SEFI@40

Driving Engineering Education to Meet Future Challenges

Société Européenne pour la Formation des Ingénieurs

SOCIÉTÉ EUROPÉENNE POUR LA FORMATION DES INGÉNIEURS
EUROPEAN SOCIETY FOR ENGINEERING EDUCATION
EUROPAÏSCHE GESELLSCHAFT FÜR INGENIEURAUSBILDUNG

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Driving Engineering Education to Meet Future Challenges

Françoise Côme, Xavier Fouger, Kamel Hawwash, Wim Van Petegem
(Editors)

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PREFACE

In the context of its 40th anniversary celebration, the Administrative Council of the European Society for Engineering Education - SEFI - decided that a commemorative book be produced to highlight the achievements of our Society and its contribution to the development of higher engineering education. It is also a forward looking book which presents some views on possible actions to be taken in the future taking into consideration new developments and new factors impacting higher education in general and the education of the engineers in particular.

Since its creation in 1973, SEFI has developed and extended its range of activities and has, over the years, an impressive record of achievements in all aspects of higher engineering education. The Working Groups and Committees of SEFI have played a key role and reflections from their chairs can be found later

As a diverse organisation, SEFI believes it needs common values that guide its work, and reflections on these values also constitute a chapter of the book. You will also find contributions from colleagues involved for many years in our activities and others who have more recently joined the team. SEFI has also had significant involvement in engineering education projects, contributing through its members

According to the wish of its founders, SEFI is the only example of a European higher engineering education organisation bringing together rectors, deans, professors, students, representatives of associations and of the corporate world involved in and passionate about higher engineering education.

SEFI's strength comes from its members - 410 in 48 countries - and, during the last 40 years, many people have given a lot of their time to our Society, that is still, presently, the largest network of engineering education stakeholders in Europe. Through its membership, SEFI connects over 1 million students and 158000 academic staff members.

It would not be possible in a work of this size to mention all those who have played a part in the work and in the life of the Society over the last four decades. A few names are of course quoted in the following contributions and the editors offer their apologies to any past or present members of SEFI whose valuable work has not been mentioned due to lack of space.

To these and to all the others who have contributed to this publication, the editors give their grateful thanks. They also would like to thank our sponsor, Dassault Systems, whose support has been of paramount importance for the realisation of this book.

This book is dedicated to the memory of Professor Francesco Maffioli, our former President and Treasurer and good friend, who was until December 2012 an extraordinarily dedicated SEFI supporter and a permanent source of inspiration to all of us.

If you are a current member of SEFI then we thank you for your support and we look forward to working with you in future. If you are not currently a member then we hope that you will see the value in being a member of the Society. Join us!

We hope that you will enjoy reading this book as much as we have enjoyed preparing it.

Kamel Hawwash, Incoming President, University of Birmingham
Xavier Fouger, Vice-President, Dassault Systèmes
Françoise Côme, Secretary General, SEFI

This book is dedicated to the memory of Professor Francesco Maffioli

who left us on 7 December 2012

CONTENTS

CHAPTER I

FROM THE PRESIDENT

40+ Years of Dedication Towards Engineering Education

By Prof. Dr. ***Wim Van Petegem****, KU Leuven, SEFI President 2011-2013*

The history of SEFI as the European Society for Engineering Education is a story of 40+ years of thousands of committed people all devoted to improving engineering education in Europe and beyond. It is my pleasure as SEFI President to present you here this book, which contains a testimony of our achievements and a reflection on our future.

Looking back on the past we are happy to show SEFI's remarkable success stories over the years. Without aiming at completeness, we proudly remember numerous activities, conferences, meetings, publications, projects, etc. in which SEFI proved to be a vast network of highly dedicated engineering educators and their partners. After so many years these achievements are still a source of inspiration for the future. And this future looks bright, despite all difficulties and crises we go or will go through, with SEFI as a beacon to guide us towards innovative engineering education of the highest quality compared to international standards.

