Towards a European Standard for Agricultural Engineering Curricula

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Contents

Preface

This work is based on the vision of a closer integration of the agricultural engineering education in Europe. The vision is, that one day, European universities will collaborate in a network, where the basic, agricultural engineering curricula are agreed on, and all courses within the network mutually accepted. The implication of this is, that an agricultural engineering degree from one university can be accepted throughout Europe, if it is based on the common curriculum. This will improve the potential for mobility of agricultural engineers within the region, and contribute significantly to local developments of specialisation. Agricultural engineering students will be able to compose their study by electing courses, offered by all the participating universities. Individual universities can focus on one specialisation area, knowing that subjects, not covered by one university will be the strong point of another, and universities can collaborate on setting up special study programs, exchanging teachers and students.

The first step towards this was taken in June 2000, when Pierluigi Febo and Da-Wen Sun presented an overview of the university structure and curricula on agricultural engineering in 36 countries. Here, information on the different study programs were collected and presented.

The next step is the present report, which outlines the basis for four European core curricula, and proposes an accreditation system. Further, a basic network of universities, offering degrees in agricultural engineering has been identified, in order to spearhead the implementation of the system.

September 2001
Bent S. Bennedsen
President of the European Society of Agricultural Engineers

1. Introduction

Agricultural engineering is under-going rapid changes as a result of the technological innovation.

Many universities now use new terms related to agricultural engineering, in order to cover the demands of the society. The traditional term of agricultural engineering is now substituted by the term "bio-engineering" or "resource systems engineering", while more and more universities include new courses in their curricula regarding environmental engineering.

Furthermore, new and expanding areas like technologies for the management of variability (including the use of GIS and GPS for positioning), system analysis of technical-biological systems, natural resources technology (including environmental production technology), and farm building construction in relation to animal health and welfare are also proposing new courses and some times totally new departments to be included in the traditional universities of agricultural engineering.

One of the main objectives of this project is to identify the new trends within Agricultural Engineering, and suggest ways in which to incorporate these in the Agricultural Engineering curricula.

1.1 Terminology[1] related to agricultural engineering

Agricultural engineering is the application of science and technology in agriculture, food and biological systems, for the benefit of humans. Its activities include: research, development, education, training, standardisation, extension and consultancy services (CIGR).

Agricultural engineering is the branch of the engineering profession that applies engineering principles, techniques and technology to the needs of agriculture and land, water and air resources.

Food engineering involves the application of engineering principles to the processing, packaging, storage and distribution of food products. In other words, knowledge of chemical, microbiological and biophysical characteristics of foods is combined with engineering and computer technologies to develop systems that produce quality and healthful food products for human consumption.

Horticultural engineering (or phytomation engineering) is concerned with controlled environment plant production systems including greenhouse design, micropropagation facilities, bioregenerative life support for space expeditions, robotics and automation. In other words, it combines plant science and biotechnology with engineering sciences and design.

Environmental engineering refers to the management and protection of natural and human environment. In other words, an environmental engineer is concerned with the investigation and solution of the environmental problems caused by human intervention.

Or

[1] *Sources: Agricultural engineering departments throughout the world (* ***Internet*** *program studies)*

Bio-environmental engineering *is concerned with maintaining the quality of the environment. It applies the physical, biological and environmental sciences to the design of solutions for environmental problems.*

Biological Engineering combines the science and art of engineering with the science of biology for the purpose of designing systems to influence, control, or utilize biological materials and organisms for the benefit of society.

or

Bio-systems engineering *emphasizes the application of engineering principles to the solution of problems associated with biologically based systems including agriculture, food and biomass production.*

Civil engineering deals with the design, the construction and the management of engineering structures such as bridge, buildings, dams, highways, airports, water supply and waste treatment systems.

1.2 Agricultural Engineering Studies in Europe

In the current Agricultural engineering curricula in Europe, the following four schemes are mainly used (See ANNEX 1).

- Universities offering diplomas in Agricultural Engineering with undergraduate studies of 5-6 years
- Universities offering studies/degrees in Agriculture with specialisation in Agricultural Engineering with undergraduate studies of 5-6 years.
- Polytechnics-Universities offering a 3-years (or 4.5 years maximum) undergraduate program, of basically technological applied studies, leading to a 3(4.5-) years BEng or Technical degree in Agricultural Engineering.
- Polytechnics-Universities offering a 3 (or 4 years maximum) undergraduate program of applied studies in Agriculture with specialisation in Agricultural Engineering or technology, leading to a 3-years BS in Agriculture.

Furthermore, there are courses and specialisations related to Agricultural Engineering, offered by other Engineering departments like Mechanical or Civil Engineering departments.

As far as the load of hours (lectures, seminars, laboratory exercises) is concerned the following points are noticed:

- A three-year curriculum requires usually a total load of 2400-2600 hours, which may include approximately 250 hours of farm/industry training and 250 hours for a short thesis or project
- A four-year curriculum requires usually a total load of about 3400-3600 hours which may include approximately 400 hours for farm/industry training and 600 hours for a thesis or project
- A five-year curriculum requires usually a total load of 4300-4600 hours, which may include approximately 500hours for farm/industry training and 800 hours for a

thesis or project. In some countries, this load corresponds to a Master's degree while in others, a Master's degree follows the five year program which leads to a diploma.

In several cases studied earlier (refer to the report of CIGR/EurAgEng), the academic system is broken down into three levels:

- First-level degree (Bachelor's, title of specialized agricultural operator) obtained after two or, more frequently, three/four years of study
- Second-level degree (Master's, title of Engineer in agronomy or, more simply agronomist) obtained after another two or three years
- Third-level degree (PhD, title of doctor) obtained after another 2-4 years of research activity with the presentation and, often the defense of an original thesis.

In other cases, the first level degree (Diploma in Agricultural Engineering offered by relevant Departments of Agricultural Engineering or Diploma in Agriculture with Agricultural Engineering specialization offered by faculties of Agriculture) is obtained after 5-6 years. The next level may be a Master's degree obtained usually in one or two additional years and then a third level corresponds to a PhD usually obtained in 2-4 additional years. There are cases where the MS level is not required towards the PhD level.

In the case of the BS-MS degrees system, the length of a degree course (1^{st} plus 2^{nd} level) varies from 4 to 6 years. Therefore, if a student begins university at the age of 19 he may receive a 2^{nd} level degree at the end his 24^{th} year and a doctorate when he is 27-28.

In cases of 5-years programs, followed by master's degree the length of a degree course (1^{st} plus 2^{nd} level) varies from 6 to 8 years.

In many countries, however these time periods are more theoretical than actual. In fact, the information gathered shows that fewer than 20% of enrolled students graduate in five years and that another 20% graduate in more than seven years.

For more details refer to "The University structure and curricula on agricultural engineering" – a publication jointly produced by the International Commission of Agricultural Engineering, the European Society of Agricultural Engineers and the Food and Agriculture Organization of the United Nations in 2000- and to " A study of University curricula in Agricultural Engineering", Agricultural University of Athens, 1999; a survey in Greek.

In ANNEX III the taught courses are classified into two categories (Basic courses: General, Technical, Agricultural Sciences and Agricultural Engineering courses) and they are presented versus the percentage of the universities teaching them, in the relative histograms.

2. Trends in Agricultural Engineering Studies in Europe

2.1 New study programmes

The challenge facing universities is to train agricultural engineers to meet the demands of the future agriculture. Many universities are in the process of modifying their studies to adapt to the new trends in agricultural engineering, and in order to recruit students in a world where classical agricultural engineering is less appealing to young students. Some common trends in this development can be identified:

- Development of independent programs of study, starting from the first year. The titles offered reflect the contents of the corresponding programs of study.
- Modern engineering courses replacing traditional courses of practical orientation
- The new course programmes are multidisciplinary i.e. discipline oriented rather than object oriented.
- Course programmes allow for specialisation e.g. in different areas of engineering, combined with different specialisations within agricultural science

The following, illustrative example reflects the current restructuring processes going on in most agricultural engineering departments within Europe. The example is mainly based on a new (2001) course programme for engineering students in bio-systems engineering, kindly provided by KU-Leuven.

The discipline comprises competence in engineering and biological sciences, including:

Classical engineering courses:

- engineering mechanics, electronics
- process technology, transport processes, unit operations, bio-environment conditioning (storage rooms, greenhouses, farm buildings, …)
- strenght of materials, structural analysis
- system analysis, design and classical control of technical systems

Modern engineering courses :

- information technology
- Mechatronics: sensor technology (including biosensors), actuation, micro mechanics, robotics, system theory and modern control engineering (identification, optimal control, model predictive and robust control,…)

- data handling and processing (statistical, fuzzy, neural networks, etc.), signal analysis (FFT, wavelets, …), image analysis and processing,
- numerical techniques in transport processes

Knowledge of biological processes and systems (humans, animals, plants) and their interaction with their physical environment:

- physiology, anatomy, bio-mechanics
- physical properties of agricultural products
- ergonomy, human and animal health and comfort

2.2 Expected skills or competence of graduated biosystems engineers :

Quantitative knowledge of (bio)(physical) processes with respect to

- plant- and animal production (primary production, food and process industry, waste treatment)
- human actors (consumers and operators)
- environmental conservation etc.

