WORLDWIDE COOPERATION IN EE: THE EUGENE ACADEMIC NETWORK

Claudio Borri[1], Elisa Guberti[2]

Abstract — *Erasmus Thematic Networks have worked successfully towards the development of the European Higher Education Area: several important results have been achieved and challenges for the near future pointed out. Among these: complete the Bologna Process, develop and spread a European accreditation system for engineering education (EUR-ACE), make the engineering studies more attractive, offer good LLL opportunities and broaden the formation to include non-technical skills. European Engineering Education shall also definitely look beyond the borders of the old continent, aiming to affirm its quality and improve its attractiveness across the Atlantic and in newly emerging economies. In the immediate future, EUGENE (EUropean and Global ENgineering Education), a new LLP Academic Network in the field of Engineering Education will open itself to the cooperation with academic, student, industrial and professional partners worldwide: the umbrella for this cooperation has just been established through IFEES and could serve brilliantly to this scope.*

Index Terms — Engineering Education, Academic Networks, international cooperation.

INTRODUCTION

Many years ago the DG EAC of the EC began promoting *ERASMUS Thematic Networks* :
"Thematic Networks … aim to define and develop a European dimension within a given academic discipline … through cooperation between universities, and academic or professional associations … A successful TN … should work towards quality … and curriculum innovation; promote … discussions on teaching methods …; foster … joint European programmes … and improve the dialogue between academic and socio-economic partners."

Since then three Thematic Networks (TN) devoted to issues of transversal interest for the development of Engineering Education (EE) in Europe have been operational: H3E, E4, and TREE. The dissemination year of TREE spanned the period from October 2007 to September 2008. The results have been collected TREE web site and in a CD Rom accompanying the volume "Re-engineering Engineering Education in Europe" published at the end of 2007 and utilised for the dissemination activity of the following year [1].

It is natural to consider contributing to the development of a European dimension of higher education as the *global goal* for TNs, humanistic or science/engineering oriented. Some general (as opposed to discipline-oriented) contributions of TNs in this direction have been the following:
- enhancing networking
- guidelines for Quality Assurance
- development of European accreditation system
- study of the evolution of the Bologna Process and of ECTN
- attractiveness of engineering studies
- situation of the third level of higher education (PhD)
- role of Life-long learning in technical universities
- exploitation of ICTs in modern learning
- synergies between research and learning
- ethical demands

Several references come to mind, and among them: E4 and TREE results [1], EUR-ACE accreditation system, the proceedings of the TechnoTN Archipelago Fora, the SEFI web site, and books/reports/sites of other TNs in particular branches of EE such as USAEE (agricultural engineering), EUCEET (civil engineering), and others.

EUROPEAN CHALLENGES

The continuous evolution of EE is facing new challenges: meeting them is crucial for the future of European EE. This has been underlined many times, also within the Bologna Process activities. More recently, on 28 and 29 April 2009, the Ministers responsible for higher education in the 46 countries of the Bologna Process met in Leuven and Louvain-la-Neuve to establish the priorities for the European Higher Education Area until 2020. They highlighted in particular the importance of lifelong learning, widening access to higher education, and mobility. By 2020, at least 20% of those graduating in the European Higher Education Area should have had a study or training period abroad [2].

Among present burning issues for European Engineering Education it appears useful to mention the following ones:

FIRST CHALLENGE - Make all efforts possible for the First Level Degree to be relevant to the labour market. It is well known that this requirement is present in the Bologna Declaration from the very beginning. But to which extent has it been implemented? Obstacles must be identified and corrected.

SECOND CHALLENGE - Protect autonomy of (Technical) Universities and at the same time harmonise their structure across Europe: this is mandatory for increased mobility and internationalisation of the engineering profession.

THIRD CHALLENGE - Arrive at a truly European Accreditation System for Degree Programmes compatible with National systems of accreditation (where they exist) [3]. This also is mandatory for increasing mobility through better transparency of formation paths in different European institutions. The EUR-ACE project (see www.enaee.eu) offers a formidable path towards meeting this challenge, but is still not fully exploited and too little known. The EUR-ACE SPREAD LLP project is aimed at improving such situation.

