CHAPTER 1

TREE: Development, Results, Challenges ■

by Francesco Maffioli
Politecnico di Milano
Co-ordinator of TREE

1.0 Introduction

I hope that you, the reader of this volume, can forgive me if I address you so directly in this Introduction. You are certainly interested in Engineering Education (EE) and its evolution in Europe and in the world. *The First message* I would like to convey: **This volume (and its companion CD) is for YOU!** You may be directly involved in EE as a teacher or student, or indirectly, as an employer, a professional, a young graduate, an employee of a Ministry of Education (or of University and Research), or a member of the European Commission, for instance of the DG Education and Culture, a syndicate expert. The product you have in front of you is the result of three years of intensive work from one of the largest Thematic Network (TN) Projects supported by SOCRATES II devoted to the many issues of transversal interest and believed to be of paramount relevance for EE in Europe. This TN was denominated TREE, for "Teaching and Research in Engineering in Europe". The first section of this chapter is devoted to trace the "roots" of this initiative. I believe that the work done is of very high value. Hence my *second message*: **USE IT!** This does not mean asking you to agree with every advise/guideline contained here, but rather to evaluate them, and compare them with your views on the key issues in EE in Europe today. *Third message*: **FEEDBACK!** i.e. please send us your comments, proposals, and suggestions. EE is evolving much faster than in the past in Europe (and in the whole world), therefore even the best possible set of instruments for enhancing its successful development is bound to become in some years, at least in part, out of date. It is easy to anticipate the need for continuing the effort to innovate EE in Europe. Hence my *fourth message*: directly or indirectly, **SUPPORT THIS EFFORT!** The big themes, the many facets of which have been studied by the 30 Special Interest Groups of TREE, are here to stay with us, presenting new challenges to the higher education community (and its many stakeholders) in the near future. Some examples: the evolution of the so-called Bologna Process; the need for improving (and augmenting) Life Long Learning opportunities; the importance of an accreditation system applicable for the whole Europe; the role of an ethical formation; the instruments for attracting to engineering (and by and large scientific) studies the best minds coming out of secondary education, and to offer them the best possible learning environment; enhancing the employability of graduates at all levels, taking into account the effects of globalisation; the need to maintain a strong autonomy of higher education institutions.
And now let me try to introduce you into the rich set of outcomes of TREE.

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1.1 Historical roots of TREE: a summary

Thematic Networks (TN)[1] have been introduced in the SOCRATES-ERASMUS programme of the Directorate General (DG) Education and Culture (EAC) of the European Commission (EC) in the nineties and "*aim to define and develop a European dimension within a given academic discipline or other issues of common interest … through cooperation between university faculties or departments, academic or professional associations, and other partners … A successful TN project might help provide a more favourable environment for a deeper understanding of the discipline concerned … Furthermore … TN projects should: work towards assessing the quality of cooperation and curriculum innovation; promote, within an active forum, discussions on improvements in teaching methods … ; foster the development of joint European programmes … and improve the dialogue between academic and socio-economic partners* ".

During a General Assembly it appeared immediately mandatory for SEFI[2], the largest and oldest of European associations devoted to Engineering Education (EE), to take advantage of such a challenging proposal for enhancing EE in Europe. The first TN with this general mission was denominated H3E, for "Higher Engineering Education for Europe", was financed under SOCRATES I, and was managed via a EEIG (European Economic Interest Grouping). It was soon realised that H3E had only begun the study of such a complex and dynamic field as EE in Europe and a second TN was proposed, this time (according to the new rules of SOCRATES II) having the "Università degli Studi di Firenze" (University of Florence for short from now on) as contractor: this new TN was denominated E4 for "Enhancing Engineering Education in Europe". It spanned the period from 2001 to 2004, and its results have been collected in a box containing six volumes (and a CD-Rom). It can be safely maintained that the most important topics of transversal interest for EE, with its rapidly evolving dynamic, are studied in-depth in the six volumes produced by E4[3]. However any effort, as good as it may have been, is bound to become obsolete, at least in part, in some years because of the rapid evolution of EE.

