Subtheme: 1

EUR-ACE: A System of Accreditation of Engineering Programmes Allowing National Variants

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Abstract:

EUR-ACE Accreditation System is a decentralised Europe-based accreditation system of educational programmes as entry route to the engineering profession: a common quality label (EUR-ACE® label) is awarded to programmes that satisfy a common basic set of standards ("EUR-ACE Framework Standards") and are accredited by an Agency fulfilling appropriate Quality Assurance (QA) prescriptions. EUR-ACE Accreditation System is currently implemented by seven Agencies throughout the European Higher Education Area (CTI, France; EngC, UK; Engineers Ireland; OE, Portugal; ASIIN, Germany; MÜDEK, Turkey; RAEE, Russia): a total of approximately 700 labels have been awarded. EUR-ACE has been repeatedly quoted by the European Commission as an example of good practice in QA of HE.

In this paper, the EUR-ACE Framework Standards, the EUR-ACE system and the significance of the EUR-ACE label for improving quality and transparency of engineering education are summarized, together with the concrete perspectives for spreading the system into other countries.

1. Introduction:

Globalization has made higher education a national concern with an international dimension. Employability of university graduates is more than ever dependent on internationally acceptable skills and abilities that they have acquired.

While institutional accreditation may be significant to assure the quality of the teaching-learning process in each higher education Institution (HEI), only outcome-based programme accreditation serves as an important instrument for ensuring - to both the HEIs and the potential employers - that the graduates of a specific programme acquire the desired set of skills and abilities. An internationally recognized qualification added to such an accreditation greatly facilitates employability and mobility of the graduates.

A good example of a mechanism for international recognition of qualifications is the EUR-ACE Accreditation System, which provides a common framework for outcome-based accreditation of engineering programmes as suitable "entry routes to the engineering profession", at the First- (Bachelor) and Second- (Master) Cycle levels.

The aim of this paper is to summarize the EUR-ACE Programme Outcomes requirements, the present status of the EUR-ACE Accreditation System, and the concrete perspectives for their improvement and growth, while at the same time stimulating the addition of further Agencies into the system.

The mentoring and review process used by ENAEE for authorizing national accrediting agencies which are interested in awarding the EUR-ACE Label to engineering programmes which they accredit is also discussed.

2. Outcome-Based Accreditation of Engineering Programmes:

Accreditation of engineering programmes in Europe and elsewhere has a long history going back to 1930's. One can quote examples such as Commission des Titres d'Ingénieur (CTI) of France which has been accrediting engineering programmes since 1934, and in UK the Engineers' Professional Institutions (now co-ordinated by the Engineering Council), some active from the 1800's in the UK, which have been accrediting engineering programmes since the 1970's. In the USA, Engineers' Council for Professional Development (ECPD) was established in 1932 with the aim of accrediting engineering programmes. Over the years ECTP transformed itself to ABET, Inc.

Outcome-based accreditation on the other hand has history of a merely a decade. In 1997, ABET in USA introduced "Engineering Criteria 2000 (EC2000)", which focused on what is learned (outcomes) rather than what is taught (inputs) and stressed the necessity of a continuous improvement process. Since then, an emphasis on program/learning outcomes has been a dominant assessment trend adopted by many national and regional accreditation agencies through out the world.

Programme outcomes may be defined as statements defining the knowledge, skills, and attitudes that students must have acquired by the time they graduate. Outcome-based accreditation requires the HIE's to show evidence that the graduates of their engineering study programmes have acquired the minimum programme outcomes specified by the accreditation agency.

A need for global recognition of engineering degrees has led to development of internationally recognized common framework standards for programme outcomes for engineering programmes. The EUR-ACE Framework Standards [1] which will be discussed in the next section of the paper is a good example for such a global approach. A similar framework for programme outcomes for engineering programmes is given in the Graduate Attributes defined by the International Engineering Alliance (IEA) for Washington Accord, Sidney Accord and Dublin Accord graduates [2].

3. The EUR-ACE Accreditation System:

The EUR-ACE Framework Standards [1], maintained by the European Network for Accreditation of Engineering Education (ENAEE), provide the basis for awarding a common quality label (the EUR-ACE® label) to engineering programmes and does not substitute for national standards. Thus, the EUR-ACE Accreditation System is essentially a bottom-up system for international recognition of national accreditation in which national (or possibly regional) agencies accredit the educational programmes, and ENAEE authorizes these agencies to add the EUR-ACE label to their accreditation, after checking that their procedures and requirements satisfy the EUR-ACE Framework Standards (and consequently the "European Standards and Guidelines for Quality Assurance in Higher Education", in short ESG). In this way, national differences and other specific requirements can be accommodated, while the experience of long-established national accreditation agencies (like the French CTI and the British Engineering Professional Institutions) is fully exploited.