An organisation like SEFI is nothing but its members. Therefore our main focus is clearly on the services we offer our members, responding to their needs or proactively anticipating them. The collaboration with our members is clearly aimed at increasing the benefits we offer them, in continuing already existing services, adapting them to new contexts or even developing new ones. Nevertheless, in these times of globalisation, we also recognise the need for international visibility. Maintaining this visibility is important when reinforcing our European activities and respecting our own values. Finding the right balance between inner and outer activities, according to the priorities of our members will be a challenge for the next coming years. Again, SEFI is well equipped to make this happen.

Of course, 40 years of history are also marked by events we will not forget because they carved deep in our hearts. We especially think of those beloved colleagues and friends that at one point in their lives have contributed so much to SEFI, and now have passed away. Most recently we lost our long-time SEFI Sage, Prof. Francesco Maffioli. Francesco has been for decades one of our most active members and was fully dedicated to SEFI in different roles. He was a living memory of our association, but he was always supporting the development of new ideas and a stronger involvement of the youth, pushing all of us to look forward. As SEFI is celebrating its 40th Anniversary in challenging times, we shall indeed not shrink on ourselves, but use this moment to explore new possibilities. That is the best way we could honour a colleague, a friend, a gentleman, a wise man as Francesco was. This book is full-heartedly written as a tribute to him.

Another important historical figure in SEFI's history (and hopefully future as well) is our Secretary-General for years, Françoise Côme. More than half of SEFI's life she was and still is the face of our organisation, towards the members and towards our partners. Everywhere engineering education is at stake, you will hear the name of Françoise. People know her as always smiling, friendly, committed, knowledgeable, helpful, loyal, in short a warm personality. She has also been the driving force behind this book, and I can only show my greatest gratitude to her. It is the highlight of many years of collaboration and two years of my presidency. I owe her so much.

Dear friends,

Nothing in SEFI would have been possible without your contribution. I thank the authors of the articles in this book, I thank the colleagues in and around SEFI for their commitment, I thank the sponsors for their support to make things move fast forward, I thank the corporate partners, organisations and institutions where we could find a fruitful ground for our new ideas, I thank the students for their never-ending and stimulating inspiration, I thank the secretariat for lots of unseen but so valuable work behind the scenes, and last but not least, I thank you for accepting me as SEFI President in this anniversary year. I wish you all another 40 years of happiness and success, both in your professional and private life!

CHAPTER II

THE HISTORY OF SEFI

The first 40 years

*By **Françoise Côme**, Secretary General SEFI and **Francesco Maffioli** (†), former SEFI President and Treasurer*

My thoughts go to our dear Francesco Maffioli who would have enjoyed so much finalising this chapter with me (F. Côme).

Since its creation in 1973, SEFI has always been doing its best to develop the European dimension in Higher Engineering Education (HEE), following in so doing the intentions of its founders. The important key words in SEFI's action during these first 40 years are cooperation and mutual exchange - excellence - innovation. Across Europe we indeed exchange ideas, experiences with students, teachers, researchers, related associations, international bodies and corporate partners. SEFI has provided quite a number of tools for these exchanges: working groups, seminars and workshops, annual conferences, a scientific journal and a series of publications, a monthly newsletter, position papers, ad hoc conventions, cooperation activities with targeted partners, international cooperation projects.

"Let us, therefore, dream of our future engineers as people who will work with respect and awareness of different traditions and heritage. Let us envisage them as "human bridges" across different cultures and regions, linking people all over the world by means of science and technology. In this way, we can draw inspiration from our glorious Roman past, which taught us that the highest authority, the Pontiff, took his privileged title from "Pontifex Maximus", the ancient Latin "Pontesfacere", i.e. the Bridge Maker!"

(C. Borri; Foreword SEFI 2002, Proceedings, XV)

This contribution will therefore contains a first section devoted to the genesis of SEFI[1], written notably thanks to the articles of former SEFI President, Philippe Olmer, "La Genèse d'une Idée: la SEFI"[2] and of one of SEFI's thinkers, Professor Burkhard Sellin[3]. A second section relates to the evolution of SEFI's structures, followed by other sections treating respectively of SEFI's events, SEFI's publications and projects, with a final section speaking about the honours SEFI regularly bestow.