Stimulated by the DG EAC, the management team of E4 began therefore in 2003 to shape a TN which could be a valuable successor of E4. A shift from the study type of work of E4 towards something able to suggest real "instruments" for the development of EE in Europe was identified as likely to offer a strong motivation for a new TN, which was denominated TREE for "Teaching and Research in Engineering in Europe". It was felt mandatory in fact to stress the importance of synergies between research and formation activities in all European higher engineering education institutions, considering as their most

1 For the convenience of the reader acronyms are introduced in parentheses when used for the first time.

2 SEFI is the European Society for Engineering Education (*www.sefi.be*).

3 The main results of E4 may also be found in the web site of TREE under Archives (*www.unifi.it/tree*).

important mission that to form the leading technical and managerial figures of European enterprises in a more an more globalised economy.

It was decided to structure TREE following four "lines", denominated respectively the *Tuning line* (A), the *Education and Research line* (B), the *Attractiveness of EE* line (C), and the *Sustainability* line (D). The intention was to articulate each Line into several Working Groups, giving to each of them the task of developing a specific instrument, be it a real tool, a study, a survey, or a set of guidelines. Such a structure was estimated functional to the new mission of TREE with respect to E4.

As it was for E4, the TN TREE also decided to rely on an International Advisory Board for on-going advise and monitoring of the progresses of the TN. Four highly qualified experts were appointed, representing different types of stakeholders. Their contribution has been not only very valuable but also continuative and challenging for the numerous activities of TREE.

1.2 The General Conference in Rome

After a few months devoted to ensuring that the TN managerial and administrative structure were well in place, a General Conference of experts representing the more than 100 universities having declared their interest in actively participating in the TN project, was convened and hosted by the Faculty of Engineering of "la Sapienza", the first University of Rome. During this very successful event the enthusiastic support of the attendees from all European countries was exploited to arrive at a definitive structure of TREE, articulating it into 30 Special Interest Groups (SIG), each one devoted to develop a particular "instrument" (or "tool" as they were familiarly called) for contributing in a concrete way to the enhancement of EE. It was decided that the size of each SIG should be kept flexible but limited, and that each SIG should have a Leader. The SIGs were subdivided into the four Lines of TREE, under the co-ordination of a Line Promoter. The four Line Promoters have been permanent members of the Management Committee (MC) of the TN, thus ensuring the timely updating of the status of the project and the "transmission chain" between SIGs and the management. The reader is referred to the Appendices of this Volume for more detailed information on the managerial structure of TREE. In order to arrive at a (provisional) "mission" for each SIG, the Rome conference was split into several working groups, one for each Line, plus others devoted to special aspects, like e.g. the structure of the web site of the TN.

In retrospective it can be safely said that the General Conference in Rome was indeed the "birth" or "kick-off event" of this ambitious project, establishing the grounds for its work in the following years. It was a

substantial financial effort, but paying off well, as far as what we have been able to judge in the sequel. In Rome it was also decided to set up another managerial structure, of paramount importance for the progress of TREE, namely the possibility to meet, at least once every year, with all SIG Leaders. This was denominated the Scientific Committee (SC) of TREE. The SC has met 2 times marking the various phases of development of the project. The first meeting of this committee was held at Villa Vigoni in Loveno di Menaggio (Italy) on 16-19 February 2006 while the second one took place at Arenberg Castle of the Catholic University of Leuven (Belgium) on 19 and 20 March 2007.