EUR-ACE Accreditation System has been quoted by the European Commission as an example of good practice in their "Report on progress in quality assurance in higher education" (September 2009) and mentioned also in the publication "The EU contribution to the European Higher Education Area", issued in March 2010 in occasion of the "Bologna Anniversary Conference".

The EUR-ACE Framework Standards are valid for all branches of engineering and all profiles of study. They distinguish between First and Second Cycle programmes, as defined in the European Qualification Frameworks and are applicable also to “integrated programmes”, i.e. programmes that lead directly to a Second Cycle engineering degree. The EUR-ACE Framework Standards specifies the abilities that the graduates must achieve (i.e. the programme outcomes) but not how they should be taught and can accommodate national differences of educational and accreditation practice.

The EUR-ACE Framework Standards distinguish between First Cycle and Second Cycle degrees and specify 21 Programme Outcomes for First Cycle degrees and 23 for Second Cycle degrees, grouped under the following six headings:

1. Knowledge and Understanding
2. Engineering Analysis
3. Engineering Design
4. Investigations
5. Engineering Practice
6. Transferable (personal) Skills

Although all six of the Programme Outcomes apply to both First Cycle and Second Cycle programmes, there are important differences in the requirements at the two levels. These differences are particularly relevant to those learning activities that contribute directly to the Programme Outcomes concerned with engineering applications, i.e. falling under Engineering Analysis, Engineering Design, and Investigations. As an example, the differences between the problem solving skills expected from First Cycle and Second Cycle graduates is exhibited in table 1 which lists the programme outcomes , falling under Engineering Analysis heading. A full listing of the EUR-ACE Programme Outcomes is given in Appendix 1.

Table 1: Engineering Analysis

First Cycle graduates should have:

- the ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods;
- the ability to apply their knowledge and understanding to analyse engineering products, processes and methods;
- the ability to select and apply relevant analytic and modelling methods.

Second Cycle graduates should have:

- the ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications;
- the ability to formulate and solve problems in new and emerging areas of their specialisation;
- the ability to use their knowledge and understanding to conceptualise engineering models, systems and processes;
- the ability to apply innovative methods in problem solving.

In addition to defining the set of programme outcomes outlined above, The EUR-ACE Framework Standards require the assessment of a programme considering at least the following items:

1. Needs, Objectives and Outcomes;
2. Educational Process;
3. Resources and Partnerships;
4. Assessment of the Educational Process;
5. Management System

Assessment criteria for each item above and are also specified in the same document [1].

4. Authorization of Accreditation Agencies for Awarding the EUR-ACE Label

Currently, seven national accrediting agencies, based in seven different countries throughout the European Higher Education Area (France, Germany, Ireland, Portugal and United Kingdom within the EU, Russian Federation and Turkey outside the EU), are authorized to deliver the EUR-ACE Label. As of October 2010, these agencies have awarded the EUR-ACE® Label to approximately 700 First- and Second-cycle engineering programmes, some outside the 7 countries.

At the same time, a number of other national accrediting agencies are either being reviewed by the ENAEE (through its "EUR-ACE Label Committee") in order to be authorized to award the EUR-ACE Label or are in the process of adapting their accreditation criteria and processes for compliance with the EUR-ACE Accreditation System. Several of these are "general" QA/accreditation Agencies that accredit engineering programmes as well; the establishment of specialized Engineering Accreditation Agencies is instead being pursued in some countries.

ENAEE membership is *not* a prerequisite for the authorization to award the EUR-ACE label. Accreditation agencies seeking this authorization may freely apply to ENAEE. In the authorization process they will need to provide evidence that their standards and procedures comply with the ENAEE Standards and Guidelines for Accreditation Agencies [3] and the programmes which they accredited fulfil the programme outcomes as set out by the EUR-ACE Framework Standards.

