QUALITY ASSURANCE IN EUROPEAN ENGINEERING EDUCATION: THE EUR-ACE QUALITY LABEL

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In a worldwide context, the accreditation agencies have to provide employers, students and the general public with clear information on the engineering programme outcomes to facilitate the international mobility of students and professionals.
These challenges must be addressed taking into account the diversity of the national education systems and regulations for the engineering profession. The agencies have to elaborate common standards and procedures, while preserving the national cultural and economic specificities.

The European situation is very illustrative in this respect with a wide diversity of education systems and professional regulations. For the engineers, one may observe a wide range for the expected programmes outcomes; in some countries, an engineer is rather an expert in a specific technical domain; in others, he (she) is more a project or team manager with a scientific background.

In this paper, we describe the European Higher Education Area (Bologna process); then we focus on the specific situation of engineering education. We then present the CTI (Commission des Titres d'Ingénieurs – France) as a typical accreditation agency for engineering programmes and the European EUR-ACE project, which has defined the Framework Standards for the engineering programmes and their accrediting agencies. We conclude with a review of the main issues under discussion in Europe.

1 - The European Higher Education Area

At the turn of this century, some European ministers of higher education have met in Bologna (Italy) and launched the so-called "Bologna process". This initiative "aimed to create a European Higher Education Area by 2010, in which students can choose from a wide and transparent range of high quality courses and benefit from smooth recognition procedures. The Bologna Declaration of June 1999 has put in motion a series of reforms needed to make European Higher Education more compatible and comparable, more competitive and more attractive for Europeans and for students and scholars from other continents. Reform was needed then and reform is still needed today in Europe is to match the performance of the best performing systems in the world, notably the United States and Asia". [1].

The three objectives of the Bologna process have been set from the start: introduction of the three cycle LMD system (bachelor/master/doctorate), quality assurance and recognition of qualifications and periods of study.

Every second year, the ministers meet to measure progress and set the new priorities. Many countries, well beyond the European continent and then beyond the European Union (EU), have joined the process [1]; in 2010, 47 countries contribute to the building of this wide area for higher education.

As far as the quality assurance is concerned, the European ministries have asked ENQA (the European Association for Quality Assurance in Higher Education) "to develop an agreed set of standards, procedures and guidelines on quality assurance and to explore ways to ensuring an adequate peer review system for quality assurance and/or accreditation agencies or bodies". ENQA has set the so-called ESG (Standard and Guidelines) [3] divided in three parts covering internal quality assurance of higher education institutions, external quality assurance of higher education, and quality assurance of external quality assurance agencies.

These ESG's have been adopted by the European ministers at the Bergen meeting (2005) ; the final Communiqué states : *"Almost all countries have made provision for a quality assurance system based on the criteria set out in the Berlin Communiqué and with a high degree of cooperation and networking. ... We adopt the standards and guidelines for quality assurance in the European Higher Education Area as proposed by ENQA. We commit ourselves to introducing the proposed model for peer review of quality assurance agencies on a national basis, while respecting the commonly accepted guidelines and criteria. We welcome the principle of a European register of quality assurance agencies based on national review."*

The final touch has been given at the London meeting (2008), where the ministers have created (EQAR), the European Quality Assurance Register for Higher Education [4], where are listed the national agencies that substantially comply with the common set of principles for quality assurance in Europe (the ESG'S).

2 - The European Higher Education in engineering

The overarching standards established by ENQA concern all the domains of higher education; they aim more at the general institutions than at the programmes. Several initiatives have been taken to develop the quality assurance processes to specific domains. Among them the engineering programmes are of the utmost importance, taking into consideration the student numbers and the impact on the engineering profession.

Building a common system of quality assurance for engineering education is a considerable challenge, owing to the diversity of higher education systems and of

professional regulations for engineers. In some countries the engineering profession is regulated (e.g. in Spain or Italy), in others it is not (e.g. in France or Germany). In some countries, the engineering degree is a bachelor, in others it is a master (e.g. in France), in some cases, the two levels coexist (e.g. in Germany). The accreditation systems themselves differ widely: programme accreditation by professional societies or agencies, academic institutional accreditation, or mere external quality evaluation. At last, one may observe a wide range of the expected programmes outcomes; in some countries, an engineer is rather an expert in a specific technical domain; in others, he (she) is more a project or team manager with a scientific background.