The genesis of SEFI

SEFI[4], the European Society for Engineering Education, is the first example of an association linking directly the institutions of Higher Engineering Education (HEE), hence independent of national and/or community *filters* in establishing its policy, as an international forum for discussing problems and solutions for HEE in Europe. It resulted in fact from a free maturation process which we can date around 1972. In those days, the protests of 1968 were not long over and they had contributed to revealing the opportunity of adapting the academic structures to the new needs of a world in rapid evolution. New professional figures emerged, the scientific and technological knowledge was developing at an explosive rate, and the access to HEE was open to a larger number of students. The management of HEE institutions faced the need to cope with these changes and at the same time to become more democratic, without lowering the level of quality of their glorious past. To do this, they also had to be aware of the fact that the role of engineers within society was rapidly changing: without putting aside the traditional technical roles, engineers were in increasing demand in research, management, services and social activities. It is worth remembering that our European Union of 28 included

1 this section is based on Prof. Maffioli' s contribution published in the context of the 25th Anniversary of SEFI, updated for the purpose of this book
2 Published in SEFI-News 48
3 "The founding story of SEFI: 40 Years existence of the European Society for Engineering Education."
4 SEFI is the French acronym of Societé Européenne pour la Formation des Ingénieurs - at the time of SEFI's foundation, the French language was the dominant language of the European Economic Community (EEC) and in most of the international organisations. *B. Sellin*

only six countries in 1972! The UK, Ireland and Denmark were about to join, whereas Norway had just refused after a referendum. Many already thought that the formation of the European Union was an irreversible process and one of its corollaries was the mobility of work forces, most notably at the level of managerial and technological responsibilities. This would soon impose on each European institution involved in HEE the need to know the education system of all partner states. After 1969 this need could not be satisfied either within UNESCO or within OECD[5]. FEANI[6] was created in 1952, but it was traditionally more interested in the professional aspects and in the equivalence of degrees, than in the education process itself.

An "Institute for the Study of European Universities" was established by the European Commission (EC) at that time and one of its directors of research, Gabriel Fragnière, was asked to report on engineering training in order to make it possible for the EC to prepare the "Engineering Directive" within the framework of the Treaty of Rome. Fragnière, together with Burkhard Sellin - a young Graduate Engineer (Ing.grad.) from the Aachen Institute for Technical and Economical Cooperation - visited many HEE Institutions in Europe and realized that there was a diffused interest, not only in the report, but also, and more importantly perhaps, in the creation of a European forum where the exchange of information about programmes, curricula and changes in HEE could continue.

The Rector of TU Eindhoven, Prof. G. Vossers, was one of the first to be won over to that idea. With the support of the EC, the Ministry of Education of the Netherlands, and TU Delft, a first meeting was organised in Delft in May 1972. About sixty representatives (Deans, Rectors) of European HEE institutions attended it. The informal character of the meeting allowed for a free contribution of ideas from each participant, since it was made clear at the opening that the organisation to be created would refrain from interfering in any way with existing national or international bodies, in particular in the field of recognition of diplomas. During this first meeting the characteristics (not always well known) of the three major European higher education systems, the British, the French and the German, were illustrated, with their variants, to an audience of academics and industrialists. The diversity of this scenario was recognised as a potential richness, but it was also evident that this potential was rarely exploited because of the lack of timely information on the continuous evolution taking place in each member state. The meeting closed with the unanimous support for the creation of a ***European Society for Engineering Education*** with the main task of constituting a forum for a permanent debate on these themes. The project of such an association had already been considered favourably by various organisations, such as the West-Deutsche Konferenz, the Conférence des Grandes Ecoles, FEANI and UNESCO.

