tourists and recreational activities, land management. Food technology and processing have become one of the main sectors offering jobs to Agricultural Engineers in Spain. Not only in the design and construction of processing plants but also in the process management, research, quality control and sell departments. Most of these professional activities could be considered part of a broader degree beyond “Agricultural” engineering. The name Biosystems Engineering could be one of the options to denominate a new degree covering the “classical” Agricultural Engineer and including new targets, always in the field of biological, food or environmental engineering. Of course it would be possible to develop specific degrees on any of these areas but a more “open-minded” engineer with a strong general background in engineering, biology and agricultural sciences could cover all the fields and concentrate the students in a context of a decreasing trend of enrollment. The definition of Biosystems Engineering could be: A multidisciplinary field of science and technology that aims to define, develop and apply engineering methodologies to organize, improve and manage the

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environmental and biological quality of natural resources, agriculture, food and livestock, increasing the standard of life of rural population and healthy conditions of humankind. This requires the technical and economical optimization of labor, soil, water, energy and natural resources under ecological and social restrictions.

2. Biosystems Engineering and the USAEE report

Regarding the USAEE proposal [USAEE 2006], it was a core curriculum that could be used to define a program of studies with different names. In our opinion Biosystems Engineering is one of them and no important changes need to be made on it. The modules proposed by USAEE could easily be modules of a Biosystems Engineering degree and from the Spanish point of view only two changes are proposed:

- The module “Water Resources Engineering” should be renamed as “Water Resources and Irrigation Engineering”, because of the importance of irrigation in Spain.
- A new module on “Environmental and Land Management Engineering” could be added. The courses could be taken from the USAEE proposal. For example the optional courses for the Engineering part could be:
  - Remote Sensing
  - Engineering Surveying – GIS
  - Instrumentation and Measurements
  - Pollutant Behaviour and Transport in the Environment
  - Liquid Waste Management
  - Solid Waste Management
  - Waste Management and Environmental Quality
  - Renewable Energy Resources & Technologies
  - Environmental Pollution from Energy Production
  - Information Systems
  - Expert Systems
  - Image Processing

And the optional courses for the Agricultural/Biological Sciences part could be:

- Environmental Impact Assessment
- Biological Process in Waste Management
- Environmental Engineering Microbiology
- Food Quality
- Animal Science and Management
- Crop Science and Management

3. Biosystems Engineering in Spain

At the moment of writing this paper in Spain there is no changes in the name of degrees (bachelor degrees). It is expected to be during this and the next year the finishing of the transition to a new University educational system. The conversations and meetings hold until now by professors and professionals in the field of the “classical” Agricultural and Forest Engineering suggest that a name of “Biosystems Engineering” is not possible as a bachelor (“graduate”, in Spain) degree. The need of a merging between Technical Engineering (3 years) and Engineering (5 years) into a 4 years degree is the main topic among University professors. The way in which this merging is going to be produced and how to share courses, students
and laboratories are as important as the degree name. Professional Associations are mainly thinking on if they have to admit the new graduates and how to do it, and they do not want changes in names. The result is that there is not a clear ending or a consensus name accepted, but the proposal of “Biosystems Engineering” name has been rejected by the group of University representatives (directors of the more than 40 Schools offering Agricultural Engineering or Forest Engineering degrees) and also by the Professional Associations.

Nevertheless, many people agree in the importance of broaden the degree scope (independently of the name) and to provide a strong Engineering background (just to maintain the Spanish tradition) in line with the Biosystems Engineering philosophy. Another option is to use the name in some of the Master (“postgraduate” in Spain) degrees that probably will be proposed by Universities. Opposite to the idea of a common name for all Universities at the graduate (Bachelor) level it seems clear that it will be multiple options in the postgraduate (Master) level. Nevertheless, this possibility could be against the idea of a basic, wide degree proposed by USAEE.

