Emerging discipline of Biosystems Engineering in Europe

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Introduction - I

During the last decade, Agricultural Engineering University studies in Europe faced dramatic problems such as decrease of student enrolment, reduced prestige, declining funding, etc.

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

Introduction - II

Major inherent problems of Agricultural Engineering University studies in Europe

- Controversial definitions and boundaries of the relevant subjects of this Academic field
- Chaotic situation of the scope and contents of the relevant programs of study
- Significant confusion with respect to terminology and definitions of specialisation
- Undecided background of the programs of study of the highly interdisciplinary field of Agricultural Engineering

Introduction - III

✓ The dramatic situation within this field of studies
✓ The chaotic state in terms of programs content
   » motivated the establishment of USAEE-TN
   http://www.eurageng.eu - link USAEE-TN

The USAEE – TN was established with the endorsement and the support of the European Society of Agricultural Engineers (EurAgEng)

Objectives of USAEE - TN

- Define core curricula to be used as benchmarks for Agricultural Engineering studies in Europe
- Establish a benchmark core curriculum serving 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 in Europe

Objectives of USAEE - TN

- 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
Outputs of USAEE - TN

Proceedings of eight Workshops concerning issues on:

- Studies in Agricultural Engineering
- Research in Agricultural Engineering
- ECTS
- Agricultural Sciences core curricula
- Accreditation procedures
- Programmes of studies meeting the FEANI and EurAgEng criteria
- Employability
- Quality assurance and assessment

ECTS: European Credit Transfer System (eq. to 25-30 h of student workload)
FEANI: European Federation of National Engineering Associations

USAEE - TN 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.).

Evolution of Agricultural Engineering to Biosystems Engineering

Moreover, 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.)

Evolution of Agricultural Engineering to Biosystems Engineering

Agricultural Engineering in Europe gradually evolves into the emerging field of Biosystems Engineering

Evolution of Biosystems Engineering in Europe - I

FACTS:

- The establishment of traditional Agricultural Engineering programs of studies in Europe lags very much behind the corresponding developments in the US
- There is a rather slow evolution of the emerging discipline of Biosystems Engineering over the last years in Europe

Evolution of Biosystems Engineering in Europe - II

- Very few viable Biosystems Engineering programs currently exist throughout Europe
- Those initiated are at a primitive stage of development, in contrast to the American educational system that has been undergoing dramatic changes over the past decade.
Evolution of Biosystems Engineering in Europe - III

Critical needs:
- To enhance the modulation and compatibility among the new programs of Biosystems Engineering
- To support their recognition and accreditation at the European and International levels
- To facilitate greater mobility of skilled personnel, researchers and students

Evolution of Biosystems Engineering in Europe - IV

Two characteristic examples illustrate the emerging developments

KU Leuven – Belgium
- Currently, the focus of the courses has been shifting
- Whereas the more classical Agricultural Engineering courses are still taught, there are trends such as:
  - Studying the biological processes of the living organism instead of the technical environment around the living organisms
  - Studying the cellular level instead of the systems on an ecosystem level

Evolution of Biosystems Engineering in Europe - V

KU Leuven investigates the potential of introducing a new module in the curriculum of Biosystems/Biological Engineering encompassing these multi-scale modelling concepts

Evolution of Biosystems Engineering in Europe - VI

University College Dublin - Ireland
According to the vision of this program, "Biosystems Engineering is the industry of the 21st century, revolutionising the production, processing and manufacture of biological materials through new engineering technologies".

The overall objective of this program is to equip the graduates with the analytical skills necessary for them to develop successful professional careers within the bio-resource and related industries both at home and abroad.

Biosystems Engineering Definitions in Europe - I

In France two definitions of the term Biosystems Engineering are distinguished.

The 1st definition concerns Biotechnology and Biochemistry (from the cell to the process) where several applications are under development:
- Bio-refining, extractions from cereals, flex fuel production and biomass valorisation, green crus.
- Biosystems Engineering, from cell to process in food processing, pharmaceutical and cosmetics
- Bio-production: the plant factory concept, target crops, cell cultivation (for vaccine and therapy, cell therapy)

Biosystems Engineering Definitions in Europe - II

The 2nd definition concerns larger scales of study in Biological and Agricultural Sciences from cells to crops and post/harvest processing.

This way all disciplines of Agricultural Engineering are involved to understand and control Biosystems (in this last case a Biosystem is analogous to a mechanical system; use of functional analysis):
- Function of Production: system modelling, applied mechanics, CAD, hydraulics, electrotechnics, applied thermodynamics, etc.
- Function of Information: traceability of crop, electronics, sensors, automation and control, computer sciences, image analysis, etc.
Biosystems Engineering Definitions in Europe - III

According to the Italian colleagues:
Biosystems Engineering is 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. plant and animal production, agricultural, forestry and food machines, post harvest technology, process engineering, ergonomics and safety, safe food production)
- 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).