A preparatory committee was formed and included: Lord Bowden (U. Manchester), F. Carassa (Politecnico di Milano), H.P. Debruyn (KU Leuven), J.G. Dijkman (TU Delft), J. Dosse (U. Stuttgart), G. Fragnière (European Cultural Foundation), G.R. Hall (Brighton Polytechnic), J. Moe (U. Trondheim), Ph. Olmer (Conférence des Grandes Ecoles), N.K. Ovesen (Danmarks Ingeniorakademi). After numerous meetings in Brussels in 1972, the mission of the future SEFI became much clearer and a restricted committee was given the delicate task of producing the Statutes and the internal regulations of this international association under Belgian law. In Leuven, in January 1973, a constitutive General Assembly took place, with the participation of about thirty representatives of HEE institutions from ten different European countries. The Statutes were approved and the first Administrative Council was formed with H.P. Debruyn as President: SEFI was born.

Its objectives have remained by large the same in the past 40 years: to contribute to the development of HEE in Europe as well as to the improvement of engineering professionals; to provide appropriate services and information about HEE to its members; to improve communication and exchanges between teachers, researchers and students in the different European countries -ultimately the corporate world was also included into our network; to promote the university-business cooperation; to act as a mediator between its members and other higher (engineering) education organisations and partners.

5 Organisation for Economic Co-operation and Development
6 European Federation of National Engineering Associations

SEFI membership is open to institutions of engineering education, individuals, industry, associations and related organisations. Admission is determined by the Statutes and the By-laws of the Society, and by joining SEFI, institutions, individuals, companies and associates express their support in the mission and objectives of the Society. The four different types of membership are the individual membership that is open to all individuals -including the students - involved or interested in the engineering education and the improvement of the engineering profession; institutional membership is open to higher engineering education institutions; industrial membership is open to companies (Corporate members and Corporate partners); associate membership is open to professional and student organisations, to institutions involved in activities of engineering education or the improvement of engineers, as well as to institutions not fitting the criteria to join as institutional members. Presently, SEFI is composed of 410 members from 48 countries.

Structural evolution

The Head Office

Gabriel Fragnière was SEFI's first Secretary General (SG). "Gaby", a sociologist with Swiss origins, was an enthusiastic and dynamic manager, and thanks to his splendid work, SEFI developed rapidly. The successors of G. Fragnière were Ed Prosser (UK), Alan Smith (UK), Guy Haug (F), Yves Beernaert (B), Keith Davies (UK), all personalities of pretty high calibre: their involvement in higher education did not stop with their term at SEFI and they all pursued their respective career covering important positions within the European Commission, IBM Europe or other international organisations, or as international consultants.

Except for a very short initial period, the Headquarters of SEFI have always been in Brussels, firstly rue de la Concorde[7], and since 2001, rue de Stassart. Our present SG, Françoise Côme, sociologist and philologist (B/F), joined SEFI in 1988 as Assistant SG, and she was appointed SG in 1993. Since that time, she is managing the Head Office, efficiently assisted since 2011, by Jacques Schibler, a young French historian specialised in EU political sciences whose competences and enthusiasm have not to be demonstrated. They are occasionally assisted in their work by young interns coming from different European countries, experiencing "Brussels European jungle" in the context of ERASMUS or LEONARDO internships. Several young colleagues from Ireland, Italy, Poland, Denmark, France, Czech Republic, Finland, also passed a year or two as employee at the SEFI Head Office. We are still in contact with most of them and it appears that for a vast majority of them, the passage through SEFI Head Office constituted the first professional step toward a European career.

The Presidency

The Presidency of SEFI has also evolved in the past 40 years. In 1978 the General Assembly approved a change in the statutes, reducing the presidential term to one year only, followed by one year in the Administrative Council as Past-president. This was changed again in 1991: not only was it found that one year of Presidency was too short a time for anyone to try to implement his/her ideas about how to improve the life of the association, but it was also felt that the President should be assisted by two Vice-presidents, one of them being expected to become the new President after one year. This arrangement also allows nominating, as the other Vice-president, leading experts not necessarily among academics, notably senior representatives of the corporate world, with the aim of improving the interaction of HEE Institutions with the productive world. So far, SEFI has been led by 26 Presidents, 4 from Italy, 3 from Belgium and from Denmark, 2 from United Kingdom, France, Ireland, Germany, Finland, Switzerland, the Netherlands, one from Portugal and from Sweden. All these Presidents were elected as representatives of SEFI's active institutional members. Let us

7 It is tempting to believe in a predestination of this small street, just off the important Avenue Louise, as far as studies in HEE are concerned: one of SEFI's first Presidents, Prof. Niels Krebs Ovesen found evidence of an "International Conference on Higher Technical Education" organised in rue de la "Concorde" at the beginning of the 19th century!

thank them all, as well as their respective institutions, for their outstanding dedication. Our thanks go also to our very dedicated three-year Vice Presidents who played a key role as far as our activities were concerned.