In the following, we present briefly the activities of one of the oldest institution working in Europe for the accreditation of engineering programmes.

2.1 – The "Commission des Titres d'ingénieur" (CTI-France)

CTI (*Commission des Titres d'Ingénieur*) is a non profit organisation officially recognized as the independent body in charge of institution accreditation to grant engineering degrees in France. Like other similar bodies in other countries, such as ABET in USA, or ASIIN in Germany, CTI establishes the standards for the higher education institutions (HEIs) which wish to deliver engineering diplomas and defines the general competence profile of engineering degrees. [5]

In France, In order to fulfil its mission, CTI performs a periodic evaluation and accreditation of all French engineering programmes (generally, every 6 years). Upon the result of CTI's programme accreditation, the Engineering Schools are accredited ("habilitated") to deliver the Engineering degree ("Titre d'ingénieur") by the concerned Minister(s).

CTI also performs accreditation of engineering programmes outside France. Moreover, CTI is part of the European Network for Accreditation of Engineering Education (ENAEE) and one of the 7 organizations that can deliver the EUR-ACE label, a European quality label for engineering degree programmes at Bachelor and Master level. [6]

CTI's decisionary organ is composed of 32 members, appointed upon legislative order, 16 coming from academia and 16 coming from industry. This equitable composition, which is a unique feature in the landscape of evaluation of higher education in Europe, makes CTI especially well placed to be aware of the needs of industry and society.

Since its creation in 1934, CTI has emphasized the role of human, social and management sciences in engineering education; the new challenges, such as the world energy challenge and the global sustainable development challenge, have indeed strong human and societal impacts and cannot be addressed only from the scientific and technical points of view.

The universe of engineering higher education institutions in France is particularly rich and complex, and includes institutions with different status (public, private, consular), different organizational natures and orientations (research oriented vs. training

oriented) and under the supervision of different ministries. The CTI accredits ten-semester integrated cursus of masters ; every year, about 31 000 students graduate from accredited cursus in France and several thousands from programmes accredited in other countries: either in Europe (Switzerland, Belgium, Bulgaria, …) or all over the world (China, Viet nam, Morocco, Burkina Faso, …).

CTI standards shape a generalist engineering professional with a strong and broad basis in fundamental sciences, but also with a vast business culture and economic, social, human, environmental and ethics awareness. Thereby, CTI considers that all French higher education institutions offering engineering programmes must comply with the following essential components of engineering education []:
- Knowledge and understanding of a broad range of basic sciences and the related capacity to summarise and perform analysis,
- Aptitude to use the scientific and technical resources related to a specialty,
- Understanding of engineering methods and tools: identification and resolution of problems, even those that are not familiar and not fully defined, possibly using experimentation, innovation and research, the collection and interpretation of data, the use of computing tools, the analysis and design of systems,
- Capacity to join an organisation, to lead it and drive it forward: self-awareness, team spirit, commitment and leadership, project management, project coordination, communication with specialists and non-specialists alike,
- Aptitude to take on board professional issues: corporate spirit, competitiveness and productivity, innovation, intellectual and industrial property, respect for quality procedures, security, health and safety in the workplace,
- Aptitude to work in an international context: command of one or more foreign languages, cultural open-mindedness, international experience, business intelligence,
- Aptitude to put sustainable development principles into practice (environment, economy, labour and corporate governance), as well as to consider and foster other societal values (endorsing social values, responsibility, ethics, health and safety).
- Aptitude to conduct investigations.
- Capacity to follow through on their professional choices and fit into a professional context.

2.2– **European accreditation of engineering programmes – The EUR-ACE project**

A few years after its creation, the Bologna process starts to successfully implement common "readability" of degrees, comparability of qualifications and shared QA standards in an increasing number of countries. However, the quality assurance activities were driven by nationally-based institutions with little transnational

evaluation of educational programmes; this point was underlined by the European Commission (EC), which noted in 2004 that "while throughout the world several recognition agreements are active, no shared European accreditation or recognition system exists"[2].

The EC was particularly concerned, since in the same time, it was developing directives for recognition of professional qualifications with the final objective to build a European job market.