Quantitative knowledge of the interactions of these processes with the (technical) environment (machines, construction, fluids) in which they take place (transformation processes)

Quantitative knowledge and skillness (analysis, design, control) of technical systems and operations in these processes

System thinking about problems in agro-technological processes:

- holistic approach of the problem with insight in the different sub-processes that take place and their interactions
- technical description of the sub-processes such that a solution can be derived
- Insight in the techniques and technologies that can lead to an acceptable solution (process control)

General:

- reporting
- Interpretation of research results
- Stimulus for self-study
- Initiating of projects
- Diagnosis of problems
- Capacity for defining solutions for problems
- Multidisciplinary team work
- Specialisation
- Internationalisation

- Innovative thinking

2.3 Some new application areas for bio-systems engineers :

- Processing and transformation of agro-products (e.g. food industry), quality control
- Supplyers for the bio-and agro-process industry
- Waste treatment sector
- IT

3. Benchmarks for four basic European core curricula in Agricultural Engineering.

3.1 Basic framework

The basic goal in this section is to set a framework for developing some basic core curricula in Agricultural Engineering. The establishment of a benchmark serves the purpose of determining a set of 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.

The benchmarks for basic European core curricula in Agricultural Engineering are based on the following requirements:

1. It must meet the FEANI criteria for being an Engineering program of studies.
2. It must meet the EurAgEng demands for 'Agricultural Science' core curricula requirements in Agricultural Engineering.
3. Four different benchmarks will be developed corresponding to the two distinct types of engineering curricula offered (refer to SEFI), one more scientifically oriented and one more application-oriented. The corresponding Master's degrees following these two distinct curricula will make a total of four different benchmarks for the four distinct programs of studies.

The three requirements are presented in more detail in the following.

3.2 FEANI criteria

Principles and structure of the educational and professional systems in Europe vary considerably. Their value is judged by FEANI according to the potential competence of the engineer who emerges from them.

The qualification of the engineer requires an approved engineering education following an appropriate secondary education. But full professional competence is only reached after gaining valid professional experience.

After a **secondary education** at a high level validated by one or more official certificates, normally awarded at about the age of 18 years, a minimum total period of **seven years' formation** - education, training and experience -is required by FEANI for the EUR ING designation. This formation consists of:

Minimum three years of **engineering education** given by a university (U) or other recognized body at university level, admitted by FEANI (see FEANI Index).

A distinguish is made however, between short and long cycles according to the requirements of SEFI.

Minimum two years of valid **professional experience** (E).

In case the education and experience together is less than the minimum seven years' formation required, the balance to seven years should be covered by education (U), experience (E), or training (T) monitored by the approved engineering institutions, or by preliminary engineering professional experience.

In addition to these formation requirements, EUR ING are required to comply with the **FEANI Code of Conduct** (see **"Guide"**).

3.3 Agricultural Science requirements

The agricultural science core curricula concerns the understanding of the diversity, dynamics, actions and reactions of biological materials and living organisms with the purpose of applying engineering principles to the solution of problems associated with biologically based systems including agriculture, food and biomass production.

Courses aimed at meeting the agricultural science requirements should not represent a loose selection of various subjects, but should combine to a systematic synthesis within basic agricultural sciences.

The content of these courses should be designed for use along with the engineering curriculum, in order to support technical aspects of agriculture.

The following examples shows subjects to be included in the agricultural science core curricula. They also demonstrates how the formation works from an understanding of the basic science to an overall understanding of biological production within the subject.

- Plant science:

  Plant physiology, plant morphology, microbiology, soil science and plant nutrition, crop production...

- Animal science:

  Animal physiology, animal feeding, animal husbandry...

- Environmental science:

  Environmental microbiology, Biochemistry, Ecology...

In order to meet the requirements, students will accumulate about 70 ETCS on agricultural science subjects during a three year Bachelor study, and a total of 120 ETCS during a Master study. It is highly recommended that formation provides situations, e.g. projects, where agricultural science and engineering are combined.

3.4 Further development of benchmarks and accreditation system

In order to translate these, rather soft requirements into quantitative templates for use in accreditation of Agricultural Engineering studies, the following steps are suggested:

1) To set up a working group comprising the pertinent expertise and working with FEANI on specifying quantitative requirements for Agricultural Engineers.
2) To form a working group, comprising the pertinent expertise, with the task of quantifying the requirements for the agricultural science part of the education.
3) To establish an accreditation committee (under the EurAgEng) for future accreditation of Agricultural Engineering studies. This committee can/should be identical to the working group suggested under item 2.
4) To establish a database of courses, or groups of courses, their content and ECTS-value, in order to facilitate evaluation in connection with accreditation, and to provide a better basis for student mobility.

4 Current trends in European Engineering Education.

4.1 The Bologna Declaration and European Engineering Education

The European Society for Engineering Education (SEFI) announced officially SEFI's opinion on the joint declaration of the European Ministers of Education, signed in Bologna, on 4th December 2000, in Brussels. In short, SEFI welcomes the important initiative taken by the European ministers of Education in signing the Joint Declaration in Bologna in June 1999. SEFI strongly supports the idea of the creation of a European Higher Education Area.

However, SEFI has offered also important general comments, which are quite important for the scope of the present project and as such, they are included in Annex 3. A part of those comments pertaining specifically to Engineering Education today in Europe, being of special interest also for Agricultural Engineering education (within the framework of European Engineering Education) is quoted in the following:

"…
The Ministers also commit themselves to the adoption of an education system based on two main cycles, where the first cycle shall in itself be relevant to the labour market and where the second should lead to a Master's degree.

The introduction of a larger number of Master's degree programmes, building on Bachelor's degrees, will no doubt make European Engineering Education more attractive for non-European students, especially if the programmes are run entirely or partly in

English. It will also facilitate student mobility within Europe. SEFI therefore welcomes a large-scale introduction of separate 1-2 year Master's Programmes in Engineering.

The particular conditions and circumstances of Engineering Education must, however, be taken into consideration. It is often said that the educational systems across Europe are very different. This may be true in some fields but in Engineering Education the systems are already similar in many respects. There are many reasons behind this. One reason is the international character of the engineering profession. Another is the influence that the classical 19th century German technical university has had in the past as a model for other countries, particularly in Northern, Eastern and Central Europe. SEFI and other organisations have also contributed to a convergence of ideas.

In many European countries, two distinct types of engineering curricula are offered, one more scientifically oriented and one more application-oriented. Both of these have been developed to respond to the particular needs of industry and graduates of both types of curricula are well received by the job market.

There is today a high degree of consensus that the professional engineering degree should take about five years following secondary school. *An exception has always been the United Kingdom, which has traditionally accepted the three-year honours degree as an adequate university education for the professional engineer, but its system of separate professional recognition adds further years of practical training to the qualification requirements. Recently, Britain has moved in the direction of its European partners by making the four-year MEng degree the minimum academic requirement for professional recognition as a Chartered Engineer.*

Most European countries also have various forms of shorter Engineering Education. The length and character of these curricula may vary slightly from country to country but they have normally two factors in common; they are more vocationally oriented, or application-oriented, than the longer programmes and, although bridges normally exist, they are not primarily designed as a first part of a two-tier system. Graduates of these programmes play an important role, particularly in small and medium-sized enterprises.

SEFI is convinced that this existing European system for Engineering Education has much merit, that the system is quite compatible with the vision of a European Higher Education Area and that it should not be sacrificed. The cultural diversity of Europe is also a source of richness and changes in the architecture of Engineering Education must not be allowed to destroy this richness.

This does not, of course, exclude the creation of a two-tier Bachelor/Master system also in Engineering Education, whenever this is judged appropriate. The Master's degree should, in such cases, be equivalent to the existing 5-year degrees.

It is also essential that changes in the organisation of engineering studies take into account the ongoing evolution in the transfer of knowledge and the emergence of virtual universities, flexible learning and distance education.

…."

4.2 The crucial points

At this point it is interesting to quote some important concerns raised by the president of SEFI (Prof. Torbjom Hedberg; EE Topics and Milestone Documents)

In the first part of his presentation, he emphasises the positive aspects of the Bologna declaration. Among them (the selected points presented here were quoted from (SEFI; EE Topics and Milestone Documents)):

"…….

