

THE EMERGING EVOLUTION FROM AGRICULTURAL ENGINEERING TO BIOSYSTEMS ENGINEERING STUDIES IN EUROPE

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Abstract

The main objectives of a new European Thematic Network entitled 'Education and Research in Biosystems Engineering in Europe (ERABEE-TN)' is to initiate and contribute to the structural development and the assurance of the quality assessment of the emerging discipline of Biosystems Engineering in Europe. To date, very few Biosystems Engineering programs exist in Europe and those that are initiated are at a very primitive stage of development. The innovative and novel goal of the Thematic Network is to promote this critical transition, which requires major restructuring in Europe, exploiting along this direction the outcomes accomplished by its predecessor; the USAEE-TN (University Studies in Agricultural Engineering in Europe). It also aims at enhancing the compatibility among the new programmes of Biosystems Engineering, aiding their recognition and accreditation at European and International level and facilitating greater mobility of skilled personnel, researchers and students.

Keywords

Thematic Networks, European Higher Education, Biosystems Engineering

1. BACKGROUND

During its four-year lifetime (01.10.2002 – 30.09.2006) the European Thematic Network USAEE-TN (<http://www.eurageng.org/usaee-tn.htm>) accomplished two sets of basic tasks:

1. Mapped the structure of studies in traditional Agricultural Engineering in Europe and facilitated European cooperation among Institutions offering such studies

One of the main objectives was the mapping of the diversity and the structure of the programs of studies in the traditional field of Agricultural Engineering in Europe. Therefore, a European wide survey was initiated so as to investigate the status concerning the program of studies and the research activities undertaken within European University Institutes. For this purpose, a continuously updated web-based database was developed. It also set the basis for the assessment of the state-of-art in the European program of studies as well as the identification of the needs for the creation of a common core curriculum to be used as a benchmark in Europe. Moreover it activated the tools for the harmonization of studies in order to fit into the Bologna scheme (use of common ECTS credits, common modules, etc). Real collaboration among European actors was fostered and a great deal of human resources was mobilized in order to promote and activate other parties, such as professional bodies, academic organizations, policy makers, etc.

2. Developed a Core Curriculum

Core curriculum was developed to function as a benchmark for the Agricultural Engineering studies in Europe. The development of a benchmark for basic European core curriculum in the relevant subject area was based on the following requirements:

- (a) Meet the FEANI criteria for being an Engineering program of studies
- (b) Have the support of EurAgEng

The main deliverables accomplished during the four years lifetime of the USAEE-TN were:

- ✓ An Agricultural Engineering core curriculum version [1] following the FEANI-EMC (European Monitoring Committee) guidelines and comments. This version (evaluated by the FEANI-EMC and approved in full in January 2007) concerns a core curriculum for the 1st Cycle Degrees of Integrated 1st and 2nd cycles (i.e. Pivot Point Degree) or for Long Cycle (i.e. traditional) Academic Orientation Programs of Studies. For the very first time such a core curriculum was developed at a European level, especially, in cooperation with experts/teachers representing the majority of European countries offering relevant programs of studies.
- ✓ A complete set of documents [2] on the EurAgEng Recognition Process. The EurAgEng Recognition Process, by using the curricula criteria established by USAEE-TN as a benchmark, encourages University programs of Agricultural Engineering to incorporate the agreed minimum curriculum content. Additionally, the EurAgEng Recognition Process rewards programs satisfying the benchmark criteria with a widely acknowledged, independent recognition of this achievement. The ultimate value of the EurAgEng recognition process is enhanced because it is completely transparent and completely independent. The Recognition Procedure of the Agricultural Engineering programs of studies, in terms of fulfilling the provisions of the USAEE-TN core curricula, is considered as a first prerequisite step in complying thereafter with the FEANI requirements.

These outcomes not only underline the successful and historical steps made by USAEE-TN during the past four years, but it also represent a great advancement for the establishment of harmonized Core Curricula of Agricultural Engineering studies in Europe that may now be recognized as such at the European level by two European professional associations, namely FEANI and EurAgEng. This development also highlights the fruitful synergies developed with both FEANI and EurAgEng, promoting not only the dissemination, but also the implementation of the project results to the very wide target of the members of two major non-academic professional European organizations.

