

# **New Trends of Electrical and Information Engineering Higher Education in Europe**

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## **1. Introduction**

Higher education all over the world is undergoing a series of changes. The most important ones are: the impact of globalization on higher education; new roles of higher education and research in the knowledge society; the impact of ICTS on higher education and the relationship between the world demographic trends and their impact on higher education in the future.

The constant and growing amount of exchanges amongst researchers and professors, the many joint projects undertaken by international groups and the increased mobility of undergraduate and graduate students, encouraged by the establishment of Exchange programs such as Erasmus, demand for a new paradigm in higher education.

The most important changes that arise in this new context are:

- Meeting the demand for increased access to higher education
- Transnational education
- ICT's application in higher education
- Quality assurance, accreditation and the international recognition of studies and qualifications
- Funding higher education
- Status of higher education teachers
- The role of Continued Education in the permanent updating of knowledge and skills.

This is especially applicable in electrical and information engineering where there is a tendency already, to two tier systems, mainly arising from the British and German technical courses tradition.

Innovative approaches to the internal functioning of higher education are implemented through two independent processes: curriculum reform and the use of ICT.

Regarding the first, common core structures of study programs, modularization and the adoption of the credit system, are emerging as the most important tools to achieve that goal. Besides, these tools have several potential benefits in terms of mobility of students, flexibility of higher education programs, and international recognition of studies and qualifications.

The Bologna Declaration on the creation of the European Higher Education Area (EHEA) which will be achieved in 2010, has given rise to a process that favours the convergence of various educational

systems in order to achieve greater transparency and compatibility for study programs and degrees, and promotes the adoption of a higher education system essentially based on three main cycles — Bachelor, Master and Doctorate.

In this paper we analyze the impact of these changes in the new course architecture and propose some guidelines for future syllabus.

## **2. The BMD model and its impact on EIE Education**

The Bologna Declaration in 1999 is a strategic plan for achieving the integration of all the higher education systems in the European Union by the end of the year 2010. Its goal is to coordinate the diverse higher education systems that function in the different member countries so that they can become more transparent while respecting the cultural diversity and autonomy of each university. This model favours not only a common credit system (ECTS) that allows an easy homologation that promotes mobility amongst undergraduate and graduate students, but also favours an earlier integration in the labour market, by shortening the duration of the first cycle to three or four years, a second cycle of 2 years and finally the doctorate to be achieved in three years.

The corresponding titles are denominated Bachelor, Master, and Doctoral degrees- also known as the BMD model.

Hence, it is necessary to evaluate the possibility of implementing pedagogical strategies, make adjustments in the teaching and evaluation areas, design flexible curricular structures, optimize academic study periods and using information and communication technologies (ICTs) within our own universities in order to be more efficient in terms of the time required for the training of engineers. Quality and efficiency are fundamental for any educational process.

The main concern is that the standardization of educational systems may overlook the cultural diversity of the countries and, therefore, be insensitive to their specific local or regional needs. Some fear that traditional schools may disappear because of the Internet, while others discuss the internationalization and Americanization of the contents of some programs. The problem, undoubtedly, is a serious one. There are universities everywhere that are good and efficient, as opposed to others that are unable to guarantee a minimum training for their students.

It is therefore necessary to reach international agreements for quality assurance, accreditation and recognition for programs and titles that reduce the risks generated by globalization and insure quality in the educational systems.

The idea of mutual recognition of national systems of quality assurance is important and essential.

From what has been explained above it is evident that, due to the rapid growth and expansion of higher education, it is urgent to establish world-renowned mechanisms for quality assurance in the

sector. The challenge is to seek the best way to maximize benefits and minimize the dangers of a global higher education system.

The convergence of higher education in Europe is now gaining way, even with all of its uncertainties and challenges, its difficulties and appeal, thanks to the crucial help of universities, academics and students that have joined in the struggle after the initial stage, during which decisions were made on a political level.