- *"mobility", "transparency", "compatibility" and "comparability".*
- *Words like "harmonisation" and "convergence" are not used in the declaration itself but they appear in background documents.*
- *A special emphasis is put on the international competitiveness of European higher education.*
- *Adoption of a system of easily readable and comparable degrees, also through the implementation of the Diploma Supplement, in order to promote European citizens' employability and the international competitiveness of the European higher education system.*
- *Establishment of the system of credits – such as ECTS system – as a proper means of promoting the most widespread student mobility.*
- *Promotion of European co-operation in quality assurance with a view to develop comparable criteria and methodologies*

Promotion of the necessary European dimension in higher education, particularly with regards to curricular development inter-institutional co-operation, mobility schemes and integrated programmes of study, training and research…"

The crucial point according to the president of SEFI is the:

•**Adoption of a system essentially based on two main cycles, undergraduate and graduate.**

The concerns expressed on this point are given below (quoted from SEFI; EE Topics and Milestone Documents):

"…..

Concern no. 1.

•The special conditions for Engineering Education are not considered.

•Engineering education is very large and important professional sector, like for instance medical education

•We already have a model for Engineering Education which is compatible with the idea of a "European Area of Higher Education".

•The integrated European 5-year curricula are quite well-established.

••Create 1-2 year Master's programmes in English, (or French and Spanish)

Concern no. 2.

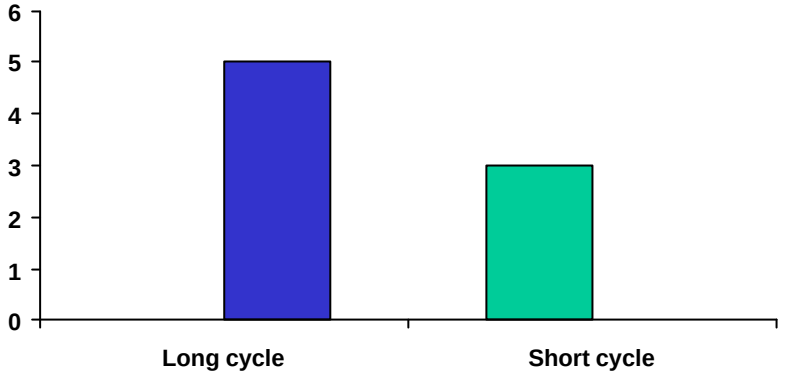
•Must we import a US model?

••*Is there any "Anglo-Saxon" two-tier model?*

••*No, the main North American Engineering Education Degree is a Bachelor's degree.*

Concern no. 3.

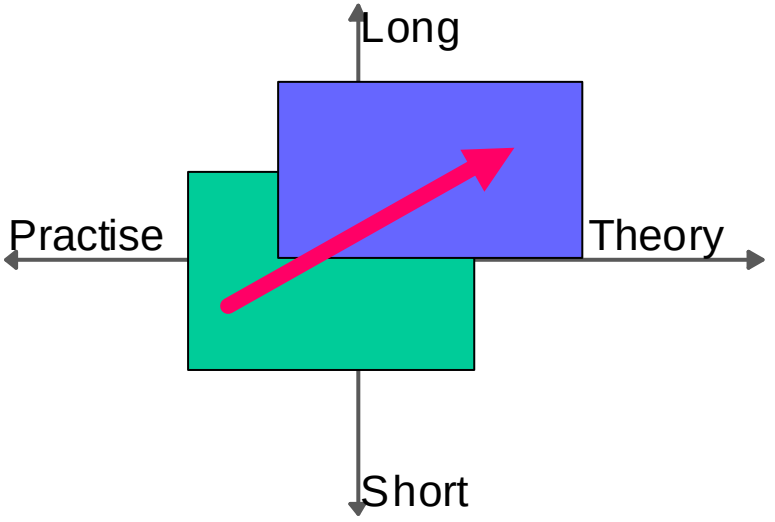
Currently, there are two types of programmes for Engineering Education in Europe:



(

SEFI; EE Topics and Milestone Documents)

What happens to the shorter and application-oriented engineering education?



(SEFI; EE Topics and Milestone Documents)…"

The answer given schematically in the presentation of Prof. Torbjom Hedberg suggests coexistence of the two cycles, with two parallel and complementary missions. The academic drift shown by the arrow points to the theory and long cycle programs.

4.3 Accreditation

Concerning the accreditation of Engineering programs, the president of SEFI presents some basic issues (quoted from his presentation; SEFI; EE Topics and Milestone Documents):

"Accreditation = a statement of accreditation body that, in the opinion of the body, a certain programme gives sufficient preparation for a career as a professional engineer.

An accreditation is preceded by a quality assessment.

The legal implications of an accreditation vary from country to country. The value depends of the position and authority of the accrediting agency

Well-established in France, UK and Ireland since the 30's

Now also in Germany, Portugal, Austria, many East and Central European countries.

Discussions going on in Holland, Italy,..."

What are the possible developments in Europe for accreditation of Engineering programs? The opinion of SEFI's president is characteristic:

"….

- *Nothing whatsoever happens.*
- *ABET takes over.*
- *Creation of an "EBET".*
- *A special EU directive.*
- *Self-appointed groups perform "self-accreditations".*
- *A European network of Accreditation Agencies*

However, an Embryo of a European Network, under the title:

ESOEPE - European Standing Observatory for the Engineering Profession and Education.

Has been created by:

the British Engineering Council, the Commission des Titres d'Ingénieur (France), the Akkreditierungsagentur für Studiengänge der Ingenieur-wissenschaften und der Informatik, ASII, (Germany), the Italian deans of Engineering, the Portuguese Ordem dos Engenheiros, SEFI, CESAER and BEST through E4, FEANI."

4.4 SEFI's view

The development of harmonised core curricula for Agricultural Engineering in Europe cannot proceed outside the framework of the European Engineering Education

organisational structure. It is therefore very important to understand the current positions of this structure. To this end, the outline of SEFI's view is given below, in terms of the conclusions of the presentation of the president of SEFI. Summarising his presentation, the president of SEFI presents some basic issues (quoted from his presentation; SEFI; EE Topics and Milestone Documents):

"….

- *SEFI welcomes the important initiative taken by the European ministers of Education in signing the Joint Declaration in Bologna in June last year;*
- *SEFI strongly supports the idea of the creation of a European Higher Education Area;*
- *SEFI shares the opinion of the Ministers concerning the need for a system of easily readable and comparable degrees, through a Diploma Supplement or otherwise;*
- *SEFI supports a wider use of the ECTS system as a proper means to promote student mobility;*
- *SEFI is convinced of the importance of increased mobility for students, teachers, researchers and administrative staff;*
- *SEFI is already committed to the idea of developing the European dimension in Education;*
- *SEFI shares the opinion of the European Ministers concerning the importance of European cooperation in quality assurance and accreditation;*

BUT

- *any reform of the structure of European Engineering Education must take the particular conditions of this field of education into account,*
- *the existing European integrated 5-year curricula in Engineering are compatible with the idea of a European Education area,*
- *the existing European system of longer integrated curricula leading straight to a Master's degree in Engineering should be maintained, possibly in parallel with a two tier Bachelor/Master system,*
- *the longer, as well as the shorter, more application-oriented, curricula correspond to a clear need and graduates from both types of programme have a good position on the job market,*
- *the specific qualities of the present, existing, application-oriented Engineering degrees should be recognised and safe-guarded,*
- *the creation of new 1-2 year Master's programmes in Engineering should be encouraged..".*

4.5 Declaration of Prague on May 19th 2001

The last Communiqué of the meeting of European Ministers in charge of Higher Education in Prague on May 19th 2001 (Annex 4) refers to a more flexible scheme for the Educational

programs of Higher Education in Europe (relaxing the fixed two-cycles scheme of Bologna's declaration). This development, being closer to the positions of FEANI/SEFI, is considered to be a positive development for Engineering Higher Education in Europe.

Thus,

"…Ministers called upon existing organisations and networks such as NARIC and ENIC to promote, at institutional, national and European level, simple, efficient and fair recognition reflecting the underlying diversity of qualifications.

….. Programmes leading to a degree may, and indeed should, have different orientations and various profiles in order to accommodate a diversity of individual, academic and labour market needs as concluded at the Helsinki seminar on bachelor level degrees (February 2001)….".

5. Teaching methods and subjects of special interest to Agricultural Engineering teaching and learning processes

Lectures is traditionally an important part of university teaching. However, students often leaves the lecture halls carrying much less actual information than was put into the lecture, and most subject related to agricultural engineering lends themselves readily to different, and more inspiring teaching methods. It is probably true, that at university level, we cannot "teach" students, but we can create situations in which they can acquire the knowledge skills and attitudes, which comprises their competence.

This document is an attempt to create a catalogue of ideas, which can inspire teachers to develop their teaching. Most of the items related to agricultural engineering are tangible, possesses a size which can be handled, and are normally readily available. Hence, a list of teaching methods is, in many cases, a matter of stating what is evident, or already part of the trend in university teaching.

There are plans of using the current list as a basis for an Internet based forum for exchange of experiences with different teaching methods.

