Chapter 4

Credits and Accreditation in the U.S.A. and Europe: Towards a Framework for Trans-National Engineering Degrees

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Developing international or multi-national programs is a critical and challenging issue for the future of engineering education. The purpose of such programs is both to encourage mobility of students in an inter-cultural multi-linguistic perspective, and the recognition of degrees and programs in a wider perspective than the national one in order to encourage the mobility of workers. For about twenty years, the European Commission, through several programs, in particular ERASMUS programmes, has implemented some tools, which are a first stage in this direction (e.g., ECTS and European Qualification Framework project). In order to put the reflection at a broader level, this chapter is the result of an Atlantis U.S.-European project aiming at giving some directions in order to set a U.S.-European degree in Real-Time Software Engineering. This chapter provides information and analysis of academic credit and program assessment and accreditation which will assist in the development of transatlantic engineering programs.

INTRODUCTION

The analysis, design, implementation, administration, and assessment of international curricula will become increasingly important in the global community of the 21st century. In support of this critical issue, the European Commission and the U.S. Department of Education have funded the ATLANTIS initiative to promote collaboration in higher education between European and American universities. One American Embry-Riddle

Aeronautical University, Daytona Beach, FL and three European universities: AGH University of Science and Technology (*Akademia Górniczo-Hutnicza im. Stanisława Staszica*), Krakow, Poland; Brno University of Technology (*Vysoké učení technické v Brně*), Czech Republic; and The University of Grenoble (*Université Joseph Fourier, Institut National Polytechnique de Grenoble*), France are presently working on the framework of a new common curriculum in real time-software systems. This two-year project "Toward International Learning Environment for Real-Time Software Intensive Control Systems" (EC grant: 2006-4563/006 001, U.S. grant: P116J060005, http://www.ilert.agh.edu.pl) was launched in January 2007. Project work is concerned with program objectives and outcomes, curriculum content and pedagogy, program administration (academic credit, course schedules, exchange of students and staff, etc.), and program assessment and accreditation.

This chapter focuses on academic credit and accreditation issues. The first section discusses academic credit systems: the European Credit Transfer System is described; the U.S. credit system is examined; and a comparison and synthesis is presented, in order to support a credit system compatible with both the US and European systems. The second section discusses and analyzes the U.S. and European program assessment and accreditation systems.

ACADEMIC CREDITS

A credit system may have two objectives:

1. To validate the fact that a module, or a course, has been successfully completed, thus measuring whether students have acquired the minimum knowledge, know-how and competencies relative to the course. This value is strategic for students if the attribution of the final diploma is based on the validation of ALL program modules. Such a system can also be used as an accumulation system for life-long learning. Another application of this system is to support students mobility:
    1. Students may transfer between universities for personal reasons or for a specialization (*permanent mobility* or *transfer student*),
    2. Students may spend part of their program in another institution during their studies (*visiting student* in the U.S. or *ERASMUS exchange* in Europe) in order to achieve a specialization or to improve multi-linguistic inter-cultural competences.
2. To grade students either within a category (e.g. [A,..,E] or [2,..,6]) or as a percentage of a maximum possible (e.g. 70 %, 14/20). In this case, students have an idea of their levels of the subject competence. This system does not by itself validate the course or module, except when some official passing-thresholds are used (e.g. as a percentage of the maximum possible). This system can provide a ranking or classification of students. Such system, under certain rules, allows that a lower grade in one course can be compensated by a good grade in another one resulting in total average qualifying for graduation.

Another aspect is the amount of credit given to a course or module. This amount will have consequences when a compensation system is used for the final attribution of the diploma, or when the final diploma is given when a certain amount of credits are successfully passed.

On a *quantitative* basis, two criteria can be used to define the amount of credit:

1. The actual number of hours the students spent in pedagogical sequences i.e. contact hours (course, exercises, labs, conferences) when their participation can be objectively measured. This system is also used to quantify the time spent by a teacher in the class. The weak point of this system is that it is difficult to measure the actual student workload which deals with individual work, projects, etc.
2. The actual workload for students considering all the time dedicated to work on the course: not only the contact hours but also personal work, academic projects, etc.

On a *qualitative* basis, the previous values can be modulated by a ponderation coefficient as a function of the "importance" given to some courses. For instance a basic course may have a "0" ponderation since it is considered that the competences gained from this course will be set and evaluated in a downstream course. On the opposite, a course which is strategic for the programme (core competence) may receive a strong ponderation.