Although the name probably will be different, there is no doubt that the changes in the University educational system will produce a new degree on Agricultural / Biological / Rural or whatever Engineering that will try to maintain the competences of the past and to gain new competences in the society.

This new degree should comply with the core curriculum of the actual Agricultural Engineering degree (publish by the Spanish government in 1990) if the graduates want to be accepted by the Professional Association and maintain the legal attributions granted to the Spanish Agricultural Engineers (for example to sign technical projects). Those programs will easily access to the USAEE and EurAgEng recognition, because the actual Spanish core curriculum almost fully comply the requirements.

4. The transition to a new Biosystems Engineering degree in Spain

The new degree, whatever its name will be, should aim to satisfy the real needs of the Spanish and European society, keeping in sight the global trends and needs. This means that changes in the professional and academic organization are expected. Probably the number of Universities offering the degree will be the same because of the difficulties of closing educational centers in a public network in which professors are civil servants. Probably there will be less homogeneity in the programs which is new for Spain, with the programs fixed by government for all Universities. Another novelty for Universities (and also for students) will be a 4 years degree, with a variety of 1 or 2 years postgraduate degrees. Great changes in organization and in the teaching-learning process are expected for the next years. If it is possible to coordinate with other European countries, Universities and Institutions, the result could be positive for mobility and enhancement of European dimension, if not the changes will only create difficulties.

The discussion on the program, core curriculum, courses, degree names and all details is basing on very few previous studies. The only one with enough entity to be cited is the study carried out by the conference of Schools directors over the graduates during the period 2000-2005 [ANECA 2005, AYUGA 2006]. A number of 15500 graduates received the survey and 2654 of them answered it, 62 % male and 38% female graduates. They also sent a different survey to 2500 companies with interest in Agricultural and Forestry Engineering graduates, 417 of them answered it.
One of the answers from the companies could be relevant to analyze the transition to the new degrees. It is about the criteria used by the companies to select their engineers:

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Number of answers for each score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No opinion</td>
</tr>
<tr>
<td>General education at University and specific in the company</td>
<td>38</td>
</tr>
<tr>
<td>General education at University and capacity to adapt to any position in</td>
<td>36</td>
</tr>
<tr>
<td>the company</td>
<td></td>
</tr>
<tr>
<td>Specific education at University for certain position in the company</td>
<td>47</td>
</tr>
<tr>
<td>Post-graduate education</td>
<td>41</td>
</tr>
<tr>
<td>Practical skills acquired at the University for certain position in the</td>
<td>32</td>
</tr>
<tr>
<td>company</td>
<td></td>
</tr>
<tr>
<td>Capacity for acquiring practical skills in the company</td>
<td>31</td>
</tr>
<tr>
<td>Other skills and knowledge acquired at the University different from the</td>
<td>42</td>
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<td>degree</td>
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<tr>
<td>Other skills and knowledge acquired by training in companies different</td>
<td>39</td>
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<td>from the degree</td>
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<tr>
<td>Other skills and knowledge acquired by international exchanges different</td>
<td>47</td>
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<td>from the degree</td>
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1. less agreement ........ 4. best agreement

One conclusion of this table can be that companies prefer a good background and capacity to adapt and to acquire new knowledge, better than specific education, even postgraduate. This result can help in defining the new program to satisfy the companies' needs.

Nevertheless, more studies, and preferably at a regular basis, would be needed to take decisions on the best programs to satisfy the future societal needs.

References:


THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN SWEDEN

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Abstract
Today the traditional term “agricultural engineering” is often substituted by the term “bio-engineering” or “biosystems engineering”. Biosystems engineering should be considered to be the interface between technology and biological systems. Biosystems engineering emphasizes the application of engineering principles to the solution of problems associated with biologically based systems including agriculture, food and biomass production. In moving from agricultural engineering to biosystems engineering education additionally systems-oriented courses should be included.