This drawback was particularly evident for the engineering domain, where academic and professional qualifications are strongly linked.

In 2004, the European Commission launched the EUR-ACE (European Accredited Engineer) project. The EUR-ACE project [7] aims to develop a framework for the accreditation of engineering degree programmes in the European Higher Education Area, with the following objectives:

- to respect the great diversity of engineering education within the European Higher Education Area,
- to create a system of accredited engineering programmes that share common objectives and outlooks,
- to facilitate transnationals recognition of academic and professional qualifications.

This project supported is driven by the ENAEE association (European Network for Accreditation of Engineering Education), which has defined the EUR-ACE outcome-based Framework Standards, i.e. the capacities or abilities that must be acquired by engineers in Europe and the criteria for the accrediting agencies.

Like most recent accreditation standards, these frameworks are outcome-based: i.e. the learning outcomes to be reached are stated, but it is not indicated how they should be achieved [7]:

- Knowledge and Understanding;
- Engineering Analysis;
- Engineering Design;
- Investigations;
- Engineering Practice;
- Transferable Skills.

The specific peculiarity of the EUR-ACE Framework Standards is the provision for accreditation at the First Cycle (Bachelor) and Second Cycle (Master) level, consistent with the "Bologna Process" approach. Thus, while other standards specify only one set of outcomes to be met, for each outcome the EUR-ACE Standards differentiate between the requirements for FC and SC graduates (see ref. [7]).

ENAEE has created a label (the EUR-ACE® label) awarded to engineering programmes which fulfil its standards , this label is not directly given by ENAEE but by accreditation and quality assurance agencies that it authorizes.

The characteristics of the EUR-ACE label [6] are:
- It encompasses all engineering disciplines and profiles, is internationally recognised and facilitates both academic and professional mobility.
- It gives international value and recognition to engineering qualifications, and is awarded to programmes which fulfil the programme outcome standards as specified in the EUR-ACE® Framework Standards.
- It respects the great diversity of engineering education within the European Higher Education Area and,
- has created a quality system for accredited engineering degree programmes that share common objectives and outlooks.

At the end of 2011, 7 agencies are authorized by ENAEE to deliver the EUR-ACE label:
- **ASIIN** (Accreditation Agency for Study Programmes in Engineering, Informatics, Natural Sciences and Mathematics), Germany
- **CTI** (Commission des Titres d' Ingénieur), France
- **Engineers Ireland**
- **RAEE** (Russian Association for Engineering Education)
- **Engineering Council**, United Kingdom
- **Ordem dos Engenheiros**, Portugal
- **MÜDEK** (Association for Evaluation and Accreditation of Engineering Programmes), Turkey

The first programmes were awarded in 2008; in 2012, the total number of 1 000 is at hand (see Table 1)

Agencies	Countries	First Cycle	Second Cycle	Total
AASIN	Germany, Switzerland	184	150	334
CTI	France, Belgium, Bulgaria, Burkina Fasso, China, Morocco, Spain, Switzerland, Viet Nam ...	–	229	229
Eng. Ireland	Ireland	70	25	95
RAEE	Russia, Kazakhstan	46	50	96
Eng.C.	United Kingdom	4	26	30
Ord. Eng.	Portugal	0	6	6
MÜDEK	Turkey	111	–	111
	Overall total			901

Table 1: EUR-ACE accredited programmes (mid-2011).

Several procedures are undergone to enlarge, in the EUR-ACE system beyond the initial core of agencies and countries. Three possible alternatives are at present considered (see ref [7]):

- Include other Agencies in the system, as soon as they fulfil the Framework Standards and associated requirements: this can be soon the case of a couple of organizations that are already members of ENAEE.
- In countries without any accreditation system, create a new Engineering Accreditation Agency. In the meantime, programmes may be accredited by an Agency already active in the system.
- In countries with established "general" accreditation agencies, they could require the fulfilment of specific Standards for their accreditation when this implies a professional recognition. In this case, they could be authorized to add the EUR-ACE label.

3 – Open questions and conclusions

As noted in a report to the European Parliament [8], the Quality Assurance is a relatively new process in many countries and "some *features (...) appear to require further discussion in order to allow for a higher level of trust between agencies and hence a sufficient level of transparency for users and society. Quality assurance agencies are still a relatively new feature in the EHEA. They will need to demonstrate their independence and professionalism to build trust among stakeholders. They will further need to convince their European peers that they offer a sufficient level of comparability, which is important as a precondition for the cross-recognition of degrees and the promotion of student mobility"*.