Analysis of the European Credit Mechanisms

The *European Credit Transfer System (ECTS)* [1, 2] has been introduced to facilitate and emphasize the mobility of students among European Higher Education Institutions. ECTS is used to measure the actual workload of the students for a given course. This workload includes all the pedagogical components: lectures, seminars, independent and private study, preparation and presentations of projects, examinations, placements, dissertation work - thus reflecting the quantity of work. Hence, it is based on a student-centered approach.

A complete year is equivalent to 60 ECTS, and the credits are allocated on a relative basis. The ECTS credits can only be obtained after successful completion of the required work and appropriate assessment of the course learning outcomes. The results are Boolean, which means either a student passes the exams and gets the corresponding credit, or does not succeed and gets zero credit. Using this system alone, it is not possible to assess the level of student competency.

An ECTS grading scale is proposed to rank the students on a statistical basis. Grades are assigned among students with a passing grade as follows: A best 10%, B next 25%, C next 30%, D next 25%, and E next 10%.

A distinction is made between the grades FX and F that are used for unsuccessful students. FX means: “fail- some more work required to pass” and F means: “fail – considerable further work required”. This system is controversial and can only be used with a "statistically" representative number of students in order to have meaning.

From the administrative and management points of view, the European commission proposes the following accompanying documents [2]:

- The *Application Form* is the agreement to be signed by the partners.
- The *Learning Agreement* contains the list of courses to be taken with the ECTS credits which will be awarded for each course.

Course unit code	Title of the course unit	Duration of the course unit	Local grade	ECTS grade	ECTS credit
RT-M7	Security of information systems	1S	14/20	B	4

TABLE 1
EXAMPLE OF THE USE OF THE TRANSCRIPT OF RECORDS

- The *Transcript of Records* documents the performance of a student by showing the list of courses taken, the ECTS credits gained, local or national credits, if any, local grades and possibly ECTS grades awarded. Table 1 gives an example of such a record for a single course.
- The *Diploma Supplement* [3] is a document attached to a university diploma providing a standardized description of the nature, level, context, content, and status of the studies that were successfully completed by the graduate. The purpose of the Diploma Supplement is to provide a description of the competences acquired by the students not only as a function of the various pedagogical sequences which were validated, but also as a function of various specific activities (elected course, animation of associations or societies, social activities if these are recognized and validated by the pedagogical team).

The ECTS can be used in an enhanced version as a *European Credit Transfer and Accumulation System* (note the term "Accumulation"). In this case, not only the number of credits required for the specific qualification is used, but also a set of sub-rules in relation to the level at which those credits must be obtained as well as the type of course. Wagenaar [4], from the TUNING [5] project, proposes the following classification:

- Basic Level Course: Introduction in a subject.
- Intermediate Level Course: Deepen basic knowledge.
- Advanced Level Course: Further strengthening of expertise.
- Specialized Level Course: Building up knowledge and experiences in a special field or discipline.

Also, in order to characterize the level attained by the student, "types of courses" are defined:

- Core course (part of the core of a major program of studies).
- Related course (supporting course for the core, such as science, mathematics, project management…).
- Minor course (elective, optional course or subsidiary course).

These works were preliminary works for the introduction of the *European Qualifications Framework* (EQF) for lifelong learning [6]. This framework defines three criteria:

- Knowledge: described as theoretical and/or factual.
- Skills: cognitive (use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).
- Competences: responsibility and autonomy.

For each criterion, 8 levels have been defined from the basic to the "most advanced frontier of the field of work or study".
The EQF proposes the following equivalence between the level of a course and the cycles of study:

- The descriptor for the *higher education short cycle* (within or linked to the first cycle), corresponds to the learning outcomes for EQF level 5.

- The descriptor for the *first cycle* in the Framework for Qualifications of the European Higher Education Area in the framework of the Bologna process corresponds to the learning outcomes for EQF level 6.
- The descriptor for the *second cycle* in the Framework for Qualifications of the European Higher Education Area in the framework of the Bologna process corresponds to the learning outcomes for EQF level 7.
- The descriptor for the *third cycle* in the Framework for Qualifications of the European Higher Education Area in the framework of the Bologna process corresponds to the learning outcomes for EQF level 8.

The EQF was formally adopted by the European Council on 14 February 2008, following its adoption in October 2007 by the European Parliament.

The ECTS alone does not give a complete representation of the level of the course. Representative of the level of the course, the *EQF* proposes descriptors for qualifications awarded to students that signify completion of the following: Higher education short cycle (within first cycle), Bachelor, Master, Doctorate.