Today in Sweden the agricultural engineering oriented programmes have been closed. The transition to a broader field will have impact on the attractiveness. As the programmes will be taught in English we anticipate an increased international interest. There has not been expressed a societal need for a transition in Sweden. The formerly MSc degree in Agriculture with specialisation in engineering was very much appreciated and respected. However, new areas outside the traditional agricultural engineering area may be relevant for employment.

1. Main characteristics and definition of the Biosystems Engineering discipline
As a result of the technological innovations and the dramatic structural changes in the higher educational system in many countries, the Agricultural Engineering subject is clearly under-going rapid changes. Today many universities use new terms related to agricultural engineering, in order to cover the demands of the society. The traditional term “agricultural engineering” is often substituted by the term “bio-engineering” or “biosystems engineering”.

Biosystems engineering, as we see it includes traditional agricultural engineering and also a number of other engineering areas in the interface between technology and biological systems. Also in education the traditional term “agricultural engineering” gradually has been substituted by the term “bio-engineering” or “biosystems engineering” and new courses have also in many cases been included in the curricula. Examples of such new areas are technologies for the management of variability, systems analysis of technical-biological systems, and natural resources technology. On the whole, all actions taken by man within production, product circulation and natural care are made with the help of technology and engineering. Product safety and certification start in the very first part of the production process. The physical and psychical working environment is formed by engineering and technical systems and how they are organised.

Thus, biosystems engineering emphasizes the application of engineering principles to the solution of problems associated with biologically based systems including agriculture, food and biomass production.
In comparison agricultural engineering can be defined as the branch of the engineering profession that applies engineering principles, techniques and technology to the needs of agricultural and land, water and air resources. These changes also have affected the Swedish University of Agricultural Sciences. The university is finding itself forced to modify education to adapt to the new trends in agricultural engineering, and in order to recruit students in a world where classical engineering is less appealing to young students.

2. Possible revisions of existing modules in the FEANI Report
The core curriculum included in the FEANI Report Template should preferably be revised with regards to the emerging Biosystems Engineering discipline. In general more biological science should be added in favour of proposed engineering and basic technological courses. Additionally system-oriented courses should be included. Examples of such courses are: “Introduction to agricultural systems”, “Systems modelling and optimisation”, “Model building and simulation”, and “Life cycle analysis (LCA)”.

3. Current situation of the Biosystems Engineering discipline in Sweden
The Bologna model was introduced in university education in Sweden from 1. July 2007. From that date a 3+2+4 years system as well as the ECTS system were implemented. However, most universities were for several years already in the process of reviewing and rearranging their courses and programmes according to the Bologna model.
At the Swedish University of Agricultural Sciences (SLU) a decision was taken in 2003 to start a new MSc study programme “Biosystems Technology (BST)”. However, it included widened mathematical courses. The programme started in fall 2003 and was replacing the formerly engineering specialisation within the MSc-programme in Agriculture. Because SLU is not entitled to graduate engineers the new programme was partly based on the previous MSc-programme in Agriculture with specialisation in Agricultural Engineering. The programme accepted students for two years (2003 and 2004) but due to a low number of applicants no students were recruited after 2005. Today the programme has been closed. Based on student interviews it was found out that the students attending the programme did not find it relevant to read so many basic mathematical and physics courses as were included, in relation to their envisaged future labour market. A more biological and systems oriented education was anticipated.
The university still runs two Master programmes in collaboration with Uppsala University where the students graduate from the latter university. They are: the Energy Systems Programme and the Environmental and Water Technology programme.
SLU has now taken the decision to cooperate in developing the NORBE (the Nordic School of Biosystems Engineering), an MSc programme cooperation between the agricultural universities in the Nordic countries. The aim is that NORBE will be an organizer and facilitator of a number of engineering courses and specializations anchored at the participating universities. The students will graduate from the university he/she is enrolled at.
NORBE focuses on putting forward the edge cutting issues within biosystems engineering, thus supplying the students with an interdisciplinary and international profile. Today NORBE is in the stage of starting being implemented. Currently five MSc programmes are under development:
1) Farm Buildings (at SLU, Dept of Rural Buildings), 2) Machinery for Biosystems (at Helsinki University, Dept of Agrotechnology), 3) Agricultural and Bioenergy Systems (at SLU, Dept of Energy and Technology), 4) Aquacultural Engineering (at Norwegian University of Life Sciences), and 5) Environmental Engineering (jointly at SLU and Norwegian University of Life Sciences). The first two programmes are running and some courses in the other three are given.

