THE GLOBALIZATION OF EUROPEAN ENGINEERING EDUCATION: AN AMERICAN OBSERVER’S PERSPECTIVE

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Abstract — Universities and Fachhochschulen in Europe are adopting the bachelor-masters-doctoral (BMD) system as the de facto international standard for engineering education. The driving force for this dramatic change is the globalization of economy, society, industry, and education. Globalization has created a need for European multinational companies to hire engineers with a more practical education, and for European engineering programs to better compete for graduate students from other countries and institutions. Several important activities and events are discussed including the 1997 International Symposium of Berlin on “Research and Engineering Education in a Global Society”, the Bologna Declaration on the European Space for Higher Education, the creation of the accreditation system for German engineering programs, and The creation of the Swiss Universities of Applied Science and their associated Peer Review.

Index Terms — European education, engineering education, globalization of engineering education

BACKGROUND

There are two distinct types of engineering educational programs in Europe. The “long” program is nominally 5 years in duration and is offered at the classical and technical universities. The “short” program is nominally 3 or 4 years in duration and is offered at the Universities of Applied Science or Fachhochschulen. Although these programs are designed to be either 3, 4, or 5 years, in practice the average time to graduation is longer. We refer to the 5-year programs as “traditional” university programs and the 3-4 year programs as Fachhochschulen programs. The 5-year programs equate their graduates to, at least, masters degree graduates from programs in the United States. The 4-year programs consider that their graduates compare to that of an honor graduate from a bachelor level program in the United States and the 3-year programs believe that their graduates are comparable to the graduates of 4-year engineering programs. The 5-year engineering programs are typically theory or science oriented. The 3- and 4-year programs tend to be more application oriented.

European universities and their faculties operate with a great degree of autonomy. However, recently these universities have come under increasing criticism\textsuperscript{1} from students, industry, and the public they serve. European universities teach in their national language. With the exception of universities in the English speaking countries, this limits the number of students available, as English is the predominant second language around the world. Also there tends to be little interaction or exchange of students between universities in different countries within Europe or even within the same country. It is difficult to obtain a degree from one country and then be accepted for advanced study at a university in another country.

This situation has resulted in calls for changes in the European educational system and particularly in engineering education. As a result of these and other issues, the Ministers of Education of 29 European countries signed the so-called Bologna Declaration in 1999. This Declaration is a pledge by the 29 signatory countries to reform their structures of higher education in a convergent way. This Declaration is being viewed within Europe as a key document which marks a turning point in the development of European higher education.

THE BOLOGNA DECLARATION

The official name of the so-called Bologna Declaration is “The European Higher Education Area, a Joint Declaration of the European Ministers of Education”. The Bologna Declaration is the successor to the Sorbonne Declaration of May 25, 1998 and the even earlier Bologna Magna Charta Universitatum of 1988. The Sorbonne Declaration stressed the Universities’ central role in developing European Cultural dimensions. It emphasized the creation of a European Area of higher education, as a key way to promote mobility and employability and the Continent’s overall development.

The Bologna Declaration adopts a more specific set of objectives with specific goals and deadlines for achieving them. The document states, in part\textsuperscript{2}:

“While affirming our support to the general principles laid down in the Sorbonne Declaration, we engage in coordinating our policies to reach in the short term, and in any case within the first decade of the millennium, the following objectives, which we consider to be of primary relevance in order to establish the European area of higher education and to promote the European system of higher education worldwide.

- Adoption of a system of easily readable and comparable degrees, also through the implementation of the Diploma Supplement, in order to promote European

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citizens’ employability and the international competitiveness of the European higher Education System.

- Adoption of a system essentially based on two cycles, undergraduate and graduate. Access to the second cycle shall require successful completion of the first cycle studies, lasting a minimum of three years. The degree awarded after the first cycle shall also be relevant to the European labor market as an appropriate level of qualification. The second cycle should lead to the master and/or doctorate degree as in many European countries.
- Establishment of the system of credits – such as the ECTS system – as a proper means of promoting the most widespread student mobility. Credits could also be acquired in non-higher education contexts, including lifelong learning, provided they are recognized by receiving universities concerned.
- Promotion of mobility by overcoming obstacles to the effective exercise of free movement with particular attention to:
  - For students, access to study and training opportunities and to related services
  - For teachers, researchers and administrative staff, recognition and valorization of periods spent in European contest researching, teaching and training, without prejudicing their statutory rights.
- Promotion of European co-operation in quality assurance with a view to develop comparable criteria and methodologies.
- Promotion of the necessary European dimensions in higher education, particularly with regards to curricular development, inter-institutional co-operation, mobility schemes and integrated programs of study, training and research.”