Biosystems Engineering Definitions in Europe - IV

In Germany, Biosystems Engineering does not have an unambiguous definition.

There are two types of relevant programs of studies:
- Mechanical Engineering Departments where Biosystems Engineering mostly refer to Agricultural Machinery and Food/Process Engineering
- Departments of relevant disciplines (i.e. Horticultural Engineering) where subjects such as Process Engineering in Horticulture, Automation and Bio-Dedicated Plant Cultivation, Application and Evaluation of Environmentally Sound Production Processes in Plant Cultivation are taught.

Biosystems Engineering Definitions in Europe - V

There are also organisations (FAL) with institutes where research is undertaken, among others, on subjects such as: Advanced ploughing system, Precision irrigation, Animal identification and livestock control, Improvement of stable air quality for animals and human beings.

However,
- ASIN does not accredit Biosystems Engineering study programs as such.
- Instead, there are subject specific criteria for accrediting “Process and Biological Engineering” BSc and MSc degree programs.

Biosystems Engineering Definitions in Europe - VI

During 2007 in Spain three new degrees were proposed:
- Agricultural Engineering
- Agri-food Engineering
- Forestry and Nature Engineering

Obviously traditional names persisted with no options for Biosystems Engineering or even Biological Engineering.

As of today, Biosystems Engineering has only been established as 2nd and 3rd cycle studies at the University of Leon and as 2nd cycle studies at the Polytechnic University of Cataluña.

The Three Cycle System

European Higher Education Area (EHEA)

Bologna, 1999
1st Cycle (undergraduate – first cycle degree e.g. BSc; 3-4 years)

2nd Cycle (graduate – second cycle degree e.g. MSc; 1-2 years)

Berlin, 2003
3rd Cycle (doctorate – third cycle degree: PhD; 3 years)

School 1st Cycle 2nd Cycle 3rd Cycle Continuing Education

Biosystems Engineering Definitions in Europe - VII

In Greece, Biosystems Engineering is defined as: “An evolving science-based engineering discipline that integrates engineering science and design with applied biological, environmental and agricultural sciences”.

During a workshop at the Agricultural University of Athens (AUA), the discipline of Biosystems Engineering was described as: “... the branch of engineering that prepares students to apply engineering to solve problems in biological systems”.

EurAgEng has changed since 2002 the title of its official Journal from Journal of Agricultural Engineering Research into Biosystems Engineering.

According to the Biosystems Engineering Journal: 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.

Biosystems Engineering in Europe – ERABEE TN

It is built-upon and further develops the outputs of the USAEE - TN by:

- Further restructuring the Agricultural/Biosystems Engineering programs of studies in terms of expanding the application areas of the modules already defined in the USAEE - TN approved core curriculum
- 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.

To catch-up with the international developments, given the European confusing situation, the Thematic Network for Education and Research in Biosystems Engineering or Agricultural and Biological Engineering in Europe (ERABEE-TN; http://www.erabee.aua.gr/index.htm) has been established as a follow-up project of the USAEE - TN project.

ERABEE - TN Objectives

- Encourage synergies and establish links between Education and Research at all three cycles
- Promote the structured 3rd cycle programs of studies
- Develop advanced European degrees of studies (e.g. European doctorate)
ERABEE - TN Objectives

- Integrate Biosystems Engineering to the corresponding developments on the European accreditation and labeling of European Engineering studies (EUR-ACE Label)
- 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, bio-based materials, quality of products

European Definition of Biosystems Engineering

During the 3rd ERABEE Workshop (Uppsala, May 2009) the following definition was adopted:

- Biosystems Engineering is a field of engineering which integrates engineering science and design with applied biological, environmental and agricultural sciences.
- It represents an evolution of the Agricultural Engineering discipline applied to all living organisms not including biomedical applications.
- Therefore, Biosystems Engineering is "the branch of engineering that applies engineering sciences to solve problems involving biological systems".

Conclusions

Biosystems Engineering, in Europe

- Focuses on applying Engineering principles to biological systems except for humans to avoid conflicts and confusion of professional competences with the discipline of Biomedical Engineering
- Does not simply include scattered courses from Biotechnology or Biology creating conflicts and confusion of professional competences with the well established non-Engineering discipline of Biotechnology
- Is founded on a broader basis of biological sciences through replacing agricultural application oriented courses with selected fundamental biological systems/agricultural sciences subjects
- Retains Agricultural Engineering as the main component of the program of studies with a clear and strong Engineering core curriculum (USAEE/FEANI)

Thank you for your attention!