2. THE EVOLUTION FROM AGRICULTURAL TO BIOSYSTEMS ENGINEERING

According to the Commission of the European Communities (Building the ERA of knowledge for growth; COM (2005) 118 final - April 6, 2005): *'...As the driver for the production and exploitation of knowledge, research is above all a linchpin in the implementation of the Lisbon strategy to make Europe the most dynamic and competitive, knowledge-based economy in the world, capable of sustaining economic growth, employment and social cohesion'*. In addition it is stated that: *'...To be a genuinely competitive, knowledge-based economy, Europe must become better at producing knowledge through research, at diffusing it through education and at applying it through innovation'*.

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 [3] was the motivation behind the establishment of the USAEE-TN project. It defined Agricultural Engineering 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.). 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 science 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 short, whereas Agricultural Engineering applies Engineering sciences to agricultural applications, Biosystems 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 biomaterials, 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 outputs of the USAEE-TN [4-11] provided already evidence and identified new areas of the emerging Biosystems Engineering University studies in which coordinated work at European level is urgently needed. These developments prove that now, more than ever, there is a an urgent need for coordinated work at a European level towards a further systematic and harmonised restructuring of these programs of studies and of a parallel gradual transition from the classical Agricultural Engineering University studies to the emerging area of the Biosystems Engineering, in exploitation of the USAEE-TN results. This need is also justified from:

- An analogous transition of the Agricultural Engineering programs of studies and of the relevant professional activities now in progress world-wide (e.g. already established in USA and Canada; [12-13]) and
- The decision of the European Commission to support financially a two-year EU/USA project under "ATLANTIS (Actions for Transatlantic Links and Academic Networks for Training and Integrated Studies)" entitled "Policy Oriented Measures in Support of establishing common policies regarding the Evolving Biosystems Engineering Studies in USA – EU (POMSEBES)"

In fact, the major international political priority relevant to BE 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. It regarded the change of the Societies' name which was considered as a major issue. At that time it had become evident that traditional Agricultural Engineering curricula experienced a marked decline in students. Prospective students from rural backgrounds entering Universities to prepare themselves for jobs in agricultural related industries were largely replaced by students from urban areas. These students were interested in the interface of biology and engineering rather than agriculture and engineering, therefore defined their interest as Biological Engineering. Hence efforts evolved to move from the application-based Agricultural Engineering to the science-based Biological Engineering programs in which Agricultural Engineering would be included. Since then most Agricultural Engineering Departments in USA and Canada have added a 'bio' modifier term (i.e. Bio-systems, Bio-logical, Bio-resources, Bio-engineering, etc.) in their titles and aligned their academic programs with the biology-based curriculum (without neglecting agricultural engineering). The name and curriculum changes have led to increased enrolments in most cases. As a result in 2005 ASAE and CSAE decided to change their name to American Society of Agricultural and Biological Engineers (ASABE) and Canadian Society for Bioengineering (CSBE), respectively.

Based on the above, the new Thematic Network on Education and Research in Biosystems Engineering in Europe (ERABEE-TN) was established. It will be built-upon and further develop the outputs of the USAEE-TN by further 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.

3. AIMS AND OBJECTIVES

The new thematic Network ERABEE-TN aims at the exploitation and expansion of the significant work already carried out in the framework of USAEE-TN. More specifically it aims to:

- Develop the 3rd cycle programs of studies in Biosystems Engineering
- Incorporate the Quality Assessment and Assurance Frameworks of European programs of studies in Biosystems Engineering into the European Engineering Quality Assessment scheme
- Integrate the Accreditation of European programs of studies in Biosystems Engineering into the European Engineering labelling scheme
- Establish an international attractiveness of European programs of studies in Biosystems Engineering
- Develop European degrees of studies (e.g. European doctorate) in the field of Biosystems Engineering
- Expand Biosystems Engineering programs of studies to include the emerging areas of bio-fuels and biomaterials along with products quality as related to the new CAP developments