The Working Groups

It was quite early[8] that SEFI realized that specific themes of HEE deserved to be studied and analysed in depth and that this could be achieved only by forming an ad-hoc Working Group (WG), or in special cases, an hoc Task Force (TF) or Committee.

The first WG was devoted to *Curriculum Development* and held its first meeting in Brussels on February 9th and 10th, 1978. I[9] was among its founding members, and our late David Jenkins, then of the City University in London, and ultimately of the Oxford University, was its first chairperson. Four main areas of work were identified: new teaching ideas and the development of teachers, environmental influences on curriculum design, methods for adapting course structures, and the engineer's profile. Each one of these areas was entrusted to a coordinator, in charge of preparing a second meeting, scheduled in London in May of the same year. This WG has been in existence since then, producing an impressive body of documents on different aspects of Curriculum Development in HEE, most of them resulting from a successful series of seminars and workshops, and published in the form of SEFI Documents or, sometimes, as special issues of the European Journal of Engineering Education. This WG was also the model for most of the other WGs of SEFI, both from the point of view of the path to follow to create a new WG and of the way to organise its activity. Departures from this model were seen when the nature of a WG suggested that this would result in an improvement given the very nature of the topics being discussed. This has been the case, for instance, for the WG on *Women in Engineering* - later in 2008 on *Gender and Diversity* which at the beginning focused on the statistics of the phenomenon.

Working Groups, Task Forces and Committees Chairs

Attractiveness
Prof. K. Hawwash University of Birmingham
Curriculum Development
Prof. U. Dominguez – University of Valladolid
Continuing Engineering Education
Mrs. K. Miettinen – Aalto University
Gender and Diversity
Prof. S. Ihsen – TU München
Engineering Education Research
Prof. Robin Clark – Aston University
Mathematics and Engineering Education
Prof. B. Alpers – University of Applied Science Aalen
Physics and Engineering Education
Prof. G. Langie – KU Leuven
Ethics and Engineerning Education
Dr. E. Alpay – Imperial College London
New Educational Technologies
Prof. Pieter de Vries – Delft University of Technology
Sustainability in Engineering Education
Prof. Anne-Marie Jolly – Polytech'Orleans
Quality Assurance and Acreditation
Prof. A. Varadi – University of Misckolc
University-Business Cooperation
X. Fouger – Dassault Systèmes
Cooperation with the students
Leonardo da Vinci medal Committee
SEFI President Prof. W. Van Petegem – KU Leuven
Cooperation with Africa
Prof. J. Uhomoibhi – University of Ulster
Web Committee
Mrs. F. Côme
EJEE Editorial Committee
Chief Editor: Prof. E. de Graaff – Aalborg University

It must be kept in mind that the policy of SEFI has always been to favour a bottom up creation of a new WG. In other words the first requirement is to bring together a group of motivated SEFI members forming a first core and working for some time in order to understand if the WG's activity is feasible. This has in some cases resulted in short lived initiatives, such as, that

8 This section reproduced parts of the interesting contributions prepared by Prof. Francesco Maffioli and Prof. Vernon John (former secretary of the CD WG) in the publication prepared for the 25th SEFI Anniversary in 1998.
9 Prof. Maffioli writing