To achieve these goals, the report has noted several "good practice" and proposes several action lines like: encouragment to use the services of registered agencies outside their country (a "good practice" of CTI), joint evaluations/accreditations by agencies from different countries (another "good practice" of CTI), or the development of transparency tools.

Within the EHEA, many agencies are operating (about 40 are full members of ENQA), the most numerous are general agencies ; a minority are specialized to specific domains (like CTI). There is a vivid debate about the interplay between general agencies and subject-specific agencies: the former estimate that the priority should be quality assurance processes solely based on the European Standards and Guidelines and question the specific contribution to quality assurance of subject-specific labels. If both general and subject-specific agencies are devoted to continuous improvement of higher education quality, the subject-specific agencies focus much more on the programmes outcomes, on their fitness to fulfil economy and society needs, and on the graduates' employability.

They have however to work within the same area and to interact with the same institutions; then agencies and institutions have to provide a satisfactory answer to the following questions: "How to combine evaluation and accreditation cultures? How

to conciliate the sometimes confronted objectives of quality enhancement and accountability?"

To understand better the underlying problems, CTI -as a subject-specific agency- has performed joint missions with general agencies. The most recent case has concerned the evaluation/accreditation of the engineering programmes in the French Community of Belgium; CTI acts in collaboration with AEQES ("Agence pour l'évaluation de la qualité de l'enseignement supérieur"), agency in charge of quality evaluation of the higher education in the French Community of Belgium.

The joint mission has to match two different objectives:
- The evaluation of the programmes in order to comply with the national requirements, established by the 2008 AEQES decree.
- The accreditation of the programmes according CTI's accreditation criteria. This exercise would thus provide access to the expected outcomes of CTI's accreditation: the "admission" of the programmes by the French government and the EUR-ACE label.

Although the mission is not yet fully accomplished, it is clear that there were no hindering difficulties to agree on a certain set of basic principles and to set a basic work framework. But the differences between evaluation and accreditation have a strong impact on the organizational culture of the agencies and on the structural elements of an external evaluation, such as the role, behavior and mission of the different panel members, or the overall attitude of HEI towards the process.

Finally, the report to the European parliament notes [8] that at both European and global level, there is a growing number of international university rankings. These are often criticised in the higher education community (by ENQA, for example) for their methodological shortfalls and their mono-dimensional approach (i.e. their focus on research achievements in 'hard sciences' and their disregard of performances of universities in areas like humanities and social sciences, teaching and community outreach).

Rankings meet a public need for clear information on higher education and can be a useful tool for comparison and contrast between HEIs and their programmes. It is generally accepted that accreditation agencies should not rank the programmes, but should provide the general public with sincere and unbiased information that they collect from their activities. The EUR-ACE label which allows to single out engineering programmes fulfilling the most demanding standards is certainly a clear step forward in this direction.

As a conclusion, one can state that ENAEE project appears able to provide European engineering education with a viable accreditation system on the continental scale, comparable with the Washington Accord. Clearly, discussions and collaborations are needed between the two systems to build trust between agencies

at the world scale and go further in the direction of a worldwide recognition of degrees and professional qualifications.

Abbreviations

ABET   Accreditation Board for Engineering and Technology
ASIIN   German accreditation agency for engineering and science programmes
CEFRL   Common European Framework of Reference for Languages
CNISF   Commission Nationale des Ingénieurs et Scientifiques de France
CTI   Commission des Titres d'Ingénieurs
EHEA   European Higher Education Area
ENQA   European Association for Quality Assurance in Higher Education
ENAEE   Engineering Network for Accreditation of Engineering Education
EQAR   European Quality Assurance Register for Higher Education
ESG   Standards and Guidelines for Quality Assurance in the European Higher Education Area
EUR-ACE   European Accreditation of Engineering Programmes
HEI   Higher Education Institutions

References

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[7] Augusti, Giuliano, 'Accreditation of engineering programmes: European perspectives and challenges in a global context', European Journal of Engineering Education, 32:3, 273 – 283
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