4. The impact of a transition
The transition mentioned above will have some domestic impact. Based on internal assessments at the university the impact can be identified as follows. The Institutional structure will mainly remain unchanged. There may be some initial problems of marketing and enrolment of students. The new curricula content with new subjects must be explained. The students will not get a Master degree in agriculture but in technology which may be confusing. Their professional status will probably be unchanged as soon as employers and society are informed of the student’s skills and knowledge. As the programmes will be taught in English we anticipate an increased international attractiveness.

5. Identified need for a transition
There has really not been expressed a societal need for a transition in Sweden. The formerly MSc degree in Agriculture with specialisation in engineering was very much appreciated and respected. National evaluations of the programme resulted in high scores. There was a good labour market for the graduated students. However, the number of students applying for entering the programme became lower and lower. In order to strengthen student attractiveness various actions, e.g. marketing, change of name etc, were taken. No independent market analysis was carried out nor has any independent report been published. In some statements it has been argued that biosystems/agricultural engineers specialised in farm buildings should broaden their biological skills in order to meet needs for higher competence in animal science when working in the expanding area of animal welfare.

6. The influence of a transition
The transition from agricultural to biosystems engineering should result in an expansion of the possible labour market. New areas outside the traditional agricultural engineering area may be relevant for employment. The biosystems engineer may to a greater extent be employed outside traditional agriculture or horticulture. New working possibilities may arise in the municipal sector and at managing levels in industries and companies.

Reference:
DEFINITION OF THE EMERGING BIOSYSTEMS ENGINEERING DISCIPLINE IN TURKEY

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Abstract
This paper, firstly, provides a definition of Biosystems Engineering and recent developments in this field in Turkey. Although there is no such programme in Turkish Higher Education system yet, there is a need for a transition and evolution from traditional Agricultural Engineering programmes to this new emerging and transforming discipline of Biosystems Engineering.
Impacts on institutional structure, students’ enrolment and possible national attractiveness are also discussed. Finally, areas for job opportunities for Biosystems Engineers, and possible conflicts with other disciplines are given.

1. Definition of Biosystems Engineering in Turkey
The biosystems engineering in Turkey has diverse definitions by diverse scientific disciplines. For example, the perception by agricultural engineering discipline, generally speaking, is such that, biosystems engineering is a new approach to agricultural engineering with respect to application and integration of engineering principles in biological systems which include agriculture, food and biomass production. For medical sciences, however, biosystems engineering is a field of biochemical engineering and/or biotechnology and/or molecular biology sciences.
“Biosystems engineering is sometimes called as biological engineering which combines the science and art of engineering with the sciences of biology for the purpose of designing systems to influence, control or use biological material and organisms for the benefit of society. It also includes, bio-environmental engineering which is concerned with maintaining the quality of the environment. It applies the physical, biological and environmental sciences to the design of solutions to environmental problems.” [1]
A biosystems engineer must have the capacity of designing and realizing new products and methods, utilizing biological resources, creating, innovating and operating complex agro-biological systems in order to meet safety regulations, environmental protection, cost reduction, operational friendliness and easiness and less maintenance requirements, and finally meeting the social and economical needs. The knowledge of a biosystem engineer, therefore, must be related to the components of agro-biosystems such as vegetal, animal, food and non-food production [1].