- Using practicals in stead of lectures provide the students with the possibility for exploring the matter themselves. Practicals can be "supervised", in which case the result is given, as is the way to achieve it. In "Unsupervised" practicals, the objectives and procedures are defined by the students themselves. The levels from lectures to "unsupervised" practicals requires a decreasing degree of action from the teacher, but interestingly enough, an increasing amount of preparation.

- An increasing amount of the students arrive with no practical experience from agriculture. In these cases, a "hidden agenda" of familiarisation with farm equipment can be build into the practicals by e,g, requiring the student to hitch and adjust an implement before doing performance measurements on it.

- Problem based learning: A concept where the students work in groups and in relation to a given problem. The problems should be actual and relevant to practical farming/engineering, and encourage the students gather information about the subject. The students are, themselves responsible for defining learning objectives, gathering relevant information and disseminating it among the group members. The result of the work is a report, poster or presentation, where the students explain different aspects of the problem, and at the same time accounts for the knowledge, acquired through the process.

- Use of the Internet: Many of the descriptive parts of teaching are related to specifications and design of existing machinery and implements. This information is available from companies web-sites and on line databases, and can easily be retrieved by the students, without other interference from the teacher than an encouragement to go and search.

- Project oriented work involving engineering students and agronomy students. The idea is to combine the skills, knowledge and experiences of agronomy students and engineering students related to accomplishing a specific task.

- Project work in collaboration with companies.

- Exchange of students between universities in different countries. (Socrates programme)

- Distance learning: This is a rather new trend, not specific to agricultural engineering. There are currently very institutions with experiences from actual implementation but more universities are seeking to introduce the method. Hence, it has been decided to establish a database (Internet based) where experiences with distance learning can be exchanged.

ANNEX I:

Framework for further development of benchmarks

First two different benchmarks (i.e. two different benchmark levels) will be developed corresponding to the two distinct types of engineering curricula offered. Each benchmark must meet separately (as described by SEFI/FEANI) the demands (requirements/criteria) for:

a) a 5-years diploma degree: a more scientifically oriented type of agricultural engineering core curriculum.

b) a 3-years Bachelor degree, a more application-oriented type of agricultural engineering core curriculum.

The benchmark for the long term programs of studies (a) will set both, different and additional requirements/criteria towards 5-years degrees/diplomas as compared to the requirements for the short terms programs of studies (a) towards 3-years Bachelor degrees. Both benchmarks will be developed to respond to the particular needs of industry, respectively. The goal is that graduates of both types of curricula are well received (in a complementary way) by the job market (refer to SEFI).

Following the establishment of these benchmarks, two additional benchmarks will be established:

- the corresponding to the long term 5-years diploma degree, Master's degree.
- the corresponding to the short term 3-years Bachelor degree, Master's degree.

These benchmarks will set different requirements/criteria for MS degrees following 5-years programs of studies than those for MS degrees following 3-years BS degrees.

The two different basic benchmark levels for core curricula in Agricultural Engineering, as well as the corresponding benchmarks for the MS degrees, will be established in the course of a specific Erasmus thematic network project (to be proposed in due course) as follows:

c) The FEANI requirements will be set out in co-operation with FEANI and SEFI. A special working group should be formed for this purpose, possibly through the thematic network project. The working group will establish a regular co-operation with the corresponding working group of FEANI/SEFI to work out a draft for the corresponding core curricula requirements for the short and long term programs of studies in Agricultural Engineering to be admitted by FEANI as 'Engineering' curricula. The specific requirements for short and long cycles programs will be set in co-operation with SEFI's relevant working group.

d) The Agricultural Science core curricula requirements for the short and long term programs of studies in Agricultural Engineering will be defined by another working group, to be formed for this purpose, also through the proposed thematic network project. This working group can be a committee under the EurAgEng. After the completion of the Agricultural Science core curricula, the committee can continue its work as accreditation committee regarding the agricultural science accreditation (item "d" below) in contact with other relevant European bodies.

e) A compatible system of credits –ECTS system – will be established by the institutions which are admitted to offer Agricultural Engineering studies as a proper means of promoting the most widespread student mobility. Courses within the ECTS system will be defined to be compatible in terms of credits, titles and subjects covered.

f) An accreditation system, integrated into the accreditation system of the European Engineering programs of studies should be established. The Organisational structure of such a system will be set within the corresponding European bodies (e.g. a possible structure may include: ASII Board, Engineering Accreditation Committee EAC, expert Committee EC, Visiting teams, following the German scheme).

Perspectives for establishing the proposed benchmarks

The two different basic benchmark levels for core curricula in Agricultural Engineering, as well as the corresponding benchmarks for the MS degrees, may be established only if funding is available in the course of a specific Erasmus thematic network project to be proposed for this purpose. The Afanet project has set the framework for the development of the core curricula but funding is needed to create working groups to work out the corresponding tasks as described above. The proposal will be prepared and submitted under the next call for proposals:

SOCRATES GENERAL CALL FOR PROPOSALS 2002 (EAC 29/01) The Community action programme in the field of education Socrates (**closing date for certain actions is 1 November 2001**) Ref.: (2001/C 191/10) Published 2001-07-07

The proposal for this call is under preparation by the AUA.

ANNEX II

University faculties and departments offering diplomas in Agricultural Engineering.

Duration ≥5 years

AUSTRIA

University of Agricultural Sciences Vienna (5 years)

Department of Land & Water Management and Engineering

Degree in civil engineering and water management

BELGIUM

Gembloux Agricultural University (5 years)

Dept of Biosystems Engineering - MSc in Agricultural Engineering

Catholic University of Leuven (5 years)

Faculty of Agricultural and Applied Biological Sciences

Department of Agricultural Engineering – MSc in Agricultural Engineering

UCL (5 years)

Faculty of Agricultural Sciences

Unit of Bioengineering – MSc in Agricultural Engineering

ULB Free University of Brussels (5 years)

Faculty of Sciences – Agricultural Engineering Course

MSC in Agricultural Engineering

University of Ghent (5 years)

Faculty of Agricultural and Applied Biological Sciences

Department of Agricultural Engineering – Agricultural Engineering specialisation

Degree in Agricultural Engineering

CZECH REPUBLIC

Czech University Prague (5years)

Technical Faculty – Degree in Agricultural Engineering

DENMARK

Technical University of Denmark. (in collaboration with The Royal Veterinary and Agricultural University) (5 years)

Agricultural Engineering specialisation in selected engineering studies, such as Informatics, Electronic Engineering r Mechanical Engineering.

Degree in engineering

FRANCE

Lille(5 years)

Institut Agricole et Alimentaire de Lille

Degree in Agricultural Engineering (food engineering)

Montpellier (5-6 years)

Ecole National Supérieure Agronomique de Montpellier

Degree in Agricultural Engineering (horticultural engineering)

Montpellier (5 years)

Ecole National du Genie Rural des Eaux et des Forets (ENGREF)

Degree in Agricultural Engineering, Water and Forestry

University of Strasburg (5 years)

Ecole et Observatoire des Sciences de la Terre (EOST)

Degree in Engineering (environmental engineering)

Toulouse (5 years)

Ecole Nationale Supérieure Agronomique de Toulouse

Degree in Agricultural Engineering

Toulouse (5 years)

ENGREF

Degree in Agricultural Engineering, Water and Forestry

GREECE

Agricultural University of Athens (5 years)

Department of Land Reclamation and Agricultural Engineering

Degree in Agricultural Engneering (agronomist; 'geoponos')

Aristotle University of Thessaloniki (5 years)

Faculty of Geotechnical Sciences. **Department of hydraulics, soil science and Agricultural engineering**

Degree in hydraulics, soil science and Agricultural Engineering (agronomist; 'geoponos')

HUNGARY

Agricultural University of Gödöllö (5 years)

Faculty of Agricultural Engineering

Degree in Agricultural Engineering

NETHERLANDS

Agricultural University of Wageningen (5 years)

Faculty of Agricultu ral and Environmental Sciences

Degree in Agricultural Engineering

NORWAY

Agricultural University of Norway (5 years)

Department of Agricultural Engineering

Degree of civil engineer in agricultural engineering

PORTUGAL

Technical University of Lisbon (5 years)

Faculty of Agriculture (Agricultural, forestry, agro-industry engineering specialisations)

Degree in Agricultural Engineering (5 years)

University of Evora

Faculty of agriculture

Degree in Agricultural Engineering (5 years)

University of Tras - os - Montes e Alto Douro

Faculty of agriculture (Agricultural Production Engineering, Forestry Engineering, Animal Production Engineering)

Degree in each specialisation

University of Azores

Faculty of agriculture (Agricultural Production; Animal Production)

Degree in engineering (in each specialisation)

SPAIN

University of Almeria (5 years)

College: Escuela Politecnica Superior (Mechanization and Rural Constructions Agricultural and Cattle Farming; Agricultural and Food Industries Horticulture, Fruit Growing and Gardening)

Degree in Agricultural engineering

University of Castilla-La Mancha (5years)