When faced with the challenge to adopt a new paradigm based on the first two cycles (bachelor and master) to replace longer term courses with a typical duration of five or six years, there are problems that arise in the process of transition.

1. What should be the minimum content needed for this first cycle to offer training that will enhance job performance?
2. There is a justifiable concern of lowering quality standards due to the reform requiring a reduction of the content levels.
3. How to clearly differentiate these new titles from the ones already being offered in technological or similar level programs?

Along with reforming the structures of existing titles, the content of study programs must also be pondered. A curricular reform per discipline is therefore irreversible. In this context, the greatest challenge is figuring out how to go from teacher-focused learning models to student-focused learning models.

According to the current ECTS system a 15 weeks semester of higher education corresponds to 30 credits and 1 credit is proportional to the student workload, including classes, individual work and exams.

Regarding undergraduate degrees, there is a clear trend across Europe toward assigning between 180 and 240 ECTS credits, equalling 3 to 4 years full-time study, while graduate degrees at Master level normally carry 60-120 ECTS credits. As the length and the content of Bachelor degrees vary, there is a need to have similar flexibility at the Master level. The most common pattern appears to be: 180 credits Bachelor+120 credits Master.

These considerations were the backbone of the Thematic Network (TN) EIE-Surveyor proposal. The new thematic network was launched based on the results of the *THEIERE* project [1], [2] ([www.eaeeie.org/theiere](http://www.eaeeie.org/theiere)) during which an observatory on the implementation of the Bologna process [3] in EIE throughout Europe was established.

*EIE-Surveyor: Reference Point for Electrical and Information Engineering in Europe* ([www.eie-surveyor.org](http://www.eie-surveyor.org)) has been a three-year European ERASMUS TN running from October 2005. The main objectives of this thematic network are:

- a reflection on generic competences and subject-specific competences in Electrical and Information Engineering (EIE),

- an implementation of quality assessment methodologies on some educational resources available in EIE,
- a reflection and proposition of a methodology for accreditation, in order to enhance comparability and common certification procedures,
- a census of the existing curricula in EIE in Europe, the multinational degrees, and the situation of the implementation of the Bologna-process in EIE, at the bachelor, master and PhD levels.

### **3. The EIE-Surveyor consortium**

This TN comprises 107 European academic institutions representing 29 eligible countries (all the 27 current EU countries except Luxembourg) plus Norway, Iceland, Turkey, and 2 non eligible countries (Ukraine and Lebanon). Besides the academic institutions some other organisations, such as: industrial companies, research institutes and societies, are involved in the network: BEST (Board of European Students of Technology), EAEEIE (European Association for Education in Electrical and Information Engineering), IEEE French and German chapters on Education and the French Club EEA ([www.clubeea.org](http://www.clubeea.org)).

The goal of the project is to become a reference point in EIE and, at the same time, to enhance the attractiveness of the European Research Area (ERA), the links with industry, and to participate in the continuous evolution of higher education in Europe. To answer these needs, the ongoing activities of the project, as identified in the contract, are:

- the setting up of common definitions about the competencies to define the paths of the students, during their studies,
- the analysis of accreditation procedures and methodologies all over Europe (and also in third world countries) in order to make some propositions for a common or shared approach, throughout Europe, in order to enhance comparability of curricula and recognition of diplomas,
- the setting of quality assessment of some pedagogical resources available in EIE in Europe,
- the state of the art of the implementation of the Bologna process in EIE in Europe, the various curricula available, at the Bachelor, Master and PhD levels,
- the existence of international curricula.