of the WG on *Developing Countries* or more recently the TF on *Cooperation with Africa*. In other cases the evolution of HEE in Europe has suggested the closure of a formerly successful WG because its mission was regarded as terminated or the merging of a WG with another: this last option was the case of the WG in *Internationalization of HEE* (created in the 90s at a time of opening towards Central and Eastern Europe) which has been invited to merge in 1998 with the Curriculum Development WG. Amongst the most active WGs we can quote today the *Continuing Education* WG, also dealing with Lifelong Learning and Continuing Professional Development's activities, the *Mathematics* WG, the former *Computers and HEE* WG - that worked a lot on "The Year 2000 problem", a topic that seems from another era with our today's eyes! - that became the *WG on ICT,* and in 2012, the WG on *New Learning Technologies*, the *Physics* WG, the *Women in Engineering* WG that evolves into *Gender and Diversity* as written before. A WG on *Environmental Engineering Education* WG (dealing notably with topics such as the international pursuit of sustainable development in parallel with the New Millennium Programme) and a WG on *Systems Engineering* were formed in the early 2000s, but dissolved after a couple of years.

In 2008, the WG on *EE Research*, has been founded as reflecting a major and permanent subject for SEFI's discussions. In the context of this group, cooperation is also ensured with the International Symposia on PBL[10], the last one having taken place in Malaysia last July.

Other groups are the WG on *Ethics*, the WG *on Attractiveness*, initially co-chaired with BEST as an outcome of the E4 Thematic Network (see later under Projects), the WG on *Sustainability*... 15 years ago, the TF on *Accreditation* was formed, more or less in the context of the future creation of the ESOEPE[11] and following a European workshop held in Paris on the *Assessment of Engineering Programmes*. ESOEPE will ultimately become ENAEE - the European Network for the Accreditation of Engineering Education - founded notably by SEFI (G. Augusti/F. Maffioli). The introduction of the ABET[12] criteria 2000, with special relevance to engineering educators were analysed by our late President, W. Schaufelberger (ETHZ) in "*Criterion 3 -Programme Outcomes and Assessment"* in SEFI Annual Report 1999.

From this picture it should appear that forming an ad-hoc WG whenever a topic deserving such attention is identified has become common practice within SEFI, even if the task is not always an easy one. Preserving this dynamic aspect of its life is one of the positive features of SEFI, contributing to reinforce the belief that a substantial part of the backbone of the association is constituted precisely by its WGs.

We hereby would like to thank all the WGs founders, members and chairs for their valuable contributions!

The list of the numerous workshops and seminars they organised, is of course, after 40 years of operation, much too long to be mentioned herewith. Nevertheless, very soon will be the list of all our WGs workshops published on the SEFI Web site. The specific history of the groups is also partially available on their respective web sites, as well as the list of all their active members and leaders from the past and of today. Later in this book, reflections on the specific topics studied by the WGs are exposed by their respective chairs.

The Task Forces and Committees

Since the beginning of the 2000s, a series of Task Forces (TFs), Ad Hoc Groups or Committees, have been established in order to answer a relatively urgent need to study in depth specific hot topics. TFs on *Marketing and Visibility*, on *Bologna Declaration*, on *Sustainability and EE*, on *Cooperation with the EU*, with *IGIP*[13], with *Africa*, with *the students*, on *University-Business cooperation*, on *Accreditation* ... were created. Several amongst them later became WGs (*Accreditation, Sustainability*...) or Standing Committees, such as on *Uni-*

10 Problem Based Learning
11 European Standing Observatory for the Engineering Education Programmes
12 Accreditation Board for Engineering and Technology
13 Internationale Gezellschaft für Ingenieurausbildung

versity-Business Cooperation or on *Student Cooperation* established in the context of 2011 SEFI Student Year - an initiative launched by our former Vice President, Kati Korhonen-Yrjänheikki (TEK)[14].

If the cooperation with the students, and in particular with BEST, started in the mid-90s in the context of the H3E project (see later under projects), the real impulse of such a cooperation was given on the occasion of the 2006 Uppsala Conference and reinforced in 2009 in Rotterdam with the conference on the theme of "Attracting Young People in Engineering: Engineering is Fun!". The Year 2011 was the SEFI Student year and in this context a series of targeted activities took place, including of course the involvement of the students in the SEFI Annual Conference 2011 (Flash Week in Lisbon) and in Thessaloniki (2012).

Discussions are already going on about a possible new TF on *Global Cooperation*. A topic that is part of SEFI's reflections as it will be seen later under the section "International Cooperation".