ENAEE recognises that the full benefits associated with its mission can only be realized satisfactorily if authorization to award the EUR-ACE Label is granted to as wide a range of accreditation agencies as possible. To this end, ENAEE offers a mentoring or advisory service to all new applicants for this authority. The purpose of the mentoring process is to advise and mentor an applicant in relation to the establishment and/or the further development of an accreditation agency so that it can satisfy the EUR-ACE Framework Standards for the Accreditation of Engineering Programmes (EAFS). Upon request by an agency, ENAEE can appoint a mentoring team which will consist of a member of the EUR-ACE Label Committee and one other experienced assessor with experience of acting on an accreditation panel of an agency which has been granted the authority to grant EUR-ACE labels.

An accreditation agency may choose to apply for authorization without making use of the mentoring services outlined above. Any accreditation agency interested in the authorization should fill in and submit the application form [3] posted on the ENAEE website and send it to the ENAEE Permanent Secretariat. The review process is initiated after this application form and the supporting documentation (In English language) is received. The review process is handled by the EUR-ACE Label Committee who will then form a 3 member Review team which will review the application

form and the supporting documentation and make the following inspection visits to the Applicant Agency:

(a) The Review Team will normally observe and evaluate at least two visits of the Applicant to accredit at least one degree programme at each programme level covered by the agency (First Cycle degree, Second Cycle degree and/or integrated programmes) and at least two programmes, if only one level is covered by the agency, as appropriate.

(b) The Review Team is also required to observe and evaluate the decision making process at a meeting of the decision making body of the Applicant, and preferably the one in which the decisions on the observed accreditation visits are to be reached. Normally only the chair of the Review Team participates in such a decision making meeting.

(c) After assessing all the evidence, the Review Team will draft a report on the application. This draft report will be sent to the Applicant for the correction of any errors of fact. The corrected report, together with recommendation of the Review Team, will be submitted to the EUR-ACE Label Committee.

(d) The EUR-ACE Label Committee will evaluate the report of the Review Team, and decide whether or not to recommend to the ENAEE Administrative Council that the Applicant should be authorised to award the EUR-ACE label. The Applicant will be informed of the decision by the ENAEE Administrative Council, and receive a final version of the report. If the decision is not to authorise the Applicant to award the EUR-ACE label, the Applicant may appeal to the ENAEE Administrative Council. The maximum period of authorisation is five years. Before the expiration of this period, an authorised agency should apply for re-evaluation to demonstrate compliance with the current EUR-ACE Standards and Procedures.

5. Conclusions

If coupled with rigorous quality assurance rules, as it should always be, outcome-based programme accreditation assures that an educational programme is not only of acceptable academic standard, but also that it prepares graduates who are able to assume relevant roles in the job market. Specifying the minimum programme outcome requirements to be met and participation of none-academic stakeholders in the accreditation process is a guarantee to this effect. An internationally recognized qualification like the EUR-ACE label, added to the national accreditation, will facilitate job mobility as well.

The EUR-ACE Accreditation System allows national differences and appropriate distinction between the cycles. It is fair to state that the EUR-ACE Accreditation System, compared with the Washington-Sydney-Dublin accord system is at the same time simpler and more flexible. ENAEE and IEA has recently initiated a joint effort for benchmarking the two accreditation systems, a work which will be a major challange for the two organizations involved.

Creating a pan-European scheme like the EUR-ACE Accreditation System certainly finds major difficulties in the great differences between educational practices, legal provisions and professional organizations across the different European countries. These are, however, the typical difficulties encountered in building a unified, but not homogenized, Europe. The fact, that common Standards could be written and can be now implemented from Portugal to Russia, in continental and Anglo-

Saxon countries, is a matter of great pride for ENAEE.

6. References:

[1] EUR-ACE Framework Standards for the Accreditation of Engineering Programmes, 05.11.2008, www.enaee.eu

[2] International Engineering Alliance Graduate Attributes and Professional Competencies, ver.2, 18 June 2009, www.washingtonaccord.org

[3] ENAEE Standards and Guidelines for Accreditation Agencies, 19.04.2007, www.enaee.eu

[4] ENAEE Application Form for Accreditation Agencies –Authorisation to award the EUR-ACE® Label, 19.04.2007, www.enaee.eu

Appendix 1. EUR-ACE Programme Outcomes.

1. Knowledge and Understanding

The underpinning knowledge and understanding of science, mathematics and engineering fundamentals are essential to satisfying the other programme outcomes. Graduates should demonstrate their knowledge and understanding of their engineering specialisation, and also of the wider context of engineering.