1 Prof. Claudio Borri, Vice Dean for International Relations and Full Professor of Computational Mechanics of Structures - Facoltà di Ingegneria, Università di Firenze - President of SEFI 2005-07 and Founding President of IFEES 2006-08 – Co-ordinator of EUGENE Academic Network (ifees-founding-president@sefi.be)
2 Dr. Elisa Guberti, Head of the International Relations Office - Facoltà di Ingegneria, Università di Firenze – Project Manager of EUGENE Academic Network (eugene@unifi.it)

FOURTH CHALLENGE - Attract the best young minds to Science and Engineering and retain them. This is perhaps the most important challenge, since it will affect directly European economy. Consider that projections show that Europe will not have enough engineering graduates to satisfy the needs of its industries in a not distant future.

FIFTH CHALLENGE - Provide effective learning instruments and opportunities for students to acquire important non-technical skills. Often quoted examples are: communication abilities, team working, linguistic abilities, entrepreneurship, etc. Most of these skills are difficult to include in classical engineering schools' teaching practice. Innovating EE is therefore mandatory and can be accomplished by qualifying EE as a true research field. The recently formed working group of SEFI on this topic is a contribution in this direction [4].

SIXTH CHALLENGE - Overcome the gap between humanistic and scientific culture. Why is this so important ? Some of the main reasons are:

- because a good European engineer must be aware of European culture
- because it can improve attractiveness to EE
- because of the need for a formation to responsibility
- because essential to play a leading role in modern organizations.

SEVENTH CHALLENGE – Technical Universities must provide good LLL opportunities. Indeed

- good adult learners are needed to face rapid obsolescence of technological knowledge
- providing continuing education opportunities (see for instance the suggestions of the working group on continuing education of SEFI) may constitute a valuable contribution to sustainability for higher education institutions
- innovative offers must be put in place to meet industrial needs (e.g. work-based learning, distant learning)

These challenges look already as a quite formidable task: is it enough? Most European engineering schools would say yes, but there are motivations for trying to arrive at a deeper understanding of what future societies will need.

GLOBAL CHALLENGES

Dr. James L. Melsa, President of ASEE in September 2007 (as reported in [5]): "We are currently preparing students for jobs that don't exist using technologies that haven't been invented in order to solve problems we don't even know we have!" This is one of the difficulties Universities face in trying to follow the Lisbon strategy, requiring to "strengthen the three poles of Europe's knowledge triangle: education, research, innovation".

Another obvious concern is that EE today is fragmented much more than in the past: ASEE is organised in 40 divisions! How do we have to tackle educating so many different kinds of engineers? Do they have to share a common background? What is the role of universities and enterprises? Which are the new characteristics that globalisation suggests to consider in EE?

New characteristics sought (on top of the classical and as important as ever scientific/technical and ICT competences):

- Adaptability
- Spirit of enquiry
- Problem solving attitude
- Communication skills
- Self learning ability
- Curiosity
- Cultural sensitivity
- Social empathy
- Motivation for work
- Ability to manage information effectively

To identify possible solutions to so many challenging issues, universities and enterprises have to enhance and consolidate their collaboration [6].

Universities by their multidisciplinary environment must allow students to extend their interests beyond traditional engineering disciplines in fields like philosophy, psychology, sociology in order to improve their humanistic skills and to develop their capacity to operate in an increasingly complex world

On the other hand industries are asked to tell universities which kind of engineers they need, to host students in stages, and contribute to the development of EE in an active manner.

European EE shall also definitely look beyond the borders of EU, aiming to affirm its quality and improve its attractiveness across the Atlantic and for emerging economies. In the near future European Academies will have to open themselves to the cooperation among students, industrial and professional partners, and fellow academics worldwide. The umbrella for such cooperation has been established a short time ago through the International Federation of EE Societies (IFEES), whose potential is still to be exploited.

EUGENE ACADEMIC NETWORK (EUROPEAN AND GLOBAL ENGINEERING EDUCATION)

Now, more than ever, collaboration across borders among our leading universities is absolutely necessary. The strength of partnerships within European Union countries universities, the longstanding preeminence of Europe in the HE sector, and, more recently, the unfolding of the global economy, validate the case for deepened – and internationalised – collaboration.

The biggest challenge ahead is to focus on ways of extending the EU model to third locations.

This will enrich immensely the universities of both countries, foster the growth of an open, competitive and accessible HE sector in other nations, and constitutes a vitally important form of soft diplomacy and power.

Most critically, it will foster – if framed by ambitious initiatives – the development of a 'global civil society' which will bind universities and countries together through common values and principles, and counter the centripetal forces of the globalised era.