1.3 Milestone events

For a complete list of meetings and main events during the life of TREE the reader is again addressed to the Appendices. The purpose of this Section is only to recall the most important ones as a way to illustrate the overall evolution of the project. Even before knowing if the application for TREE would have been successful, a first meeting of foreseen SIG Leaders and of the MC took place in Leuven end of October 2004. It was followed in February 2005 by the plenary meeting of all TREE partners held at the School of Engineering of the Università "la Sapienza" in Rome. Other important events have been the two SC meetings mentioned above, which grouped together the Line Promoters and the Special Interest Groups leaders of the Network, and the TREE dedicated sessions within the SEFI annual conferences (September 2005 in Ankara, June 2006 in Uppsala, and July 2007 in Miskolc). Moreover it appears worth recalling the strict cooperation between TREE and the engineering students community, underlined by the link with BEST. An example of this cooperation has been the TREE session within BEST Academics and Companies Forum held in Brussels in March 2007. TREE has also taken part actively in 2004, 2005, 2006, 2007 in the events organised by TechnoTN[4], and was deeply involved in the First Engineering Deans Convention organised in Florence in November 2005.

1.4 Introduction to the results of TREE

The results of TREE are reported in full in the enclosed CD-Rom, under the heading of each SIG whereas, for seek of readability, they have been grouped by chapters of this volume. These chapters intend to provide a guide for the users. In this section a brief outline of each chapter is offered to facilitate the task of

4 TechnoTN is the Archipelago of TNs in Scientific and Technological fields whose main task is to organise every year a Forum for discussing together hot topics in education relevant for all these fields. For more information see the web-site *www.upv.es/TechnoTN* .

the reader. The editorial board of this volume decided to organise it not reflecting strictly the subdivision of the TN into the four Lines already mentioned, in order to enhance its coherence and readability. For the majority of topics considered each SIG includes also examples of good practice in the relevant subjects.

Most of what has been studied in the *Attractiveness of EE* Line (C) is the subject of **Chapter 2**, titled ***Tools for Enhancing the Attractiveness of EE in Europe.***. A first group of topics is concerned with attractiveness in a strict sense: from instruments to promote higher EE with secondary school students, to suggestions of instruments for widening the participation of underrepresented groups to engineering studies, and to attract female students. One of the strongest instruments for retaining students is the promotion of pedagogical abilities of engineering teachers: in an ad-hoc section a survey of the situation across Europe and suggestions for its improvement are provided. An important role in enhancing attractiveness is played by extracurricular activities: a special section is devoted to their role, as viewed by a distinguished group of engineering students. Two other more specialised topics treated here are instruments for enhancing Tempus Projects and the status of double degrees in engineering in Europe.

Chapter 3 is about ***Innovative Learning and Teaching*** **Methodologies**. The need for innovating the curricula is felt from the very first semesters in particular for what concerns the mathematical formation of engineering students, hence a section devoted to the core curriculum in mathematics for EE. Active learning, problem-based, project-oriented, techniques are some of the most important ways to innovate the EE and are the subject of ad-hoc sections. The relevant presence of virtual universities in Europe is increasing: a section is surveying the European situation with its many new challenges. Related to the innovative learning topic we can find mentioned in other chapters the development of the Bologna process (see chapter 5) as well as the importance of the ethical formation for engineering students (see chapter 6)

Chapter 4, titled ***Education and Research Synergies*** is devoted to the various ways research and education positively interact. This topic is treated in general in section 1. Other sections are concerned with: a survey of third level (i.e. PhD) studies in Europe, presenting and evaluating a very diversified situation; the importance of stimulating research activity also at the undergraduate level, if nothing else for its pedagogical potential; and the tools for facilitating international/interdisciplinary projects in teams, which provide a very stimulating experience for students, but present often difficult organisational/ financial problems.

Quality and Accreditation of EE in the framework of the "Bologna Process" is the title of **Chapter 5**. A survey of National systems of EE, QA and Accreditation is the topic of the first section. It is also devoted to the progresses of the so called "Bologna Process", updatiyng the survey preposed

some years back by E4. The complex picture of accreditation systems in EE in Europe is presented, then, in section 2 and the proposals of the project EUR-ACE[5] are given an opportunity to be known by the largest audience possible. Suggestions and guidelines for quality assurance and assessment are offered in the next section. The evolution of ECTS towards a tool for a complete profiling of engineering graduates is the subject of section 4. The main motivation for a European accreditation system is the enhancement of mobility of engineering professionals within the EU. It is then natural to include in this chapter the results of two other SIGs, one inquiring about the real needs of European industries as far as internationalisation in the formation of future engineers, the other aiming at a survey of demands and offers of the European labour market, especially focusing on the engineers' competencies required, to enhance wide employability.
The IGIP[6] System of accreditation for programmes in engineering pedagogy is also presented in the final section of chapter 5.