College: Escuela T?cnica Superior de Ingenieros Agrsnomos

Degree in Agricultural engineering

University of Csrdoba (5years)

College: Escuela T?cnica Superior de Ingeneiros Agrsnomos y de Montes

Degree in Agricultural engineering

Polytechnic of Catalonya (Lleida) (5years)

College: Escuela T?cnica Superior de Ingenieria Agraria

Degree in Agricultural engineering

Polytechnic of Madrid (5 years)

College: Escuela T?cnica Superior de Ingenieros Agronomos

Degree in Agricultural engineering

University of Santiago de Compostela (Lugo) (5 years)

Escuela Politecnica Superior

Degree in Agricultural engineering

Polytechnic of Valencia (5 years)

College: Escuela T?cnica Superior de Ingenieros Agrsnomos (Rural Engineering specialisation)

Degree in Agricultural engineering

Duration = 5 years

GERMANY

Technical University of Berlin (4.5years)

Faculty of International Agricultural Development

Degree in Agricultural Engineering

Humboldt University of Berlin (4.5years)

Faculty of Agricultural and Gardening Sciences

Degree in Agricultural Engineering

University of Bonn (4 years)

Faculty of Agriculture

Degree in Agricultural Engineering

HUNGARY

Debrecen Agricultural University (3 years)

College of Agriculture, Hadmezövasarhely

Degree in Agricultural Engineering

IRELAND

University College Dublin (4 years)

Faculty of Engineering and Architecture

Degree in agricultural and food engineering

SPAIN

University of Almeria (3 years)

College: Escuela Politecnica Superior

Technical Degree in agricultural engineering

Polytechnic of Catalonya (Lleida) (3 years)

College: Escuela T?cnica Superior de Ingenieria Agraria

Technical Degree in agricultural engineering

UNITED KINGDOM

Harper Adams Agricultural College - Newport with Stafford University (3 years)

Department of Agricultural engineering (Food and environmental engineering specialisations)

Degree in Agricultural engineering

Writtle College with Middlesex Polytechnic (4 years)

Department of Mechanical engineering (agricultural engineering option)

BEng Honours in Mechanical Engineering

Silsoe College - Cranfield University (3 or 4 years)

Faculty of Agricultural Engineering, Food Production and Rural Land Use

BEng in Agricultural Engineering

Silsoe College - Cranfield University (3 or 4 years)

Faculty of Agricultural Engineering, Food Production and Rural Land Use

BEng in Rural Environment Engineering

Silsoe College - Cranfield University (4 years)

Faculty of Agricultural Engineering, Food Production and Rural Land Use

BEng in Agricultural Technology and Management

Universities/Faculties offering diplomas in Agriculture with specialisation in Agricultural Engineering.

Duration ≥5 years

DENMARK

Royal Veterinary and Agricultural University of Copenhagen (5 years)

Department of Agricultural Sciences – Technical specialisation in Agricultural Engineering

Degree in Agronomy

FINLAND

University of Helsinki (5 years)

Faculty of Agriculture and Forestry – Specialisation in Agricultural Engineering

Degree in Agronomy

GREECE

University of Thessary (5 years)

Department of Agricultural Sciences

Degree in Agronomy

ITALY

All Agricultural Universities (5 years)

Faculties of Agriculture (specialisation in agricultural engineering)

Degree in Agronomy

Duration = 5 years

HUNGARY

Pannon University of Agricultural Sciences (4 years)

Georgikon Faculty of Agriculture, Keszthely (engineering specialisation)

Degree in Agriculture

IRELAND

University College Dublin (4 years)

Faculty of General Agriculture (engineering technology specialisation)

Degree in agriculture

SWEDEN

Swedish University of Agricultural Sciences (4,5 years)

Faculty of Agriculture, Landscape Planning and Horticulture

MSc-programme with specialisation in Agricultural Engineering

MSc degree in Agriculture

Universities/Faculties offering diplomas in Engineering (agricultural engineering courses)

Duration ≥5 years

GERMANY

Technical University of Berlin (6 years)

Faculty of Machine Design and Production

Degree in engineering (agricultural engineering courses)

University of Braunschweig (5 years)

Faculty of Mechanical Engineering

Degree in Mechanical engineering (agricultural engineering courses)

University of Technology – Dresden (5 years)

Faculty of Mechanical Engineering

Degree in engineering (agricultural engineering courses)

GREECE

National Technical University of Athens (5 years)

Department of Rural and surveying engineering.

Degree in engineering (geography and regional planning courses; infrastructure and Agricultural development)

Demokritos University of Thrace (5 years)

Faculty of Engineering. **Department of Environmental Engineering**

Degree in Environmental Engineering

Technical University of Crete (5 years)

Department of Environmental Engineering – Divisions (Environmental Hydraulics & Environmental Engineering, Environmental Management, Environmental Process Design and Analysis)

Degree in Environmental engineering

HUNGARY

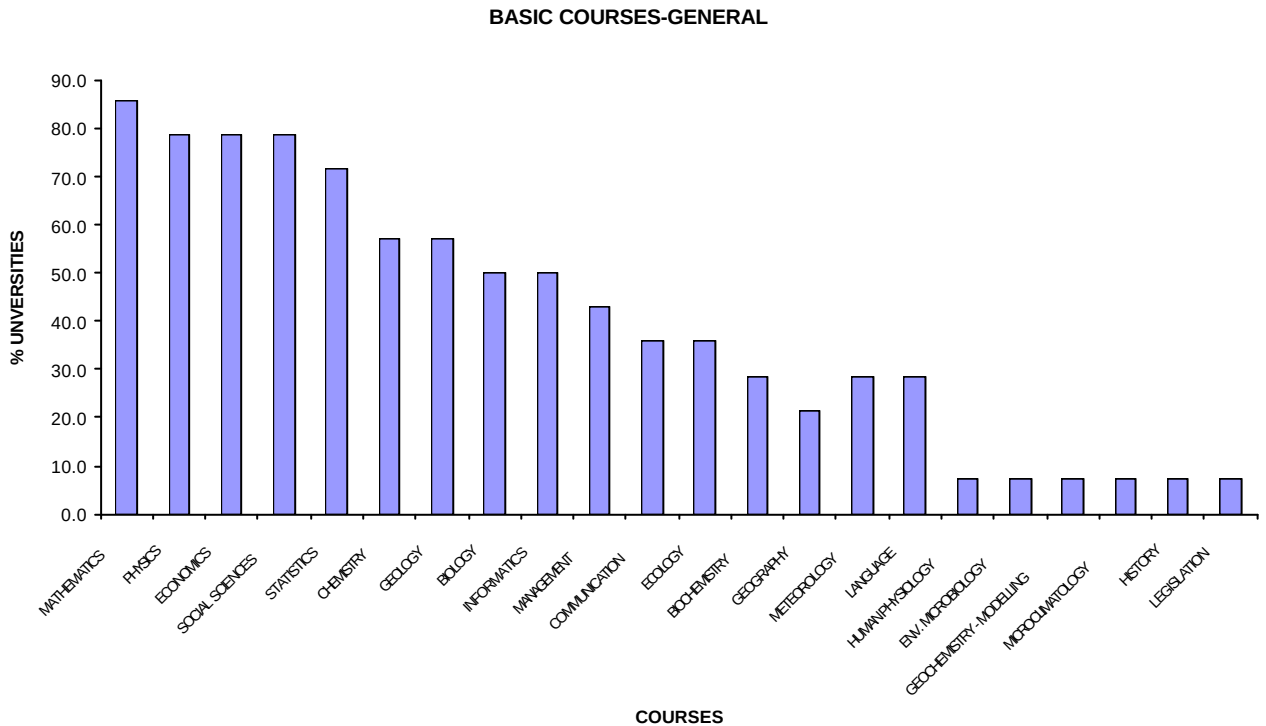
Technical University of Budapest (5 years)