Descriptors draw upon other sources some of which are associated with national frameworks of qualification. The descriptors describe various kinds of knowledge, skills, competencies, for each of the various levels and the implementation of the competences is different as a function of the level of the degree [7].

Mechanism of credit transfer at U.S. Colleges and Universities

In the United States, there is no national policy or procedure for transfer and acceptance of credit from one academic institution to another; that is, there is no system similar to the ECTS for governing or administering the transfer of academic credit.

Transfer policies and procedures vary from state to state and from institution to institution. Hence, transfer of credit on a nation-wide basis is complex, and sometimes confusing and inconsistent. The list below describes a variety of transfer categories [8]. These categories presume all colleges and universities are regionally accredited and are either public or independent (not-for-profit).

- Two-year (A.S "Associate of Science" degree and A.A "Associate of Arts" degree) to four-year colleges and universities: Students completing an associate degree from a community college often can receive full credit and junior standing at another state institution through articulation agreements. Such "two-plus-two" arrangement allows the student completing the associate's degree and move directly into a coordinated upper level program to complete the bachelor's degree. Credit transfer to a two-year college from another institution (four-year or two-year) is handled similar to that described in the below paragraph (four-year to four-year).
- Four-year to four-year colleges and universities: Are typically not covered by formal arrangements. There may be situations where students enrolled as a regular or "non-degree" students, accumulate credits and then wish to transfer them to their "home" institution. The credits often will transfer, but may be accepted only as elective credit or as credit that does not count toward the degree.
- Four-year to two-year institutions: Some students take a reverse path having completed some coursework at a four-year institution and subsequently seeking a degree at a two-year institution. Credit transfer is handled similar to that described for “four-year to four-year” transfers.

- Multiple credits from multiple institutions to a "home" institution: A student may take courses from a variety of institutions, hoping to "bank" them eventually at an institution and earn a degree. This can work, but credits earned in this fashion are subject to greater scrutiny.
- Proprietary (even when regionally accredited) to public and independent institutions: Students attempting to transfer credit from a proprietary institution to a public or independent college or university often face a loss of credit in the transfer process.
- Credits earned through assessment, prior learning, credit equivalency, and other non-traditional means to a "home" institution: There are significant differences in institutional policy regarding the acceptance of credits earned through alternative methods, both in terms of the number that might be acceptable and use of the credits.

Institutions and academic degree programs are accredited by various organization and agencies. Accreditation organizations (state, regional or professional) typically specify high-level requirements for acceptance of transfer credit. The following two examples are from SACS and ABET.

The *Southern Association of Colleges and Schools (SACS)* [9] is the recognized regional accrediting body in the eleven U.S. Southern states (Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas and Virginia) for those institutions of higher education that award associate, baccalaureate, master's or doctoral degrees. SACS specifies that *"The institution has a defined and published policy for evaluating, awarding, and accepting credit for transfer, experiential learning, advanced placement, and professional certificates that is consistent with its mission and ensures that course work and learning outcomes are at the collegiate level and comparable to the institution's own degree programs"*.

The Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET) [10] is responsible for accrediting U.S. engineering programs. EAC specifies the following criterion regarding transfer credit: "*The institution must have and enforce policies for the acceptance of transfer students and for the validation of courses taken for credit elsewhere"*.

Because of the variation and flexibility in awarding and transferring academic credit, the possiblity of adopting an academic credit system similar to ECTS in the U.S. would be extremely challenging and is highly unlikely.

Synthesis on the credit transfer in the U.S. and Europe

Both in Europe and in the U.S., credit systems are designed to evaluate students and to provide for student mobility between institutions.

When credits are used for the *evaluation* of students, the situation is the same in the U.S. and in the European countries (note that at this stage European countries generally use their own national or local grading systems). The credits are given after a term in order to continue the academic curriculum or after the completion of a complete curriculum in order to obtain the final diploma.

When credits are used for *permanent mobility*, appropriate "equivalences" must be found. The rules of equivalence could vary depending on institutions or programs, but generally students will keep a record of their results in the originating university and will go to the new university through an admission procedure. This admission procedure will be based on the type and content outcomes of the "transfer" courses.

In Europe, ERASMUS introduced a *transient mobility* to encourage students to spend part of their studies abroad, to work in multinational muti-lingual multicultural environment and also to appreciate the European dimension. A student going abroad, for a semester or a year, pursues courses which are considered equivalent by the originating university. Typically, the student gets the diploma from the originating institution.