The importance of offering strong possibilities to continue to learn even after the completion of universities studies is a well known necessity and has seen strong developments in the recent past worldwide. A lot remains however to be done for enhancing the role of European higher education institutions in offering, as efficiently as possible, Life-Long Learning opportunities to engineering professionals operating in their regional area of influence. ***Sustainability of Engineering Competencies through Continuing Education*** is then the title of **Chapter 6**. Main subjects considered are: how Universities can manage CEE (acronym of Continuing Engineering Education) effectively; a state-of-the-art report on the sustainability of engineering competencies in today's knowledge society; Ethics and Social responsibilities as key topics of EE; new ICT-based forms of continuing professional development, stressing a list of critical success factors and guidelines for the integration of ICT in the learning process; major challenges for CEE resulting from the ongoing and future changes in the working environment, and recommendations on how to comply with them. The final part considers adult education model for European universities, in particular, but not only, the tools to validate non-formal learning in CEE.

Chapter 7 collects results of general relevance for European EE. One of them is the ***Glossary*** of terms and definitions in EE in English, with an annex reporting translations in some of the main European languages: this effort updates the incomplete one done under E4, and is a "must" tool for improving transparency and circulation of opinions about EE. Another section is a ***Guide of Engineering Schools in Europe***, in the form of a fast access tool to the relevant web sites that each higher education institution offers: in a certain sense a "guide to guides".

5 www.enaee.eu

6 IGIP: the International Society for Engineering Pedagogy (www.igip.org)

A final section is presenting the results of the analysis of a questionnaire inspired by TUNING within TREE Partners.

Concluding remarks, recommendations, future challenges are offered in **Chapter 8**, trying to anticipate the needs of the European Higher Education Area (EHEA), of the European Research Area, and more generally of European economy and labour market, to which the Engineering schools must respond. Indeed the need to adapt the European higher education systems to ensure that EHEA remains competitive in our globalised world has been stressed in the London Communiqué (LC) resulting from the meeting of Ministers responsible for HE in the countries participating in the Bologna Process in London in May 2007. The results of TREE match very well with the challenges outlined in the LC, but it is quite obvious that a lot remains to be done. The LC can in fact be looked at as a source of suggestions for further work in all fields of HE, but in particular in Engineering formation, given the key role that EE plays in the development of European economy.

The final Chapter of this volume consists of the ***Appendices***. Some report the data of the TN project, the list of partners, and other important (but perhaps not of general interest) data. Another contains the report of the International Advisory Board on the activity developed by TREE during its 3 years of life. Instructions on how to take advantage of the search engine included in the CD to interrogate it from various points of view (see also below) are also mentioned, but only briefly since the user of the CD is guided interactively when opening it.
In fact the enclosed CD-Rom is provided with a search engine, which allows for different consultation possibilities. The most obvious one is of course by the titles of the Sections and/or the Chapters, i.e. following the Index of this volume. We have provided a list of keywords and another consultation form is by using them. A third consultation possibility is by Target Audiences: they are listed in Table 1. Another form of consultation is suggested by the life-long formation of today's engineers: the stages of this process have been subdivided as reported in Figure 1.
Other consultations are also possible and are illustred in the welcome page of the CD-Rom.

Table 1

Target Audience
Industry/Enterprises
1° & 2° level
PhD and Research level
Accreditation/Quality Assurance
General audience
Students
International activities
Disadvantaged communities
Management
Learning techniques
Continuing Education
National and International Authorities
Pre-university level
Teachers level
Actors in implementing Bologna demands
Applicants to engineering study programmes
Admission tutors
Recruiting committees
University Officiers

Figure 1