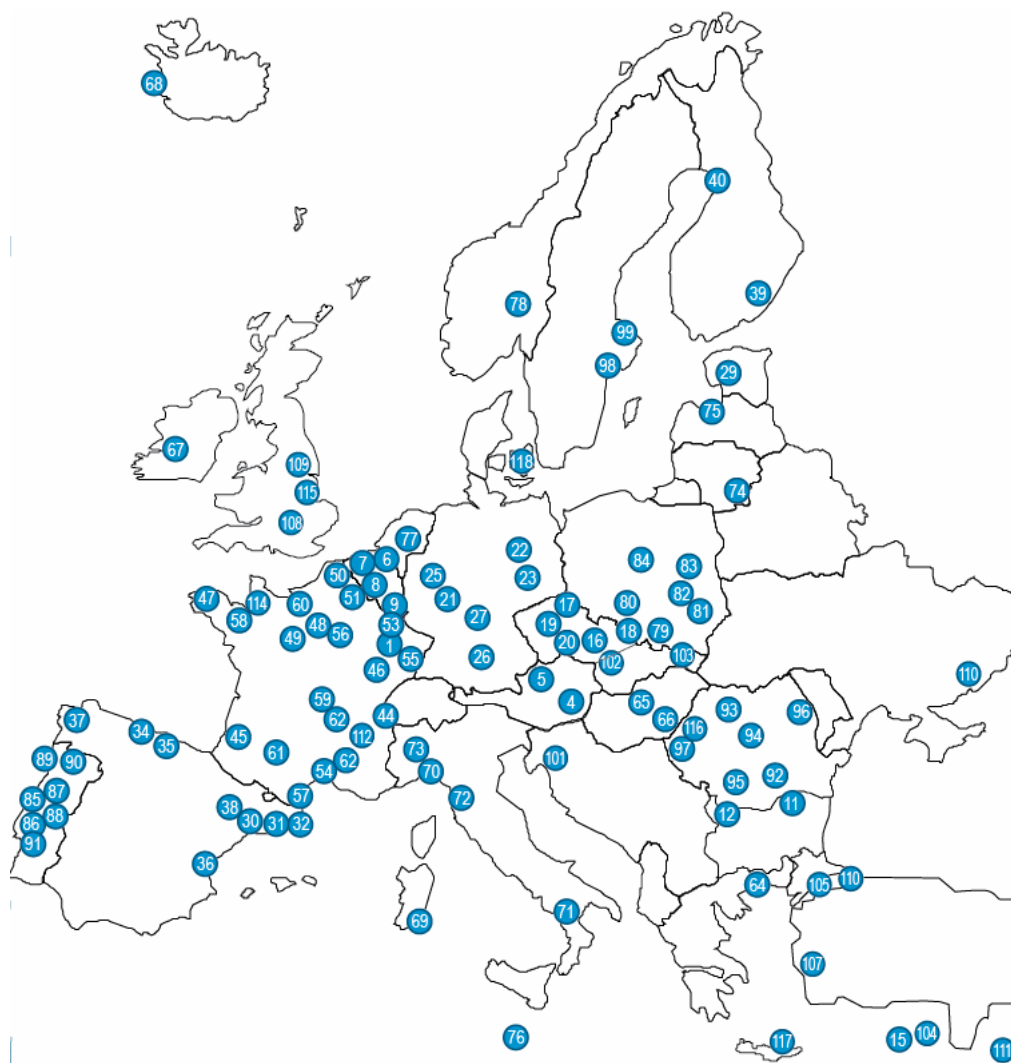


Figure 1- The EIE-SURVEYOR consortium

#### **4. Description of the study**

##### **(A survey of the Bologna process in EIE at the bachelor, master and PhD levels)**

The activities in this task are the finalization and update of the maps of European undergraduate and postgraduate studies. As mentioned previously, a monograph (Collective, 2003) [4] was published during the THEIERE project (2000-2003), but some countries were still to be completed and some information needed to be updated because the situation was still evolving. Another monograph issued during the THEIERE-DISS project (2004-2005) [5], concerning an overview of PhD studies must be completed, together with the identification of the existing links between masters and PhDs, taking into account the master courses which will prepare the students for PhD studies.