National Correspondents

It is in 1999, that SEFI Administrative Council decided to create a SEFI internal network of national correspondents. Indeed, SEFI extending in many more countries, it became urgent to ensure close relationships with local groups in order notably to get access to the most relevant information on HEE in these different countries and ensure the visibility of SEFI notably thanks to the organisation of "SEFI Days". This had been done notably in UK, in France, in Poland and Hungary (with very dedicated groups), in Spain, in Italy...

Events

The Annual Conferences

Since the beginning of its life SEFI has always considered its Annual Conference as its most important event. The task of organising an Annual Conference is given to one of our institutional members, who also proposes the theme of the conference. If one looks at the list of these themes, one finds that it is very hard to find an aspect of HEE which has not been considered yet! In certain cases, the theme was deliberately very general in nature: this happened in Paris in 1980 ("The Education of the Engineer in and for his Society"), in Madrid in 1985 ("Engineering Education: Patterns for the Future"), in Leuven in 1988 when SEFI celebrated its 15th anniversary ("Engineering Education in Europe"), in Portsmouth in 1992, SEFI's conference being a part of the World Conference in HEE, in Florence in 2002 ("The Renaissance Engineer of Tomorrow"), in Valencia in 2004 ("The XXI Century: The Golden Opportunity for EE"), in Miskolc in 2007 (organised in cooperation with IGIP "Joining Forces in EE toward Excellence"), in Trnva in 2010 (again with IGIP "Diversity unifies - Diversity in EE"), in Thessaloniki in 2012 "Engineering Education 2020: Meet the Future" and of course this year, in Leuven again for our anniversary "Engineering Education Fast Forward: 1973>2013>>".

The *fundamentals* of HEE and the way they are provided in the first years of study was chosen as the central theme in Copenhagen in 1977, in Louvain-la-Neuve in 1979, and was again the main concern in 1999 in the conference organised jointly by Winterthur University of Applied Sciences and ETH Zürich. *Continuing Education* in Engineering was chosen in Aachen in 1976, in Paris in 1983 on the occasion of the 2nd World Conference on this theme, and in a broader perspective in Vienna in 1996 ("Educating the Engineer for Lifelong Learning"). *Non-technical* but essential parts of engineering education were the central theme as early as in the first conference in Chatenay-Malabry in 1973 and, focusing on humanities and arts, in Krakow in 1997 as well as in Helsinki in 1998 on non-technical subjects, like entrepreneurship and management. Alternative *styles in learning* as well as the impact of *new technologies* in engineering education were the main focus in Manchester in 1974 (project-oriented curricula), in Nürnberg in 1984 (information technology), and

14 Academic E ngineers and Architect in Finland

in Marseilles in 1991. The importance of *research* and of the training for innovation came to the forefront in Lausanne as early as 1975, then in Delft in 1982, and in Compiègne in 1995. The *rôle of Governments* in providing the conditions for the required development of HEE was the theme at Brighton in 1981. The concern about the need to cope with an increasingly rapid evolution of the world and hence of the engineering profession inspired the conferences in Pavia in 1978, and in Napoli in 1989. An Annual conference of a very high standard focused on "achieving and assessing quality" in Luleå in 1993 or in Aalborg in 2008 ("Quality Assessment, Employability and Innovation"); another in Dublin in 1990 centred on the role of design in HEE. *Internationalization and interdisciplinarity* were the two key-words in Helsinki in 1987; the relations between *Industry and Academia* were chosen as the theme in Edinburgh in 1986. The East-West partnership in HEE in Europe in the first five years after the fall of the Iron Curtain were the central theme in Prague in 1994, when SEFI's conference was organised for the first time jointly with IGIP. The Annual Conference of the year 2000 has been in Paris, organised by a group of prestigious Grandes Ecoles (Paris Tech), which propose to focus on "Educating Internationally Orientated Engineers". In 2005, the Conference was held in Ankara on the theme of "EE at the Cross-Roads of Civilisations". "Internationalisation" which became "Globalisation" in the 2000's was chosen in Porto in 2003 ("Global Engineer: Education and Training for Mobility") and very recently in Lisbon in 2011 (together with the 1st World EE Flash Week on "Global Engineering Recognition, Sustainability and Mobility").