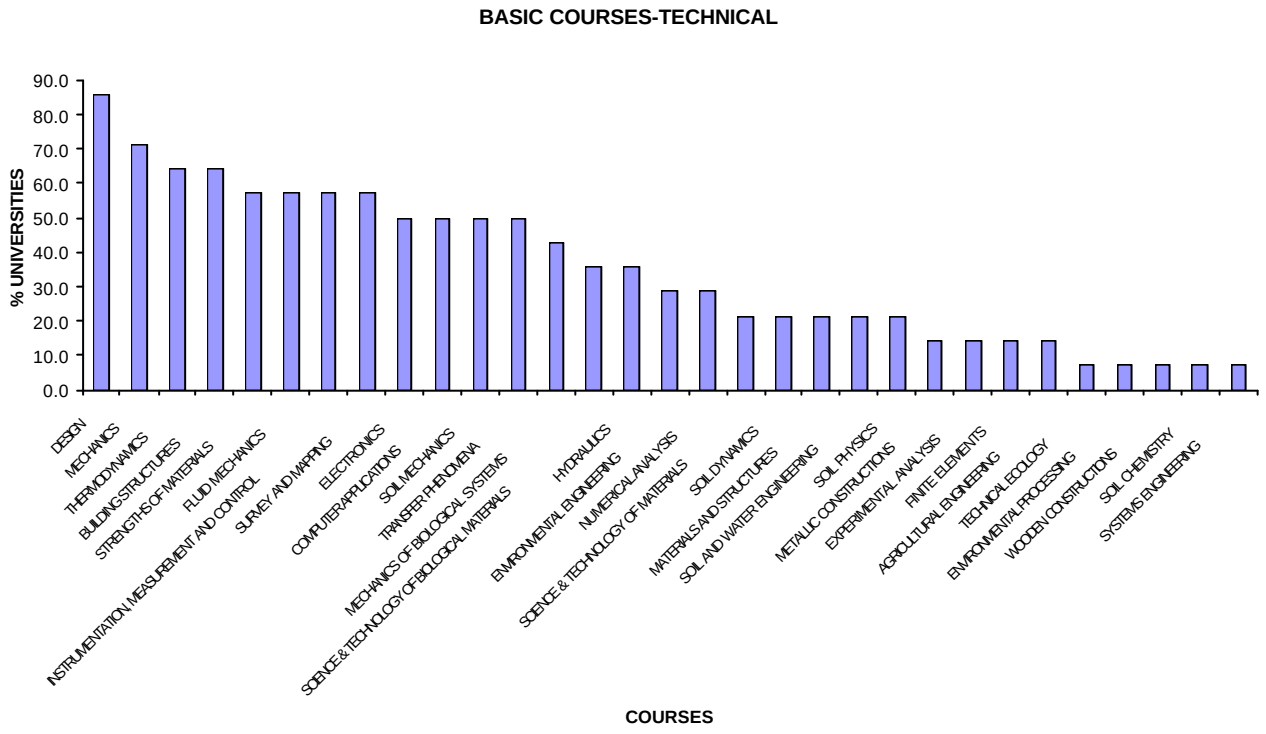
Faculty of Mechanical Engineering (agricultural machine design specialisation)

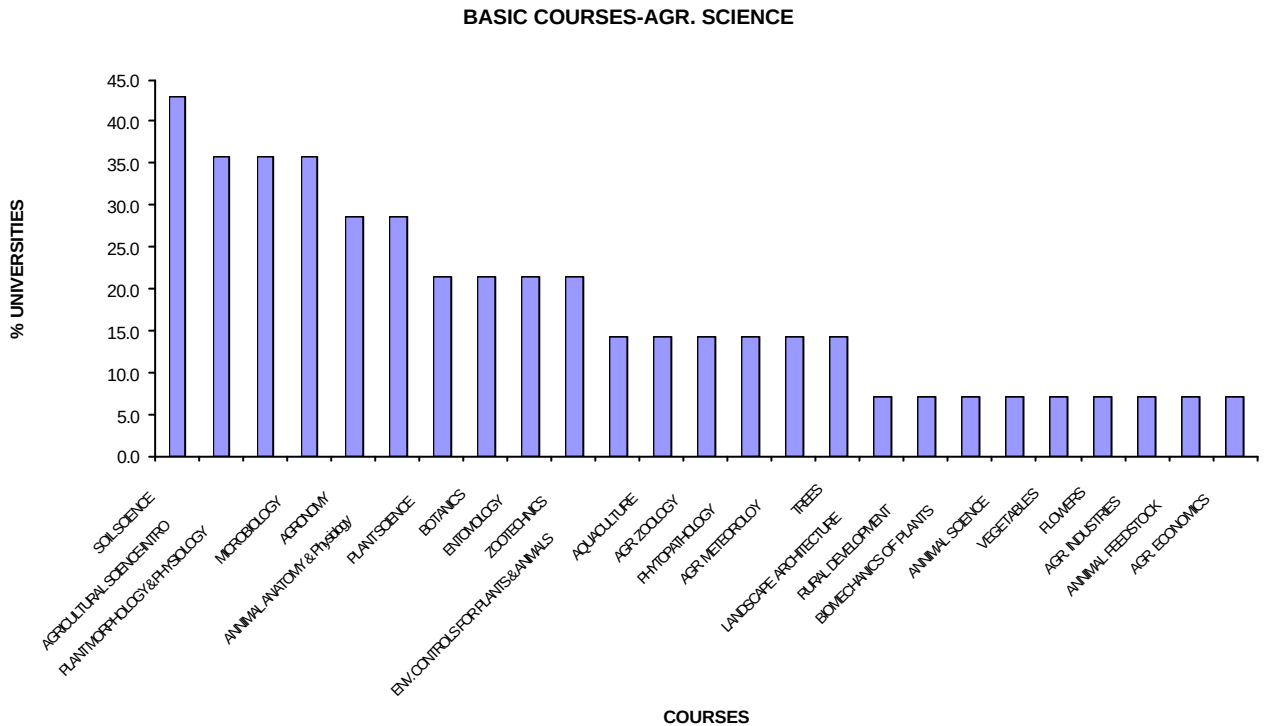
Degree in mechanical engineering

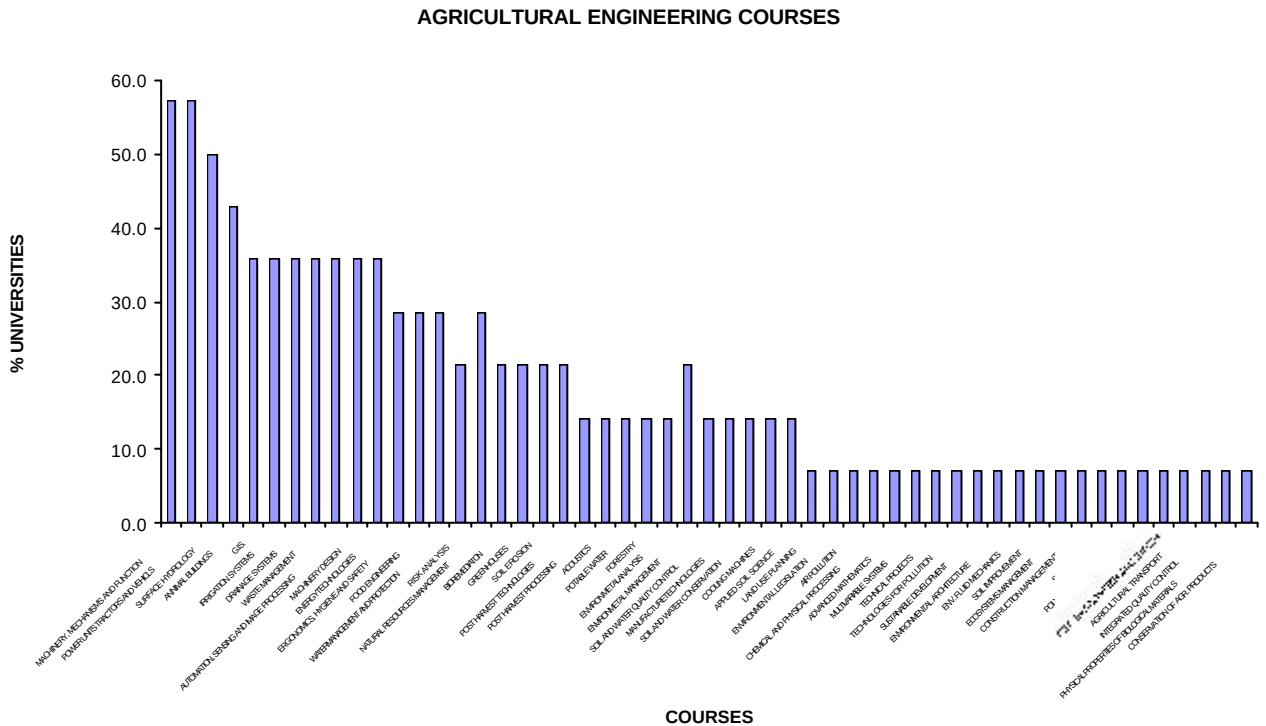
ANNEX III

Histograms of courses taught at various Departments of Agricultural Engineering around the word (source; A study of University curricula in Agricultural Engineering, Agricultural University of Athens, 1999; in Greek).