2. Current Situation of Biosystems Engineering in Turkey
As mentioned before, there is confusion on the definition of biosystems engineering in Turkey. Currently, there are a few undergraduate programmes or laboratories with
the name of bio-engineering and they sometimes call it as biosystems engineering. For example, a programme on bio-engineering was initiated by a university in Turkey, where bio-engineering is defined as an interdisciplinary field based on physics, mathematics, chemistry, biology, molecular biology, cell metabolism, basic engineering and material sciences that applies engineering principles to biological systems for the purpose of developing new technologies (biotechnologies) and services to improve the living standards of societies. However, many of these definitions are related with mainly biomedical sciences or biotechnology or biochemistry. They do not have an exact description of application of engineering principles in biological systems including agriculture, food, environment and biomass. In other words there is no such programme and core curriculum in action in Turkey yet, as proposed by the USAEE-TN.

Currently, there is an adoption effort by academics from mainly agricultural machinery discipline and partly from agricultural structures and irrigation sciences on the transition from classical agricultural engineering programmes of study to biosystems engineering. For any undergraduate programme to be initiated in any of the universities in Turkey there is a necessity for the approval of the Higher Education Council. Very recently two national were organized by the Education Commission (the author is a member of this commission) to the Agricultural Mechanization Board of Turkey (an advisory board to the Ministry of Agriculture and Rural Affairs on issues of agricultural mechanization) in order to discuss the matters on biosystems engineering and to provide recommendations on restructuring the curricula on agricultural engineering compatible with the biosystems engineering as it is proposed by USAEE-TN. Also two international workshops were organized by the Chamber of Agricultural Engineers, where experts from Europe, including the coordinator of the USAEE-TN, Prof.Briassoulis, participated with their invaluable knowledge and exchange their ideas for a reform in this respect. The outcomes of all these workshops were submitted to the Higher Education Council (HEC) of Turkey, to the Council of Higher Education on Agriculture, Forestry and Fisheries, and also to all Faculty Departments of Agricultural Machinery and Irrigation. Also a core curricula has already been drafted by this commission by taking the USAEE-TN proposals and the criteria of the FEANI, into consideration.

3. Transition from Agricultural Engineering to Biosystems Engineering in Turkey
All the Agricultural Faculties in Turkey cover all disciplines of agricultural sciences, and the degree title given to all those are "agricultural engineering". At the third year of this program, students select an option (sub-program) for their specialization which are: Agricultural Machinery, Agricultural Structures and Irrigation, Soil Science, Horticultural Crops, Plant Protection, Dairy Technology, Agricultural Economics, Field Crops and Animal Science. However, only the first two of these options are considered to be suitable for the transition to biosystems engineering discipline. The duration of the current study program of agricultural engineering in Turkey is four years. During the first and second years, the courses are generally on basic sciences, basic engineering and general agriculture. The programs of the third and fourth years are directed towards acquiring practical skills and learning the use of technology through theoretical and applied courses given within the range of each department. The undergraduate program, which is spread to 4 years, awards a Bachelor of Science (BSc) degree after its successful completion.
The Agricultural Engineering programmes have been restructured twice within the last 7-8 years. However, these restructuring processes have not been done in accordance with the Bologna nor any other international norms. Undergraduate programs (except Food Engineering and Landscape Architecture) have been downsized to one single program with specialization (options). The idea behind these changes was to create “engineers who knows everything about all aspects of agriculture”. On the other hand there have been very little done about the consideration of the market (farming businesses, machine manufacturers, private agro-industry, etc) needs, and definition of the formation of the graduates. Downsizing all programmes into one single programme for the first three years have brought about various problems of meeting the FEANI criteria and USAEE-TN proposed curricula. This is mainly because, there are approximately only 20 credits allocated for the specialization courses and only 10 credits allocated for the engineering courses both of which are well below the FEANI criteria.

It is also well known that the current structure of the education system for agricultural engineering does not have any flexibility to adopt itself to technological developments in the sector.

Having structured and introduced a biosystems engineering course as a new approach to agricultural engineering with respect to application and integration of engineering principles in biological systems which include agriculture, food and biomass production, this would have an important positive impact on national and international attractiveness and the demand by potential students will significantly expand.