In this context a new Thematic Network (Academic Network in LLP) with the main goal of improving the impact of EEE on competitiveness, innovation and socio-economic growth in a global context has been recently approved by the DG Education and Culture of the European Commission. EUGENE (EUropean and Global ENgineering Education) will cover the period Oct. 2009 – Sept. 2012 and its overall aim

will be that one of setting–up a *top-level "discussion & action" forum* to follow the continuous evolution of EE in Europe and enhance its competitive profile worldwide (opening the borders).
Why:

- Although EE and Research in Europe is generally well recognised worldwide, the attractiveness of EHEA and its degree of efficiency and innovation is not at the most advanced stage (if compared with other major regions of the world)
- after many years of cooperation in the sector within Europe, time has therefore come for European EE to discuss and analyse its position in a global context
- opening the borders of geographic regions of Europe for analysing European HE's strengths and weaknesses becomes mandatory if one looks to the impressive figures of emerging HE areas in the world (about 1,000,000 new engineers educated every years in China and 600,000 in India, only!)
- as the socio-economic growth and competitiveness of our production system is definitely "technology driven" and mainly based on innovation and entrepreneurship, education in Engineering and Technology is a priority for the industrial/professional corporate world: a new and intense cooperation with industry is therefore urgently needed in Europe with strong relation the global developments.
- EE is crossing all technology-oriented disciplines, which will benefit from an improved EE
- Entrepreneurship and innovation: among non-technical aspects of the formation, entrepreneurship and innovation have a prominent role, and suggestions on how to stimulate their consideration in the formation process constitute a key topic for research in EE
- Interculturalism: EE in Europe vs. EE world wide. Future engineers have already and will have more and more to face different cultural and working environments.

Aims and objectives of EUGENE (main activity lines)

The complex multitask nature of EUGENE suggests to split tasks and responsibilities. This is the reason behind the creation of 5 activity Lines and 3 Transversal Activities, each one coordinated under the responsibility of one or two active members (academic or non-academic) who will be assisted by an administrative officer.

Line A: PhD STUDIES: Structure and Bologna follow-up in the competitiveness issues (main question: are PhD studies in Engineering and Technology in Europe effective/innovative/competitive enough?)

In recent years in many universities in Europe doctoral schools have been established and doctoral programmes are offered. In the past PhD consisted exclusively of individual research, under the supervision of a promoter/ advisor. Now, (advanced) courses are offered to doctoral students, trainings are organised, doctoral students participate in projects with industry etc. The proportion of these activities with respect to the individual research effort varies.

Most of us are convinced that individual research should remain the backbone and the main constituent of PhD work In many places we have already some experience with the doctoral programmes and activities of doctoral schools. It would be most interesting to find out how effective these new activities are: are the PhD theses better? Are the PhD's better engineers? Are they better innovators or entrepreneurs ?
The purpose of this Activity Line will be to collect information on the experience with different doctoral programmes and formulate recommendations for the future.

Line *B: PROMOTE EE IN EUROPE AS A TRUE RESEARCH FIELD* (with comparison of worldwide developments in EER): a true and innovative research area to improve entrepreneurship, innovation and competitiveness.

A second Activity Line is targeted to promote the recognition in Europe, as it already happens in other regions of the world, of *EE as a true research area*. In fact in order to develop the potential of European Higher Education institutions it is of paramount importance to identify aspects of the learning process where innovation is needed, putting in place the required research activities. These will require the contribution of researchers from the EE community as well as from other fields, as for instance social sciences and psychology, when possible already active in the study of the learning processes in science and engineering. A substantial part of this research activity will be devoted to measure the effectiveness of some of the suggestions contained in the guidelines of the repository. For doing this the obvious tool is the diffusion of questionnaires, but other measuring tools must be designed, such as for instance experiments of small groups of institutions, so that this part of the TN activity can qualify as true research in (engineering) education.

Line C: IMPROVE transnational MOBILITY of engineering students, graduates and professionals.

This item will involve two main aspects: (a) within EHEA, that is checking and improving the applicability and consistency (in the Engineering field) of European Qualification Frameworks, EU Directive on Recognition of Professional Qualifications, Accreditation Standards and other relevant "European" documents and (b) on the global scale which will imply the comparison of the "European" documents with other documents and agreements (Washington and other Accords in the IEA, but also regional and national Standards in other parts of the world: e.g. North Africa, S.E. Asia, Latin America); tentative agreements for mutual recognition.
Both aspects should involve not only the "academic" side, but also the "professional training" (and "Vocational education and training").

Line D: LLL & CONTINUING EDUCATION as a tool to improve competitiveness and innovation of European engineers.