BASIC COURSES-GENERAL
% UNVERSITIES
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
MATHEMATICS
PHYSICS
ECONOMICS
SOCIAL SCIENCES
STATISTICS
CHEMISTRY
GEOLOGY
BIOLOGY
INFORMATICS
MANAGEMENT
COMMUNICATION
ECOLOGY
BIOCHEMISTRY
GEOGRAPHY
METEOROLOGY
LANGUAGE
HUMAN PHYSIOLOGY
ENV. MICROBIOLOGY
GEOCHEMISTRY - MODELLING
MICROCLIMATOLOGY
HISTORY
LEGISLATION
COURSES


BASIC COURSES-TECHNICAL
% UNIVERSITIES
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
DESIGN
MECHANICS
THERMODYNAMICS
BUILDING STRUCTURES
STRENGTH OF MATERIALS
FLUID MECHANICS
INSTRUMENTATION MEASUREMENT AND CONTROL
SURVEY AND MAPPING
ELECTRONICS
COMPUTER APPLICATIONS
SOIL MECHANICS
TRANSFER PHENOMENA
MECHANICS OF BIOLOGICAL SYSTEMS
SCIENCE & TECHNOLOGY OF BIOLOGICAL MATERIALS
HYDRAULICS
ENVIRONMENTAL ENGINEERING
NUMERICAL ANALYSIS
SCIENCE & TECHNOLOGY OF MATERIALS
SOIL DYNAMICS
MATERIALS AND STRUCTURES
SOIL AND WATER ENGINEERING
SOIL PHYSICS
METALLIC CONSTRUCTIONS
EXPERIMENTAL ANALYSIS
FINITE ELEMENTS
AGRICULTURAL ENGINEERING
TECHNICAL ECOLOGY
ENVIRONMENTAL PROCESSING
WOODEN CONSTRUCTIONS
SOIL CHEMISTRY
SYSTEMS ENGINEERING
COURSES


BASIC COURSES-AGR. SCIENCE
% UNIVERSITIES
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
SOILSCIENCE
AGRICULTURAL-SCIENCEINTRO
PLANTMORPHOLOGY&PHYSIOLOGY
MICROBIOLOGY
AGROLOMY
ANIMALANATOMY&Physiology
PLANTSCIENCE
BOTANICS
ENTOMOLOGY
ZOOTECHNICS
ENV.CONTROLSFORPLANTS&ANIMALS
AQUACULTURE
AGR.ZOOLOGY
PHYTOPATHOLOGY
AGR.METEOROLOY
TREES
LANDSCAPE ARCHITECTURE
RURAL DEVELOPMENT
BIOMECHANICS OF PLANTS
ANIMAL SCIENCE
VEGETABLES
FLOWERS
AGR. INDUSTRIES
ANIMAL FEEDSTOCK
AGR. ECONOMICS
COURSES


AGRICULTURAL ENGINEERING COURSES
% UNIVERSITIES
60.0
50.0
40.0
30.0
20.0
10.0
0.0
MACHINERY MECHANISMS AND FUNCTION
POWER UNITS TRACTORS AND VEHICLES
SURFACE HYDROLOGY
ANIMAL BUILDINGS
GIS
IRRIGATION SYSTEMS
DRAINAGE SYSTEMS
WASTE MANAGEMENT
AUTOMATION SENSING AND IMAGE PROCESSING
MACHINERY DESIGN
ENERGY METHODOLOGIES
ERGONOMICS, HYGIENE AND SAFETY
WATER MANAGEMENT AND PROTECTION
FOOD ENGINEERING
RISK ANALYSIS
NATURAL RESOURCES MANAGEMENT
BIOREMEDIATION
GREEN HOUSES
SOIL EROSION
POST HARVEST TECHNOLOGIES
POST HARVEST PROCESSING
ECOLOGY
POWER PLANTS
WATER
FORESTRY
ENVIRONMENTAL ANALYSIS
ENVIRONMENTAL MANAGEMENT
SOIL AND WATER QUALITY CONTROL
MANUFACTURE TECHNOLOGIES
SOIL AND WATER CONSERVATION
COOLING TECHNIQUES
APPLIED SOIL SCIENCE
LAND USE PLANNING
ENVIRONMENTAL LEGISLATION
CHEMICAL AND PHYSICAL PROCESSING
AGRICULTURE
ADVANCED MATHEMATICS
MULTIPHASE SYSTEMS
TECHNICAL PROJECTS
TECHNOLOGIES FOR POLLUTION
SUSTAINABLE DEVELOPMENT
ENVIRONMENTAL ARCHITECTURE
ENVIRONMENTAL PARKS
SOIL IMPROVEMENT
ECOSYSTEMS MANAGEMENT
CONSTRUCTION MANAGEMENT
PHYSICAL PROPERTIES OF BIOLOGICAL MATERIALS
AGRICULTURAL TRANSPORT
INTEGRATED QUALITY CONTROL
AGRICULTURAL MATERIALS
CONSERVATION OF AGRICULTURAL PRODUCTS
COURSES

ANNEX IV:

Brussels, 4th December 2000

SEFI's Opinion on the Joint Declaration of the European Ministers of Education, signed in Bologna.

SEFI welcomes the important initiative taken by the European ministers of Education in signing the Joint Declaration in Bologna in June last year. SEFI strongly supports the idea of the creation of a European Higher Education Area.

SEFI wishes to make the following general comments:

- SEFI shares the opinion of the Ministers concerning the need for a system of easily readable and comparable degrees, through a Diploma Supplement or otherwise,
- SEFI supports a wider use of the ECTS system as a proper means to promote student mobility,
- SEFI is convinced of the importance of increased mobility for students, teachers, researchers and administrative staff and it does in many ways promote such mobility,
- SEFI is already, by its statutes, committed to the idea of developing the European dimension in Education. It does so primarily by serving as a network of engineering educators and a forum for discussion and information exchange, as well as through the activities of its Working Groups, for instance, in curriculum development,
- SEFI shares the opinion of the European Ministers concerning the importance of European co-operation in quality assurance and accreditation. In certain countries in Europe, Engineering Education programmes are already accredited by competent bodies. SEFI welcomes any initiative leading to a common reflection, aiming at a deeper understanding and co-operation between these agencies. SEFI is fully prepared to pursue its action in this area, in co-operation with these accreditation agencies and other organisations.

The Ministers also commit themselves to the adoption of an education system based on two main cycles, where the first cycle shall in itself be relevant to the labour market and where the second should lead to a Master's degree.

The introduction of a larger number of Master's degree programmes, building on Bachelor's degrees, will no doubt make European Engineering Education more attractive for non-

European students, especially if the programmes are run entirely or partly in English. It will also facilitate student mobility within Europe. SEFI therefore welcomes a large-scale introduction of separate 1-2 year Master's Programmes in Engineering.

The particular conditions and circumstances of Engineering Education must, however, be taken into consideration. It is often said that the educational systems across Europe are very different. This may be true in some fields but in Engineering Education the systems are already similar in many respects. There are many reasons behind this. One reason is the international character of the engineering profession. Another is the influence that the classical 19th century German technical university has had in the past as a model for other countries, particularly in Northern, Eastern and Central Europe. SEFI and other organisations have also contributed to a convergence of ideas.

In many European countries, two distinct types of engineering curricula are offered, one more scientifically oriented and one more application-oriented. Both of these have been developed to respond to the particular needs of industry and graduates of both types of curricula are well received by the job market.

There is today a high degree of consensus that the professional engineering degree should take about five years following secondary school. An exception has always been the United Kingdom, which has traditionally accepted the three-year honours degree as an adequate university education for the professional engineer, but its system of separate professional recognition adds further years of practical training to the qualification requirements. Recently, Britain has moved in the direction of its European partners by making the four-year MEng degree the minimum academic requirement for professional recognition as a Chartered Engineer.

Most European countries also have various forms of shorter Engineering Education. The length and character of these curricula may vary slightly from country to country but they have normally two factors in common; they are more vocationally oriented, or application-oriented, than the longer programmes and, although bridges normally exist, they are not primarily designed as a first part of a two-tier system. Graduates of these programmes play an important role, particularly in small and medium-sized enterprises.

SEFI is convinced that this existing European system for Engineering Education has much merit, that the system is quite compatible with the vision of a European Higher Education Area and that it should not be sacrificed. The cultural diversity of Europe is also a source of richness and changes in the architecture of Engineering Education must not be allowed to destroy this richness.

This does not, of course, exclude the creation of a two-tier Bachelor/Master system also in Engineering Education, whenever this is judged appropriate. The Master's degree should, in such cases, be equivalent to the existing 5-year degrees.

It is also essential that changes in the organisation of engineering studies take into account the ongoing evolution in the transfer of knowledge and the emergence of virtual universities, flexible learning and distance education.

SEFI's view is thus that:

- any reform of the structure of European Engineering Education must take the particular conditions of this field of education into account,
- the existing European integrated 5-year curricula in Engineering are compatible with the idea of a European Education area,
- the existing European system of longer integrated curricula leading straight to a Master's Degree in Engineering should be maintained, possibly in parallel with a two-tier Bachelor/Master system,
- the longer, as well as the shorter, more application-oriented, curricula, correspond to a clear need and graduates from both types of programme have a good position on the job market,
- the specific qualities of the present, existing, application-oriented Engineering degrees should be recognised and safe-guarded,
- the creation of new 1-2 year Master's programmes in Engineering should be encouraged.