The reaction to this document appears to be enthusiastic acceptance by the 3-and-4 year Fachhochschulen. This gives undergraduate teaching institutions an entry into research and development, making it easier for them to recruit faculty and students. It allows them to create masters level programs and it gives their graduates entry into the masters/doctoral programs.

As might be expected, the acceptance of the principles of this document is much more guarded by the traditional universities with their 5-year engineering programs. SEFI, the European Society for Engineering Education, has endorsed the objectives of the document in principle but, at the same time, opposes any actions that would weaken the engineering programs at the traditional universities.

Next to the need to “achieve greater compatibility and comparability in the systems of higher education” (mainly an intra-European issue), the Declaration wants “in particular” to increase the “the international competitiveness of the European systems of higher education”. It says that the “vitality and efficiency of an civilization can be measured by the appeal its culture has for other countries”. The signatory countries explicitly express their goal to “ensure that the European higher education system acquires a worldwide degree of attractiveness equal to Europe’s extraordinary cultural and scientific traditions. In stressing so explicitly the need for European higher education as a (cohesive) system to become more attractive to students from other world regions, it provides one more reason for moving in the direction of a coherent European system and implicitly invites European institutions to compete more resolutely than in the past for students, influence, prestige and money in the worldwide competition of universities.

The ministers from the signatory countries are scheduled to meet again in Prague in May 2001, together with representatives from Europe higher education institutions and associations, in order to assess progress achieved and to agree on new steps to be taken.

The Bologna Declaration applies to all of European higher education but engineering programs appear to moving quickly to adopt its objectives and in modifying their program structures. The most apparent change is the adoption of the bachelor-masters-doctoral system at both traditional universities and Fachhochschulen. Some of the new bachelor/masters level programs are being taught in English, especially in the first one or two years of the program.

**THE EUROPEAN STANDING OBSERVATORY FOR THE ENGINEERING PROFESSION AND EDUCATION (ESOEPE)**

The European Standing Observatory for the Engineering Profession and Education (ESOEPE) is an agreement between European Accreditation Institutions for co-operation and exchange of information of mutual interest. The document of agreement was signed in Paris on September 9, 2000. The objectives of this group are to

- Facilitate the free exchange of information on educational and professional standards in Engineering
- Provide information about national accreditation systems and standards
- Facilitate agreements of mutual recognition, and
- Facilitate the development of accreditation standards.

The charter signatories of the agreement are

- The Engineering Council (EC) of the United Kingdom
- The Commission des Titres d’Ingénieurs (CTI) of France
- The Akkreditierungsagentur für Studiengänge in Ingenieurwissenschaften und Informatik (ASII) of Germany, and
- The Ordem dos Engenhiros (OE) of Portugal
Observers to this new group presently include:

- The Sistema Nazionale di Valutazione e Accreditamento dei corsi di studio in Ingegneria (SINAI) of Italy, and
- The Thematic Network “Enhancing European Engineering Education” (E4) which is supported by the European Union.

**AN EXAMPLE OF CHANGE IN EUROPEAN ENGINEERING EDUCATION - GERMANY**

Perhaps the most dramatic changes in engineering education that have occurred to date have been in Germany. German universities have a long and proud heritage. Classical European universities existed in Germany as early as 1300 AD, 200 years before the discovery of America. The industrial revolution of the mid-1800’s gave rise to the “polytechnic” or “technical” university. There was an explosion in new universities in Germany at the end of World War II and around 1970 Germany established its “Universities of Applied Science” or “Fachhochschulen”.

While the European universities served as models for the United States in the 19th century, there are widespread complaints [1] about how these universities are serving their constituents today. German industry, with strong leadership from Siemens AG, Munich, is leading the call for changes in German and also European engineering education. The driving force for these changes is the Globalization of economy, society, industry, and education. In 1995, Siemens formally complained about the decreasing attractiveness of German Universities for students from the Asia-Pacific region and in 1996 the company presented a concept for engineering education in Germany based on what it called the “de facto international standard of bachelor, masters, and Ph.D. degrees”. In 1997, Siemens convened a symposium with over 60 leaders in engineering education worldwide. These leaders represented top universities in Europe, Asia, and the United States as well as many of the universities and Fachhochschule of Germany. The theme of this symposium was “Research and Engineering Education in a Global Society”. In his keynote address to the symposium attendees, Werner Maly, Head of Corporate Human Resources for Siemens, stated that European universities must enter the global educational market on a broader basis, redesign their engineering programs to include more international content, adopt international standards, and establish greater compatibility and mutual recognition among themselves.
In 1997 and 1998, declarations supporting the concept of the bachelor-masters-doctoral (BMD) system for European universities were issued by German industry organizations (VDMA and ZVEI) and German engineering professional associations (VDI-association of engineers and VDE-association of electrical engineers). 1998 and 1999 saw several milestones in the changes in engineering education in Germany. These included pilot projects, changes in the federal legislation, changes in local legislation, adoption of regulations for engineering program accreditation, and adoption of the structure of new bachelor and masters programs.