## **5. Comparative analysis**

The construction of the European Higher education Area until 2010 is the aim of the Bologna process. Since then follow-up conferences in Prague (May 2001) and Berlin (September 2003), have reviewed some of the initial objectives.

A three-cycle system was established, with a common credit system – ECTS. The first cycle, entitled **Bachelor** should not last more than 4 years, with a number of credits varying from 180 to 240 credits. The second cycle – **Master**, after the first degree, should require 90 to 120 credits. The third cycle-**Doctorate**, should not last longer than 3 years.

The true revolution of the Bologna process also known as the **BMD (Bachelor-Master-Doctorate)** process is that the teaching-learning process is focused on learning outcomes, rather than on syllabus, with the learners as the focal point of the educational strategy.

The use of learning outcomes to define the programmes means that the content of a specific course is expressed as knowledge, competences and skills acquired, rather than on information delivered. ECTS are based on workload rather than on presential class hours. Two initiatives have defined a framework for the establishment and development of the educational process and qualification system - the Dublin Descriptors and the Tuning project [8] [9].

At present, the situation still presents a varied profile, since some countries have already applied in full the Bologna recommendations whereas others are still discussing the implementation.

An overview of the process allows the conclusion that a convergence of Higher Education Degrees has been attained at this level. The 3 cycle BMD system is used now in most European countries and the crediting system ECTS is applied in all the countries that have signed the declaration.

The Doctorate level is the one that is still under revision and presents more changes between the old and the new framework.

While the implementation of the Bachelor and Master's degrees according to the Bologna process began in 2000, the situation of doctoral studies was only raised in 2003, since access to this third cycle required a successful completion of the second cycle.

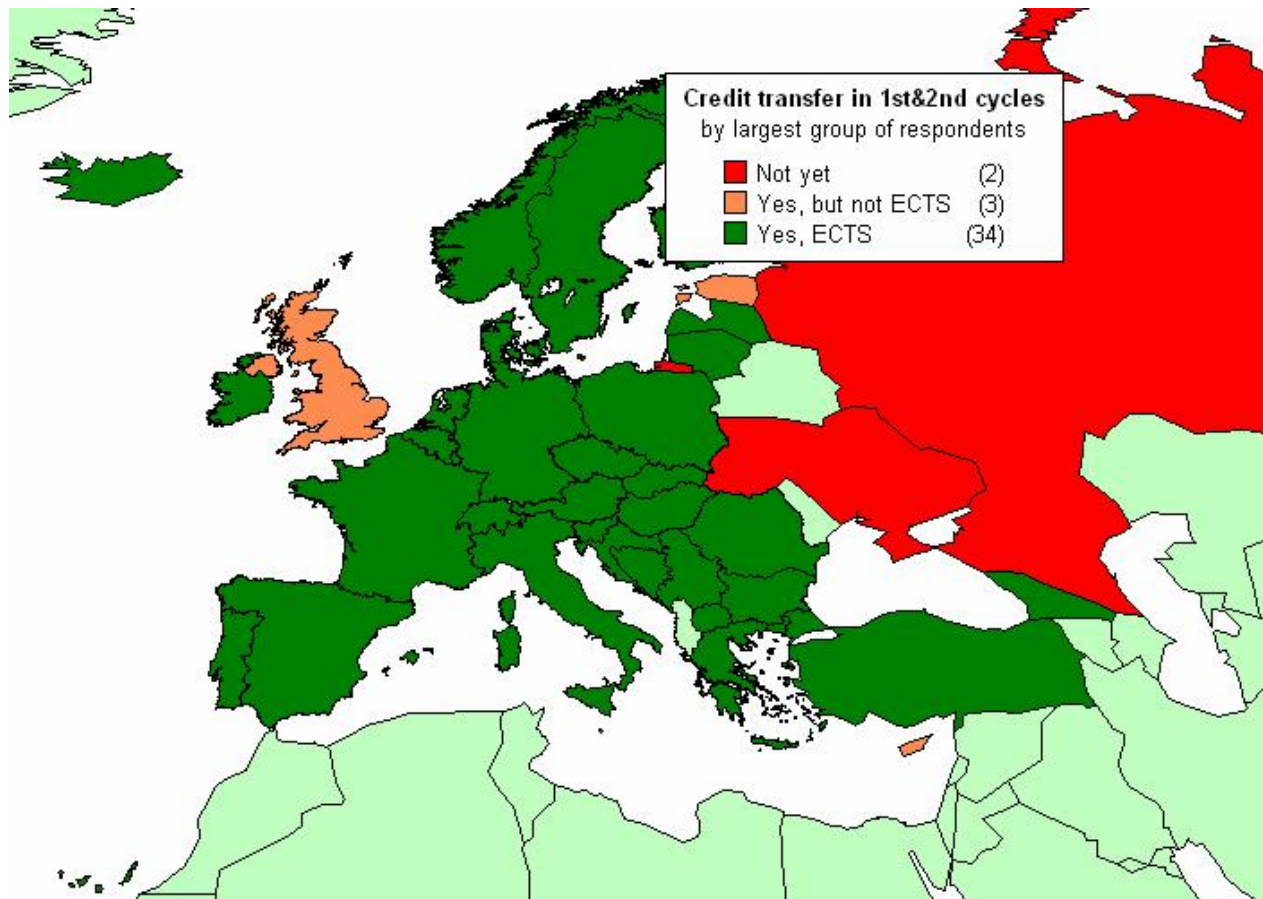
A previous study [5] showed that there were big differences in the doctorate in Europe, concerning duration, financial supports and duties, as for example complementary classes and seminars that are compulsory in some countries and non-existing in others, or with respect to duties as lecturers.