ANNEX V:

TOWARDS THE EUROPEAN HIGHER EDUCATION AREA
Communiqué of the meeting of European Ministers in charge of Higher Education in Prague on May 19th 2001

Two years after signing the Bologna Declaration and three years after the Sorbonne Declaration, European Ministers in charge of higher education, representing 32 signatories, met in Prague in order to review the progress achieved and to set directions and priorities for the coming years of the process. Ministers reaffirmed their commitment to the objective of establishing the European Higher Education Area by 2010. The choice of Prague to hold this meeting is a symbol of their will to involve the whole of Europe in the process in the light of enlargement of the European Union.

Ministers welcomed and reviewed the report "Furthering the Bologna Process" commissioned by the follow-up group and found that the goals laid down in the Bologna Declaration have been widely accepted and used as a base for the development of higher education by most signatories as well as by universities and other higher education institutions. Ministers reaffirmed that efforts to promote mobility must be continued to enable students, teachers, researchers and administrative staff to benefit from the richness of the European Higher Education Area including its democratic values, diversity of cultures and languages and the diversity of the higher education systems.

Ministers took note of the Convention of European higher education institutions held in Salamanca on 29-30 March and the recommendations of the Convention of European Students, held in Göteborg on 24-25 March, and appreciated the active involvement of the European University Association (EUA) and the National Unions of Students in Europe (ESIB) in the Bologna process. They further noted and appreciated the many other initiatives to take the process further. Ministers also took note of the constructive assistance of the European Commission.

Ministers observed that the activities recommended in the Declaration concerning degree structure have been intensely and widely dealt with in most countries. They especially appreciated how the work on quality assurance is moving forward. Ministers recognised the need to co-operate to address the challenges brought about by transnational education. They also recognised the need for a lifelong learning perspective on education.

Further actions following the six objectives of the Bologna process

As the Bologna Declaration sets out, Ministers asserted that building the European Higher Education Area is a condition for enhancing the attractiveness and competitiveness of higher education institutions in Europe. They supported the idea that higher education should be considered a public good and is and will remain a public responsibility (regulations etc.), and that students are full members of the higher education community. From this point of view Ministers commented on the further process as follows:

Adoption of a system of easily readable and comparable degrees

Ministers strongly encouraged universities and other higher education institutions to take full advantage of existing national legislation and European tools aimed at facilitating academic and professional recognition of course units, degrees and other awards, so that citizens can effectively use their qualifications, competencies and skills throughout the European Higher Education Area.

Ministers called upon existing organisations and networks such as NARIC and ENIC to promote, at institutional, national and European level, simple, efficient and fair recognition reflecting the underlying diversity of qualifications.

Adoption of a system essentially based on two main cycles

Ministers noted with satisfaction that the objective of a degree structure based on two main cycles, articulating higher education in undergraduate and graduate studies, has been tackled and discussed. Some countries have already adopted this structure and several others are considering it with great interest. It is important to note that in many countries bachelor's and master's degrees, or comparable two cycle degrees, can be obtained at universities as well as at other higher education institutions. Programmes leading to a degree may, and indeed should, have different orientations and various profiles in order to accommodate a diversity of individual, academic and labour market needs as concluded at the Helsinki seminar on bachelor level degrees (February 2001).

Establishment of a system of credits

Ministers emphasised that for greater flexibility in learning and qualification processes the adoption of common cornerstones of qualifications, supported by a credit system such as the ECTS or one that is ECTS-compatible, providing both transferability and accumulation functions, is necessary. Together with mutually recognised quality assurance systems such arrangements will facilitate students' access to the European labour market and enhance the compatibility, attractiveness and competitiveness of European higher education. The generalised use of such a credit system and of the Diploma Supplement will foster progress in this direction.

Promotion of mobility

Ministers reaffirmed that the objective of improving the mobility of students, teachers, researchers and administrative staff as set out in the Bologna Declaration is of the utmost importance. Therefore, they confirmed their commitment to pursue the removal of all obstacles to the free movement of students, teachers, researchers and administrative staff and emphasised the social dimension of mobility. They took note of the possibilities for mobility offered by the European Community programmes and the progress achieved in this field, e.g. in launching the Mobility Action Plan endorsed by the European Council in Nice in 2000.

Promotion of European co-operation in quality assurance

Ministers recognised the vital role that quality assurance systems play in ensuring high quality standards and in facilitating the comparability of qualifications throughout Europe. They also encouraged closer co-operation between recognition and quality assurance networks. They emphasised the necessity of close European co-operation and mutual trust in and acceptance

of national quality assurance systems. Further they encouraged universities and other higher education institutions to disseminate examples of best practice and to design scenarios for mutual acceptance of evaluation and accreditation/certification mechanisms. Ministers called upon the universities and other higher education institutions, national agencies and the European Network of Quality Assurance in Higher Education (ENQA), in cooperation with corresponding bodies from countries which are not members of ENQA, to collaborate in establishing a common framework of reference and to disseminate best practice.

Promotion of the European dimensions in higher education

In order to further strengthen the important European dimensions of higher education and graduate employability Ministers called upon the higher education sector to increase the development of modules, courses and curricula at all levels with "European" content, orientation or organisation. This concerns particularly modules, courses and degree curricula offered in partnership by institutions from different countries and leading to a recognized joint degree.

FURTHERMORE MINISTERS EMPHASIZED THE FOLLOWING POINTS:

Lifelong learning

Lifelong learning is an essential element of the European Higher Education Area. In the future Europe, built upon a knowledge-based society and economy, lifelong learning strategies are necessary to face the challenges of competitiveness and the use of new technologies and to improve social cohesion, equal opportunities and the quality of life.

Higher education institutions and students

Ministers stressed that the involvement of universities and other higher education institutions

and of students as competent, active and constructive partners in the establishment andshaping of a European Higher Education Area is needed and welcomed. The institutions have

demonstrated the importance they attach to the creation of a compatible and efficient, yet diversified and adaptable European Higher Education Area. Ministers also pointed out that quality is the basic underlying condition for trust, relevance, mobility, compatibility and attractiveness in the European Higher Education Area. Ministers expressed their appreciation of the contributions toward developing study programmes combining academic quality with relevance to lasting employability and called for a continued proactive role of higher education institutions.

Ministers affirmed that students should participate in and influence the organisation and content of education at universities and other higher education institutions. Ministers also reaffirmed the need, recalled by students, to take account of the social dimension in the Bologna process.

Promoting the attractiveness of the European Higher Education Area

Ministers agreed on the importance of enhancing attractiveness of European higher education to students from Europe and other parts of the world. The readability and comparability of European higher education degrees world-wide should be enhanced by the development of a common framework of qualifications, as well as by coherent quality assurance and accreditation/certification mechanisms and by increased information efforts. Ministers

particularly stressed that the quality of higher education and research is and should be an important determinant of Europe's international attractiveness and competitiveness. Ministers agreed that more attention should be paid to the benefit of a European Higher Education Area with institutions and programmes with different profiles. They called for increased collaboration between the European countries concerning the possible implications and perspectives of transnational education.

CONTINUED FOLLOW-UP

Ministers committed themselves to continue their cooperation based on the objectives set out in the Bologna Declaration, building on the similarities and benefiting from the differences between cultures, languages and national systems, and drawing on all possibilities of intergovernmental co-operation and the ongoing dialogue with European universities and other higher education institutions and student organisations as well as the Community programmes.

Ministers welcomed new members to join the Bologna process after applications from Ministers representing countries for which the European Community programmes Socrates and Leonardo da Vinci or Tempus-Cards are open. They accepted applications from Croatia, Cyprus and Turkey.

Ministers decided that a new follow-up meeting will take place in the second half of 2003 in Berlin to review progress and set directions and priorities for the next stages of the process towards the European Higher Education Area. They confirmed the need for a structure for the follow-up work, consisting of a follow-up group and a preparatory group. The follow-up group should be composed of representatives of all signatories, new participants and the European Commission, and should be chaired by the EU Presidency at the time. The preparatory group should be composed of representatives of the countries hosting the previous ministerial meetings and the next ministerial meeting, two EU member states and two non-EU member states; these latter four representatives will be elected by the follow-up group. The EU Presidency at the time and the European Commission will also be part of the preparatory group. The preparatory group will be chaired by the representative of the country hosting the next ministerial meeting.

The European University Association, the European Association of Institutions in Higher Education (EURASHE), the National Unions of Students in Europe and the Council of Europe should be consulted in the follow-up work.

In order to take the process further, Ministers encouraged the follow-up group to arrange seminars to explore the following areas: co-operation concerning accreditation and quality assurance, recognition issues and the use of credits in the Bologna process, the development of joint degrees, the social dimension, with specific attention to obstacles to mobility, and the enlargement of the Bologna process, lifelong learning and student involvement.

ANNEX VI:

Abbreviations of Organisations

CIGR: **International Commission of Agricultural Engineering**

AFANet: **SOCRATES Thematic Network for Agriculture, Forestry, Aquaculture and the Environment**

FEANI: **Federation Europeenne D'Associations Nationales D'Ingenieurs**

SEFI: **European Society for Engineering Education**