The societal need for a transition from agricultural engineering to biosystems engineering has well been discussed and identified at national level in Turkey. As mentioned before, all departments of agricultural machinery (engineering) in Turkey have provided their opinion on this issue and two national and two international workshops were organized with the participation of the representatives of these departments, and conclusions were reported to various bodies for support and approval.

4. Influence on Labour Market in Turkey

Biosystems engineer must have the capacity of designing and realizing new products and methods, utilizing biological resources, creating, innovating and operating complex agro-biological systems and finally meeting the social and economical needs.

Biosystems engineers, will therefore have so many potential areas of job opportunities which include the utilization of renewable energy resources, new technologies such as precision farming, microelectromechanical systems, nanotechnology in agriculture, adoption of farming systems to climate change and draught conditions, environmental issues of agricultural systems, food chain from field to consumer, food safety, good agricultural practices, biomass, bioprocess, biosensors, aquaculture, quality control of biological systems, etc.

Turkey has a great potential of growing agriculture and agro-food sectors and there is an emerging labour market for these areas. On the other hand, global warming and climate change has a significant effect on the Turkey’s territories and there is an extending problem of environmental issues arousing mainly from agricultural practices and agro-food industry.

It is presumed that, the initiation, recognition and accreditation of the biosystems engineering programmes in Turkey will help solving all problems related with the
components of agro-biosystems, such as vegetal, animal, food and non-food production. Consequently, it is foreseen that, employability for current agricultural engineers and new job opportunities for biosystems engineers may arise in the labour market.

5. Conclusions
A biosystems engineer must have the capacity of designing and realizing new products and methods, utilizing biological resources, creating, innovating and operating complex agro-biological systems in order to meet safety regulations, environmental protection, cost reduction, operational friendliness and easiness and less maintenance requirements, and finally meeting the social and economical needs. The biosystems engineering in Turkey has diverse perceptions by diverse scientific disciplines and therefore there is confusion on the definition of biosystems engineering discipline in Turkey. Currently, there is an institutional effort on the transition from classical agricultural engineering programmes of study to biosystems engineering. Very recently two national and two international workshops were organized in order to discuss the issues on biosystems engineering and to provide recommendations on restructuring the curricula on agricultural engineering compatible with the biosystems engineering as it is proposed by USAEE-TN. Also a core curricula has already been drafted by taking the USAEE-TN proposals and the criteria of the FEANI, into consideration.
It is foreseen that, structuring and introducing a biosystems engineering course in Turkey, would have an important positive impact on national and international attractiveness and the demand by potential students will significantly expand. Turkey has a great potential of growing agriculture and agro-food sectors and there is an emerging labour market for these areas where biosystems engineers will have so many job opportunities.

References:


AGRICULTURAL ENGINEERING AND BIOSYSTEMS ENGINEERING IN THE UK

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Abstract
No programme for Biosystems Engineering exists at undergraduate level in the United Kingdom as there has been little recognition of a need to move away from conventional Agricultural Engineering towards Biosystems Engineering by either government, professional bodies or employers. Any development of a Biosystems Engineering programme in the UK will depend on the agricultural engineering industry recognising the value of graduates from such courses to their developing businesses.

1. Historical Perspective
Six years ago there were three Universities delivering Agricultural Engineering programmes in the UK but now Harper Adams is the only University left offering a first degree in Agricultural Engineering. The decline in the number of agricultural engineering courses is a direct result of the overall decline in student numbers in the UK wishing to study engineering in general and agricultural engineering in particular. The decline in numbers wishing to undertake studies in engineering seems to be due to a number of factors. As there is no baccalaureate system in the UK the school student can choose his/her post-16 subjects without being compelled to take a broad field of study ie including mathematics and science. The student perception is that mathematics and sciences are harder options and since both students and schools are anxious to optimise their ‘points’ scores from examination results there has been a move away from the sciences towards the Humanities. Also the engineering industry, despite successes in certain areas, has been in decline in the UK for some years and hence is not seen as a particularly attractive career option. This has been accentuated in the agricultural engineering sector by the decline of agriculture in the UK due to successive problems of BSE, foot and mouth disease etc. This has suggested to prospective students that agricultural engineering would not be a suitable career option. Because of the reduction in numbers of entrants into the agricultural engineering profession there is now a shortage of trained graduate engineers and the competition for engineers from companies has caused a marked increase in the starting salaries for graduate engineers and this may mark a turning point in the attractiveness of agricultural engineering as a career.