First Cycle graduates should have:

- knowledge and understanding of the scientific and mathematical principles underlying their branch of engineering;
- a systematic understanding of the key aspects and concepts of their branch of engineering;
- coherent knowledge of their branch of engineering including some at the forefront of the branch;
- awareness of the wider multidisciplinary context of engineering.

Second Cycle graduates should have:

- an in-depth knowledge and understanding of the principles of their branch of engineering;
- a critical awareness of the forefront of their branch.

2. Engineering Analysis

Graduates should be able to solve engineering problems consistent with their level of knowledge and understanding, and which may involve considerations from outside their field of specialisation. Analysis can include the identification of the problem, clarification of the specification, consideration of possible methods of solution, selection of the most appropriate method, and correct implementation. Graduates should be able to use a variety of methods, including mathematical analysis, computational modelling, or practical experiments, and should be able to recognise the importance of societal, health and safety, environmental and commercial constraints.

First Cycle graduates should have:

- the ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods;
- the ability to apply their knowledge and understanding to analyse engineering products, processes and methods;
- the ability to select and apply relevant analytic and modelling methods.

Second Cycle graduates should have:

- the ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications;
- the ability to formulate and solve problems in new and emerging areas of their specialisation;
- the ability to use their knowledge and understanding to conceptualise engineering models, systems and processes;
- the ability to apply innovative methods in problem solving.

3. Engineering Design

Graduates should be able to realise engineering designs consistent with their level of knowledge and understanding, working in cooperation with engineers and non-engineers. The designs may be of devices, processes, methods or artefacts, and the specifications could be wider than technical, including an awareness of societal, health and safety, environmental and commercial considerations.

First Cycle graduates should have:

- the ability to apply their engineering knowledge and understanding to develop and realise designs to meet defined and specified requirements;
- an understanding of design methodologies, and an ability to use them.

Second Cycle graduates should have:

- an ability to use their engineering knowledge and understanding to design solutions to unfamiliar problems, possibly involving other disciplines;
- an ability to use creativity to develop new and original ideas and methods;
- an ability to use their engineering judgement to work with complexity, technical uncertainty and incomplete information.

4. Investigations

Graduates should be able to use appropriate methods to pursue research or other detailed investigations of technical issues consistent with their level of knowledge and understanding.

Investigations may involve literature searches, the design and execution of experiments, the interpretation of data, and computer simulation. They may require that data bases, codes of practice and safety regulations are consulted.

First Cycle graduates should have:

- the ability to conduct searches of literature, and to use data bases and other sources of information;
- the ability to design and conduct appropriate experiments, interpret the data and draw conclusions;
- workshop and laboratory skills.

Second Cycle graduates should have:

- the ability to identify, locate and obtain required data;
- the ability to design and conduct analytic, modelling and experimental investigations;
- the ability to critically evaluate data and draw conclusions;
- the ability to investigate the application of new and emerging technologies in their branch of engineering.

5. Engineering Practice

Graduates should be able to apply their knowledge and understanding to developing practical skills for solving problems, conducting investigations, and designing engineering devices and processes. These skills may include the knowledge, use and limitations of materials, computer modelling, engineering processes, equipment, workshop practice, and technical literature and information

sources. They should also recognise the wider, non-technical implications of engineering practice, ethical, environmental, commercial and industrial.

First Cycle graduates should have:

- the ability to select and use appropriate equipment, tools and methods;
- the ability to combine theory and practice to solve engineering problems;
- an understanding of applicable techniques and methods, and of their limitations;
- an awareness of the non-technical implications of engineering practice.

Second Cycle graduates should have:

- the ability to integrate knowledge from different branches, and handle complexity;
- a comprehensive understanding of applicable techniques and methods, and of their limitations;
- a knowledge of the non-technical implications of engineering practice.

6. Transferable Skills

The skills necessary for the practice of engineering, and which are applicable more widely, should be developed within the programme.

First Cycle graduates should be able to:

- function effectively as an individual and as a member of a team;
- use diverse methods to communicate effectively with the engineering community and with society at large;
- demonstrate awareness of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice;
- demonstrate an awareness of project management and business practices, such as risk and change management, and understand their limitations;
- recognise the need for, and have the ability to engage in independent, life-long learning.

Second Cycle graduates should be able to:

- fulfil all the Transferable Skill requirements of a First Cycle graduate at the more demanding level of Second Cycle;
- function effectively as leader of a team that may be composed of different disciplines and levels;
- work and communicate effectively in national and international contexts.