European universities are facing enormous challenges in developing their LLL practices and processes to help European

working life to meet the requirements of fast change towards the new business logic of global industrial value networking. A practical consequence of this is that the necessary competence development of knowledge professionals and other academic level experts is becoming more complex. Requirements for systemic lifelong professional development are increasing. The latest research results need to be integrated to the continuing education (CE) programmes and these to be transformed to become facilitated work-based learning practices, where innovation and effective use of ICT are the most critical success factors.

Productivity and innovative use of ICT are prerequisites for competence development and through that for empowerment and social well-being. Universities' knowledge based on research is, however, not well utilized in societal interaction. The purpose of this Activity Line is by the help of benchmarking good practices and analysing the latest university research results in this focus area to conceptualize the needed actions in the university-industry collaboration. Special focus is on the modern use of ICT and the orchestration of the activities to increase synergy between and through that societal impact of research, teaching and the third mission operations.

The major outcomes within Line D will be conceptualized core processes with benchmarked good practices and implementation manual. By the help of these universities can develop their LLL and CE activities as a powerful tool for employability and competitiveness of European engineering graduates.

Line E: INCREASE ATTRACTIVENESS of studies in science and engineering and to EHERA: involve students organisations (ERASMUS Mundus Network, TEMPUS Mediterranean, as follow-up) and promote awareness outside the EU of EE evolution and opportunities.

The main aim of the activities of this working group will be to Identify examples of good practice enhancing the attractiveness of engineering as a career both to traditional and non-traditional groups. The focus will be on attracting students of the right quality to both Bachelor and Masters degrees.

EUGENE Transversal Activities.

Besides the above mentioned activity Lines, 3 Transversal activities will support the Network:

T1) direct involvement of industrial stakeholders (European corporate with global dimensions) in all above activities A) to E), with an active contribution;

T2) Promote the establishment of the standing European Engineering Deans Council (as an interlocutory body with the newly established GEDC by IFEES);

T3) identify and put in practice sustainability tools beyond the 3 years of life of the TN, by means of: 1) ensuring visibility through an interactive web-site (informatic portal), 2) set-up a frequently updated "repository" of guidelines for the enhancement of EEE visibility world-wide, 3) foster the creation of a "Florence EE Group/Network" (an Academic Network like the Utrecht, or Coimbra ones, grouping Universities to work exclusively on EE items and future projects/initiatives)

Impact and sustainability

As already pointed out Engineering Education (EE) in Europe is in a phase of continuous evolution, under the stimuli of economic globalisation, of the so-called Bologna Process, and of many other factors. Helping guiding this evolution towards a better and better system for EE, or more exactly towards a set of systems, is the ambition of EUGENE Academic Network. Therefore the identification of a path towards self-sustainability is a mandatory part of the network. It will be a target of the MC from the very beginning and many alternative options will probably be evaluated. One such option could take the form of a non-profit consortium of EE associations, Industrial associations, individual industries, to continue (some of) the main activities beyond its lifetime, supporting it also financially, as a permanent service to the EE community in Europe.

EUGENE ACADEMIC NETWORK MOVING TOWARDS AN ERASMUS MUNDUS ACTION 3

In the perspective of becoming a pole of excellence in the field of higher education, many actions are being taken at European level. The key word behind these actions is to encourage the concrete creation of the European Higher Education Area by 2020. The European Commission is helping member states and neighboring countries in their modernising efforts through policy initiatives, discussion papers and forums, as well as through EU programmes such as Erasmus, Tempus and Erasmus Mundus. Europe recognises the importance of higher education for economic and social development. Higher education plays a crucial role in producing high quality human resources, in disseminating scientific discovery and advanced knowledge through teaching and educating future generations of citizens, high level professionals and political leaders, who in turn can contribute to better governance.

The increasing speed at which existing knowledge becomes obsolete, and the rapid changes in the means by which it is delivered and renewed, will require high adaptability of the education sector to meet the needs of the economy and of society as a whole. Countries that are only weakly connected to the global knowledge economy will find themselves increasingly at a disadvantage and will not be able to generate adequate socio-economic conditions for the population. In a context of globalisation, this knowledge divide does not contribute to harmonious relations between nations and to understanding among the peoples, thus adversely influencing political stability.

Against this background, the promotion of international cooperation between the European Union and third-country higher education institutions and in particular the facilitation of institution-based mobility is a win-win situation for its potential contribution to the mutual enrichment of nations and to a better understanding of peoples. Institution-based mobility has the capacity not only to improve the results of education, but also to create lasting links and generate mutual enrichment and understanding between the peoples.