The Bologna-follow-up conference in London in May 2007, was an important step towards the reflection of the evolution in doctoral studies. The main objective is to promote a closer alignment of the European Higher Education Area (EHEA) within the European Research Area (ERA), with the aim of improving the quality and competitiveness of European higher education.

An overview of doctoral studies, shows that there is a recent trend to include, besides the thesis research work, additional lectures, seminars, summer-schools, etc. that are particularly oriented at the needs of doctoral candidates [7] (see also the following paper in this book entitled "*New trends of Doctoral studies in Europe: special considerations for the field of Electrical and Information*

*Engineering*"). Some ECTS credits are awarded for attending these events. The total workload of these events during the doctoral phase might be 50 to 150 hours in the average. It must not exceed this time in order not to put at risk successful research works.

As shown in the figure below, the integration of European higher education systems into a common crediting procedure (ECTS) is already achieved for most of the European countries with the exception of U.K. and Estonia.



**Figure 2- Implementation of ECTS in Europe**

In figure 3 is presented the state of implementation of the Bologna-B-M-D system in Europe. As can be inferred the state of implementation of the new model still presents a lot of difference between the various countries. This is due to the fact that a very important factor is the acceptance and recognition of the new model by the professional engineering associations that accredit the degrees and the needs and expectations of the labour market.

The costs associated with a change of paradigm are also a key factor that may delay the transition to a new educational framework.