2. Biosystems Engineering
Despite the participation of UK universities in the development of the European programme on biosystems engineering, there has been no societal need for biosystems engineering identified at a national level by either government, professional bodies or employers. Indeed many employers seem more interested in more practical engineering skills being added to courses rather than a widening of the curriculum. Hence, the move towards biosystems engineering is progressing slowly and currently there is no undergraduate programme of biosystems
engineering study in the UK. Because of the decline in agricultural engineering student numbers referred to in the previous paragraph, we in the Harper Adams Engineering Department are very interested in any development that may increase the numbers of students entering the agricultural engineering profession in one guise or another.

One reason for our University’s success in maintaining viable agricultural engineering courses has been the close links between the University and the agricultural engineering industry in the UK and consequently the formation of graduates who are very employable within the industry. The main aim of our agricultural engineering courses has always been to educate designers and test-and-development engineers for the agricultural engineering industry; hence, there is a heavy emphasis on mechanical design and related theoretical studies within our curriculum. Employers would need to recognise the wisdom of widening the curriculum to incorporate biosystems. Perhaps the better phrase is employers would need to be educated in the wisdom of widening the curriculum to include more agriculture and biological sciences.

3. Engineering Council

However, a complicating factor is that the Engineering Council, which runs the engineering profession in the UK, also oversees engineering education in the UK in the sense that it accredits engineering courses and without that accreditation a student is unlikely to study that particular course. Without going into great detail, the Engineering Council introduced over twenty years ago the title of BEng, instead of BSc, to indicate that the holder had studied an engineering degree as distinct from any other science subject. This title is jealously guarded and cannot be used for any course with more than 20% of what would be seen as non-engineering material, e.g., foreign languages, business studies etc. Hence, as things stand, there would be resistance to the introduction of agricultural/biological sciences into a BEng degree, certainly on the scale proposed by the FEANI/USAEE scheme. However, there would be certainly be scope to use the wider title of BSc for such courses and this would probably be the way forward initially, until such courses gain a wider acceptance.

4. Industry perceptions

The UK agricultural engineering industry consists of a mix of a few large international companies, e.g., John Deere, Case New Holland, Claas, JCB, Caterpillar, Terex etc. and a larger number of smaller enterprises. The large international firms would no doubt see the wisdom in employing graduates with a wider knowledge of biosystems within their Research & Development teams for researching the next generation of agricultural machines etc. However, the rest of the industry is made up, largely, by small to medium sized companies where mainstream engineering studies along with business studies are their priorities for graduate engineers and consequently would be more resistant to biosystems studies at least initially.

This analysis has ignored tractor manufacturers in the UK as they traditionally have tended to recruit automobile engineers, mechanical engineers and even aeronautical engineers in preference to agricultural engineers to meet the specific needs of their industry.
5. Future development
Harper Adams University College specialises in land-based courses and the Engineering Group is likely to put forward a programme in the near future which will combine engineering modules with a wider study of agricultural and biological sciences. However, because of financial constraints these modules are likely to be existing modules developed for agricultural and animal science courses rather than modules developed specifically to be incorporated into agricultural engineering courses.
In developing new courses of this type the main problem is to decide what to leave out from a previous course to make room for the new material and our main concern with the FEANI/USAEE proposed programme is that it is possibly overfull. Also with limited student numbers it is difficult to be able to offer much in the way of options and still remain financially viable.