Also, among the objectives set are to:

- Promote synergies between Education and Research, namely promote the structured 3rd cycle programs of studies and establish linkage between education and research at all three cycles
- Support activities in the field of Accreditation and Quality Assurance, namely develop advanced European degrees of studies (e.g. European doctorate) and enhance accreditation and quality assessment and assurance frameworks integrating the Thematic Network activities to the corresponding major developments on the European accreditation and labelling of European Engineering studies (EUR-ACE-IMPLEMENTATION)
- Define and upgrading Generic and Sectoral Competences, namely implement TUNING Template
- Establish international attractiveness of European programs of studies in Biosystems Engineering
- Expand the Biosystems Engineering programs of studies to include emerging areas such as bio-fuels, biomaterials, useful waste, etc. as related to the new CAP developments and the European knowledge based bio-economy framework
- Reinforce the link between Education in the emerging field of Biosystems Engineering and society introducing the new developments to the non-academic community and the public

These aims and objectives will be tackled by the ERABEE-TN with well-coordinated networking activities and the development of synergies and schemes of cooperation so as to strengthen the interaction between all relevant stakeholders, academic and non-academic in Europe and internationally.

4. THE EUROPEAN CHALLENGE OF THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

Biosystems Engineering is the more biology-based evolution of Agricultural Engineering and applies to all living organism systems with the exception of human ones. It integrates engineering science and design with applied biological, environmental and agricultural sciences and can be defined as *“the branch of engineering that prepares students to apply engineering to solve problems in biological systems”*. In the context of this evolution, Biosystems Engineering should exclude Biomedical Engineering, Bioengineering and Biotechnology [14].

Employment opportunities are currently available in areas (i.e. discipline of Agricultural Engineering) such as providing services in building analysis, design and construction (i.e. livestock structures, greenhouses, storage structures, etc.), facility planning, and manure management, offer of expertise to the power and machinery industry, conservation of water and soil resources, develop plants and equipment for post-harvest treatment and food processing, propose planning of rural land and green areas, restoration and reuse of historical rural buildings, environmental impact assessment, safety and health at work, investigation of accidents, design and evaluation of new products.

In the future 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 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).

The major areas of expertise of Biosystems Engineering are the following [14]: (1) Biological Engineering, (2) Natural Resources/Soil & Water, (3) Machine and Power Systems, (4) Information & Electrical Technologies, (5) Structures & Environment / Controlled Environment, (6) Aquacultural Engineering, (7) Bioprocess Engineering, (8) Environmental Quality and (9) Energy Systems Engineering.

The aforementioned areas of expertise must be based on core and mid-level competencies. Core competences refer to the core Engineering and Agricultural/Biological part of the Biosystems Engineering curriculum, whereas mid-level competences refer to the optional specialisation of the core curriculum. Mid-level competences are extended and completed with applied courses on specialised areas of expertise over the 2nd cycle programme of studies (or during the last two years of the integrated programmes of studies).

Research needs and/or opportunities concerning Biosystems Engineering are related, among others, to areas such as [14]: (1) Power and machinery and precision agriculture, (2) Information technology and the human interface, (3) Automation, mechatronics and emerging technologies, (4) Animal production technology, (5) Post harvest technology, (6) Soil and water, (7) Rural development, (8) Structures and environment and (9) Others (i.e. implementation of Life Cycle Assessment (LCA) in any process, reforestation operations, etc.)

The transition from the traditional field of Agricultural to that of Biosystems Engineering will directly affect programmes of study, student learning, information access and course advising. It will further be a significant contribution towards the harmonization of European Higher Education and possibly pave the way for analogous initiatives of other professional fields. It is expected that the project will also help Europe to catch-up with the corresponding developments already in an advanced stage in the USA and Canada. Finally, it will indirectly support industry seeking specialised experts to provide high level knowledge concerning specific subjects.

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