Some key points[3] from the German legislation of 1998/99 were that

1. Both the bachelor and masters degree must qualify for an engineering profession
2. The duration of the bachelor’s program can be from 3-4 years
3. The duration of the masters’ program can be from 1-2 years
4. The total duration of the combined bachelor-masters degree program must not exceed 5 years, and
5. The masters’ degree from either a university or Fachhochschule satisfies one of the requirements for admission to a doctoral program. The doctoral programs are limited to the traditional universities.

The Universities of Applied Sciences were created in an effort to bring the Swiss higher education in line with the European sphere and to improve the efficiency of education by exploiting synergies between undergraduate degree courses, graduate courses, applies research and development, and service to third parties [4]. The English name of the new universities was chosen in the belief that it best describes the their role and scope and will be best understood by the rest of the world. However they are also referred to as “Fachhochschulen”, “Hautes écoles spécialisées”, “Scuole universitarie professionali” sometimes within Europe and are abbreviated UAS/FH/HES/SUP.

In additional to the seven UAS’s, Switzerland has 12 “traditional” universities. Ten of these are cantonal institutions partially financed by the federal government and there are two Federal Technical Universities. The UAS’s differ from the traditional university in their admission requirements and in the nature of the education they provide, which is strongly geared to professional practice. Admission to the traditional universities is usually by means of the general Baccalaureate (Matura) while a majority of students entering the UAS’s hold a professional Baccalaureate. However, it appears that an increasing number of students with general Baccalaureates are choosing to study at the UAS’s [5].
The new UAS system is developing at a rapid pace. Since their creation in 1996, a Federal Commission has been formed and the administrations of the approximately 60 formerly independent institutions have been merged into the seven UAS’s. To date the UAS’s offer the same courses of study as their parent institutions. The number of degrees offered is currently approximately 220. Engineering is offered by as many as 30 of the 60 campuses. The engineering programs tend to be highly specialized and structured for the local population (e.g. horticultural engineering, HVAC engineering, etc.).

The engineering programs are 3 year Fachhochschulen types. These programs were limited to undergraduate teaching programs prior to the establishment of the UAS’s. Now, in accordance with the Bologna Declaration, many are planning to introduce bachelor and masters degrees and to develop applied research programs.

The Swiss Government has given provisional recognition to the courses of study offered by the UAS’s until 2003. However, it has also mandated a thorough review of all 220 courses of study. Each course of study will be required to apply for accreditation by 2003. The goal is to insure that the UAS’s offer quality programs. Programs that are judged to lack quality and/or resources will likely be asked to merge with other programs or demonstrate that they can achieve quality within a specific period of time.

In 2003, the Federal Commission and Federal Council for the UAS/FH/HES/SUP will petition the Swiss Government to remove the provisional status and grant the new universities and their courses of study “permanent” accreditation. After this, the UAS’s will begin to seek international recognition and will concentrate on quality assurance, financial accountability, and strategic planning.

**SUMMARY**

European engineering education is rapidly adopting the bachelor-masters-doctoral system. To expand to pool of available students, some programs are being taught in English. Traditional universities are introducing the bachelor-masters program to exist in parallel with their existing 5-year engineering programs. Fachhochschulen are adding masters programs and expanding into research and development. A stated objective of these changes is to better compete worldwide for students, prestige and money.

A review process is currently underway in which each of the courses of study is to be evaluated by a team of “peers”. A complete peer group ideally consists of six members. Each member of the team studies a self-study report prepared by the program under review. The team then makes a two-day on campus visit and prepares a report. More than 290 peers from Switzerland and abroad are to be appointed for this task. They will be divided in 49 peer groups or teams and they will produce around 270 evaluation reports. The peer review process is to be completed by the end of 2001.

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