The same situation exists in the U.S.A., with the transfer credits earned from the host institution, allowing the students to go to another institution in another state or abroad. Bi-national degrees and diplomas exist both in the U.S.A and Europe.

ASSESSMENT AND ACCREDITATION

In this section there is a discussion of accreditation issues from a transatlantic perspective. Current requirements prescribe that a transatlantic curriculum should be accredited both in the U.S. and each of the European partners.

In the U.S., ABET and the EAC manage accreditation of engineering programs. Although there is no formal relationship between ABET accreditation and state licensing of engineers, graduation from an ABET accredited program is a typical requirement for licensing. In Europe, despite the existing European project EUR-ACE, described below, there exists no single European accreditation agency or mechanism responsible for accreditation of engineering programs. Although the accreditation process is under the responsibility of the member states in Europe, accreditation criteria and processes proposed at the European level are being integrated into national accreditation systems. In the future, procedures in the member states could be based on a common set of European accreditation principles and methods.

In the following sub sections are presented the principal features of ABET, elements of the EUR-ACE project, and other considerations on accreditation systems in the member states of the European Union.

Accreditation Board for Engineering and Technology

In the U.S. system for engineering accreditation, ABET provides the general accreditation policies and procedures [10] and the EAC [11] specifies eight general accreditation criteria:

- Criterion 1. Students
- Criterion 2. Program Educational Objectives
- Criterion 3. Program Outcomes and Assessment
- Criterion 4. Professional Component
- Criterion 5. Faculty
- Criterion 6. Facilities
- Criterion 7. Institutional Support and Financial Resources
- Criterion 8. Program Criteria

Criteria 2 and 3 are particularly critical to the assessment and accreditation process: they require an engineering program to have long-term objectives for program graduates and more specific outcomes associated with recent graduates. Although the EAC is flexible in allowing programs to determine their own objectives and outcomes, it does specify eleven general outcomes that each program must include. Two examples of such required outcomes are as follows: each program must show that its graduates have the ability to “function on multi-disciplinary teams” and to “design a system, component, or process”. This “outcomes assessment” approach is typical of many 21st century accreditation processes.

Criterion 8 is specific to the type of program being accredited. This is an area where specific course material or faculty qualifications might be designated. For example, the program criterion for software engineering requires that a program demonstrate that its graduates possess knowledge and skill about each of the phases of the software lifecycle.

U.S. undergraduate programs typically require four years of study. The EAC requires at least one year of science and mathematics and at least one and one-half years of engineering material. Although ABET concentrates on undergraduate programs there is provision, in some limited cases, for accreditation of graduate programs.

EUR-ACE

A proposed European system for engineering accreditation is specified in [12] as part of the EUR-ACE (Accreditation of Engineering Programmes) project, in collaboration with the European Network for Accreditation of Engineering Education. The “Framework” document [12] is organized into four sections, which present the requirements for accreditation of a European engineering program:

- Section 1: Programme Outcomes for Accreditation.
- Section 2: Guidelines for Programme Assessment and Programme Accreditation.
- Section 3: Procedures for Programme Assessment and Programme Accreditation.
- Section 4: Template for Publication of Accredited Programmes.

EUR-ACE presents two levels of accreditation: First Cycle and Second Cycle. EUR-ACE envisages that First Cycle (Bachelor) programs will have at least 180 ECTS credits (approximately three years of study) and Second Cycle (Master) programs will have at least 300 ECTS credits (five years of study), including the First Cycle level.

EUR-ACE specifies the following outcomes for First Cycle graduates:

- 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 (in addition to the First Cycle outcomes):

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

Comparing ABET-EAC and EUR-ACE

Both EUR-ACE and ABET-EAC prescribe an accreditation process that is focused on program objectives and outcomes. An analysis of the common features of the objectives and outcomes shows a great deal of similarity between the two. However, EUR-ACE puts greater emphasis on engineering analysis, project management and business practices, while the ABET-EAC highlights an understanding of contemporary issues, and professional and ethical responsibility. Both accreditation processes require periodic selfassessment, external review and they make judgments about accreditation in a similar manner.

It is clear the two approaches are similar in their goals, requirements and processes. The chief area of difference is in the curriculum requirements and the required length of study. The EAC requires specific curricular areas (math, science, engineering, general education, design experience), over a four year period, while the EUR-ACE first cycle specifies at least 180 ECTS credits (about three years) and does not specify curricular areas. It certainly seems possible to develop an engineering curriculum that could satisfy both sets of requirements – a three year program for Europe and an additional year of general education added for a U.S. program.