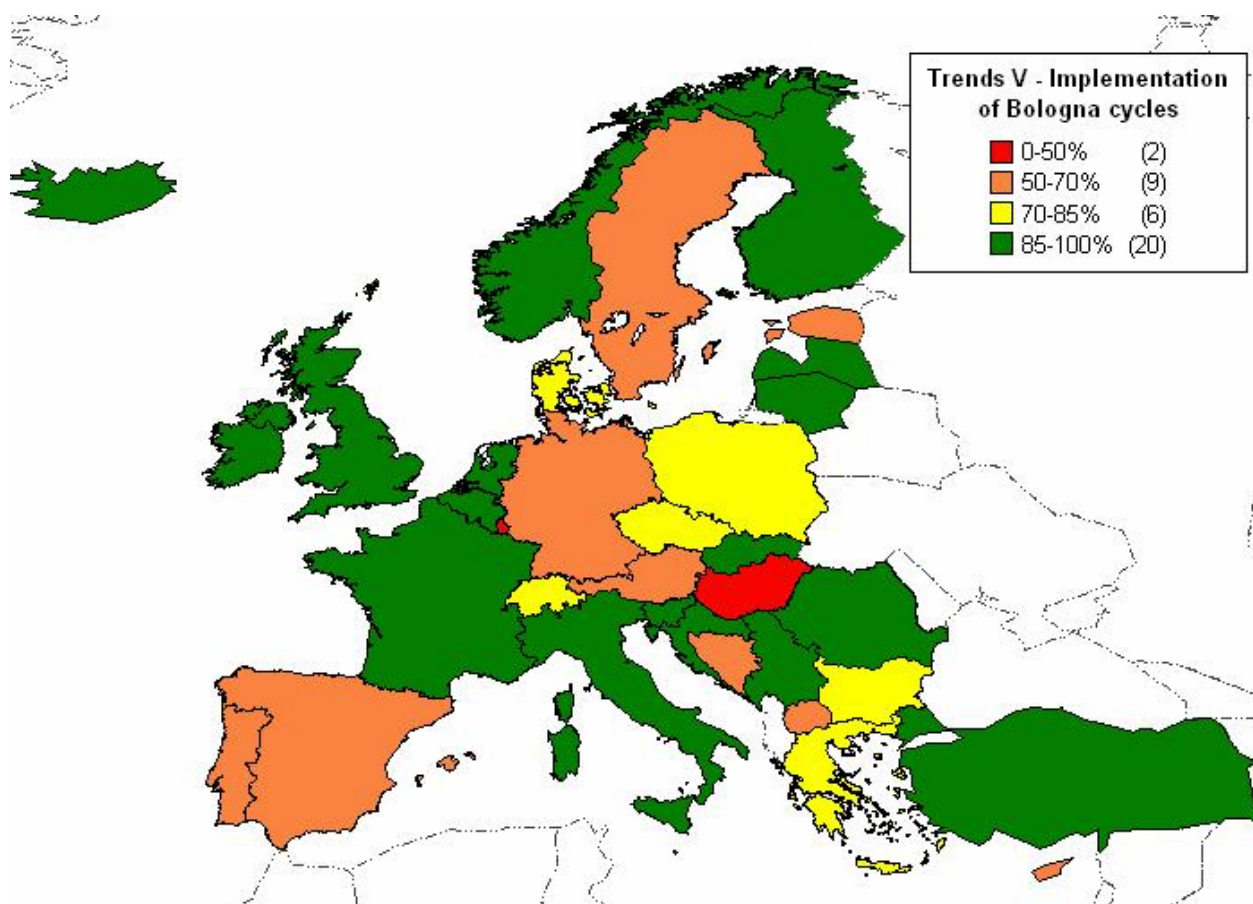


Figure 3 - State of implementation of the Bologna model in Europe in 2008.

## 6. Conclusions

This publication presents a summary of the Electrical and Information Engineering higher education in 2008. In some cases it was impossible to obtain information or an up-date of the existing information for some countries. The following pages essentially reflect a joint effort of the various EIE-Surveyor partners to provide an accurate picture of the evolution of European Higher Education in their respective countries. We will try to update the information in an interactive way by using the EIE project website (<http://www.eie-surveyor.org>).

As a conclusion we might say that the main objective of introducing a two cycle basic formation in EIE has been applied in most countries in Europe. The crediting system is now for the most part based on ECTS, which facilitates the inter-institutions recognition of diplomas and student mobility.

Doctoral studies have lagged behind and there is still a lot of controversy, namely on the weight of independent research work and the mandatory inclusion of seminars and courses also credited by ECTS.



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