In this context, the Erasmus Mundus Action will offer a unique occasion for EUGENE in order to enhance cooperation and training opportunities relevant to the Network.

CONCLUSIONS

What presented up to now is certainly of vital importance, but still centered on the present model of society, for which the augmentation of the GDP is generally considered as the best parameter to measure the quality of life and competitiveness of a country. This is reflected by the commonly recognised goal of implementing the "knowledge society". In fact the exploitation of knowledge by modern technology has produced many results that make our life easier and longer. But there are also problems.

For example the demand for newer and newer technological devices has shorten the time products (such as cameras, computers or cars) remain appealing on the market. Innovation of these products needs time and a lot of money. Moreover less and less people understand how (even superficially) a device works, not to speak of being able to repair it. Another kind of problems arise in the health system, which has become more and more based on standard procedures (e.g. computer-based), lacking flexibility, personal skills, capacity to solve problems, common sense. Moreover health systems should be more engaged in prevention and education. As a final example consider civil engineering: in the future, buildings should be constructed using suitable low cost materials, and with an energy saving approach. The same for cars. And the list could easily go on.

The knowledge society not only needs excellence and top rate research but also depends on a larger number of highly educated people who, while not engaged in active research, have sufficient knowledge to make good use of the latest research results.

To learn 'core competences' and to be trained in employability skills more and more students should have the opportunity to make stages in research groups and in other working environments, not only at doctoral level but also at graduate and undergraduate level.

As higher education and research are becoming more and more strategic activities for a new kind of development for our knowledge society the governments should proportionally increase their investments in research and higher education institutions.

Universities seem to be the most suitable institutions for developing integrated activities of higher education, research, and innovation, and therefore they should be the main destinations of new public and private funds devoted to development.

On the other hand, to optimize the exploitation of public and private funds given to universities it is necessary to enlarge the universities autonomy, to introduce both internal and external evaluation procedures, and to improve the social responsibility awareness of teachers, researchers and students. The European University Association (EUA) is strongly committed to these challenges, and state governments as well as European Union Commission and Parliament have to act in this direction.

With a perhaps coarse synthesis, we could say that, in order to be RIGHT, society should ensure that everybody has a work, a house, enough drinkable water, an effective health system, and a good level of education. In summary we have to change our concept of development from a quantitative to a qualitative one. What we need is a different model closer to people. For instance parameters to measure the quality of life should be: level of education, effectiveness of health system, environmental protection, etc.

Science and technology have a great role in this mission, but they are not enough: human values such as respect for the others, tolerance, capacity to listen and to dialogue, improvement of ethical behaviours, etc. are essential. Finally if the knowledge society has to evolve correctly, the present egoistical behaviour has to be overcome. Hence it is today more important than in the past to form respectful and ethical minds: "ethically correct" is far more important than "politically correct".

These considerations point out to the need to enrich EE (as well as other scientific formations) with humanistic values. What we need is a wiser use of our knowledge, that is a use in favour of every single human being respecting the absolute dignity of each person as well as the environment. In summary we need to begin acting now to evolve from the "knowledge society" towards what we could call the "wisdom society" [7]. And this requires also a new look on EE.

Is all this nothing but a dreaming exercise? Not if a long-sighted enough cost to benefit ratio is considered, taking into account social and environmental costs for the whole planet. This evolution has to begin somewhere in the world. Why not in Europe?

REFERENCES

[1] Re-engineering Engineering Education in Europe edited by Claudio Borri and Francesco Maffioli. Firenze University Press, 2007. ISBN 978-88-8453-675-4

[2] The Bologna Process 2020 - The European Higher Education Area in the new decade Communiqué of the Conference of European Ministers Responsible for Higher Education, Leuven and Louvain-la-Neuve, 28-29 April 2009

[3] Augusti, G., "Transnational recognition and accreditation of engineering educational programmes in Europe: perspectives in a global framework," European Journal of Engineering Education, Volume 31 No. 3.

[4] SEFI Working Group on Engineering Education Research. Additional information on http://www.sefi.be/index.php?page_id=1192

[5] New Features Debut in Prism by Frank Huband, ASEE Prism, September 1, 2007 Copyright American Society For Engineering Education Sept 2007.

[6] Becker, F., S.,*"How can Engineering Education better reply to the needs of European Enterprises?* SEFI Industry - Academia Forum Universities Brussels, October 27, 2008 – unpublished contribution.

[7] Blasi., P., "The European University - Towards a Wisdom-Based Society", Higher Education in Europe, 1469-8358 Volume 31, Issue 4 December 2006 , pp. 403 - 407