Accreditation systems in the member states of the European Union

Despite existing reflection for a European frame for accreditation, the situation of accreditation today in Europe is nationally-based. The accreditation procedures can differ also depending on the kind of syllabus. Generally speaking, the methodologies for accreditation can be based on the following:

- Accreditation of an institution: school, institute, department, (ex: CTI, *Commission des Titres de l'Ingénieurs*, Commission for the Title of Engineer, in France).
- Accreditation of a syllabus, or a program, (ex : VDE, *Verband der Elektrotechnik Elektronik Informationstechnik e.V,* in Germany).
- Accreditation of a course and/or an experience (ex : IEE in United Kingdom, *Ordem dos Engenheiros*, Order of Engineers, in Portugal).

In the case of the accreditation of an institution or a syllabus, the accreditation is done on a periodic base, generally at the same time for the institution and the relevant syllabi. This approach may be refered as *structural accreditation*.

The pedagogical content must be approved by Ministry of Education, but there is generally no common program at the national level (e.g., Czech Republic, France, Poland). These regulations represent a set of general standards divided into categories that state basic requirements on information and technical provisions, personnel provisions, and the general formats of Bachelor, Master and Doctoral study programs. Some criteria used may be the number of students, the future of the students, the composition of the pedagogic team, the general policy of the university, the coherence of the global programs proposed, etc.

There are also quality control systems: in this case the monitoring procedures are carried out by commissions (composed by senates or rectors, for instance in Poland).

The accreditation process is controlled by an accreditation committee for the specific field, which examines the program and individual courses, and the qualifications of the teaching staff. There is a trend to have a further involvement of representative of the economic and industrial world (companies, professional bodies) in the accreditation committees, in order to work at par together with academics. These committees are charged with two major roles [13]:

- To assess the quality of education in individual areas of study.
- To provide advice to the minister responsible for higher education on applications to establish new higher education institutions, or to establish new study areas.

Specifically for the engineering field, some extra procedures may exist. FEANI (*Fédération Européenne d'Associations Nationales d'Ingénieurs*, European Federation of

National Engineering Associations) [14] has proposed the title of European Engineer since 1987. To receive the title of European Engineer means to registrate to the FEANI European register. This title is recognised by the 29 member states. The European Commission has recognised FEANI as "an excellent example of self-regulation at the European level … This title indicates that, whatever the duration and the content of the general education, the engineer has received a certain level of professional competences, he is recognised by his pairs, at the national level as well as the European level" [15].

Parallel to this structural accreditation process, for institution and syllabus, there also exists accreditation procedures for a course and/or experience; this procedure can be called *personal accreditation*. This is achieved for instance in UK (IEE) or Portugal (*Ordem dos engenheiros*) where not all students get the title of engineer. In fact, in these countries the title of engineer is mainly a professional title given to some of the former students, after some years, whereas in France it is given only to students who pass a "diplôme d'ingénieur" (who follows a course in a "Ecole d'Ingénieurs") whereas in Germany, Benelux or Scandinavian countries there are two kinds of engineers: engineers from traditional universities and FH engineers from Fachhochschülen i.e. Universities of Applied Sciences. In USA, a graduate for an ABET accredited four year university engineering program may receive Professional Engineer (PE) license issued by a specific state. The process requires completing Fundamentals of Engineering examination, accumulate up to four years of experience under supervision of a licensed PE, and pass a rigorous written examination: Principles and Practices in Engineering.

DISCUSSION AND SUMMARY

The organization of an engineering transatlantic program, which could ideally be accredited and recognized on both coasts of the Atlantic Ocean, requires one to precisely define the expected learning outcomes. Subsequently, the content of the syllabus should be defined. The setting of credits, taking into account the various pedagogical sequences (courses, exercises, labs, personal works, projects…) should be defined as a function of the workload of students to fit appropriately with the learning outcomes. In order to be able to evaluate the "level" of a course, the use of descriptors should be used,

The accreditation of an academic program, especially an engineering program, is essential in order to verify its relevance, quality and currency. Both Europe and the United States have viable accreditation processes in place. Although the European processes are more diverse, at least at the moment because there are no official European standards, the EUR-ACE project holds hope for a common process that could be quite easily integrated with the ABET-EAC process, in order to develop a transatlantic accreditation system that would serve the best interests of their universities, their faculty, their student and the public in general.

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