The Proceedings of our Annual Conferences - all the recent ones available on the SEFI site - constitute one of the most valuable sets of publications that SEFI has produced over the last four decades. As for most international conferences around the world, the quality may sometimes be uneven, and many of the issues considered « hot » in the past are no longer so today. On the other hand, it is noticeable that many of those hot topics remain nowadays key topics! Let us here mention topics such as mobility, university-business cooperation, the non-technical skills and competences, the position of the engineer in our society, preparing for the future, the quality assessment (accreditation) and excellence,... without speaking about the attractiveness of EE including the gender and diversity issues.

From a more structural point of view one has to take into account that it is at the Annual Conference that SEFI's General Assembly ordinary takes place. It approves the work done during the past year, elects members of the Administrative Council as well as Vice-presidents, discuss changes to the Statutes and of the strategy of SEFI etc.

Activities for Deans

Already in 2001, together with ESMU[15], SEFI initiated discussions in order to create special activities for deans and vice-rectors. At that time, we thought about special courses or workshops in order to brief those recently elected in that position about new EU developments. The idea was clearly to set up a special network for Deans in engineering. An idea that was finally realised when, in 2005, on the initiative of Prof. Borri, University of Florence, the very First Convention for Engineering Deans was organised - in cooperation with CESAER[16]. The theme of the Convention was of *Present and Future Challenges for Engineering Education and Research in Europe*. It was followed in early 2008 by the 2nd SEFI Deans Convention, organised this time by Prof. Jörg Steinbach in Berlin on *Special Challenges for Higher Engineering Education*. Since 2011, SEFI has invited CESAER to co-organise its Deans Conventions; in Paris, in 2011, the Convention was on the theme of *Engineering Education for an Innovative Europe;* in 2012, in Birmingham, on *Tomorrow's Engineers for an Attractive Europe: Working Together to Build on Europe's Excellence in EE",* and in April 2013, in Aalborg, *Engineering Education for a Sustainable Europe*.

15 European Association for the Strategic Management of Universities
16 Conference of Engineering Schools for Advanced Engineering Education and Research

Further to the Deans Convention, SEFI, together with the Instituto Superior de Engenharia de Lisboa (whose Rector is Prof. JC Quadrado, SEFI-Vice President 2008-2011), created, as an outcome of the EUGENE[17] Academic Network project (see later) the European Engineering Deans Council (EEDC). The aim of the EEDC is to implement a network of European Engineering Deans (individuals) and to leverage these deans' collective strengths for the advancement of engineering education and research, with as specific objectives to provide a forum for exchange of information and for discussion of experiences, challenges and best practices to lead an engineering college, faculty or school; to identify opportunities for engineering deans to collaborate with industry and other stakeholders in education, research and innovation; and to built a network that will support engineering deans in playing a leadership role in developing European and national policies for the benefit of Society. In September 2011, in Lisbon, Deans from all over Europe signed the "Declaration of Lisbon" and in March 2012, the new organisation was legally established in Brussels, within the SEFI Head Office.

SEFI Publications

The ***Proceedings*** of our past annual conferences were already mentioned under the section presenting our Annual Conferences.

The European Journal of Engineering Education - EJEE

A contribution of its Chief Editor, Prof. de Graaff, who in 2006 succeeded Prof. Jean Michel who had led the Journal during 28 years, can be found later in this book but let's keep in mind in the context of our 40th anniversary celebration, that it is in early 1976 that SEFI decided to publish a quarterly scientific journal devoted to the presentation and discussion of important developments in HEE, focusing on the European scene, but open to contributions from everywhere in the world. The EJEE is recognised as one of the major scientific publications in the field, its reputation being based, among other aspects, on a peer refereeing process. The Editorial Board has been expanding and now in 2013 has 39 members, of which 9 are from non-European countries (Australia, USA, Chile, Brazil, Bahrain). Since 2006, the EJEE is bi-monthly.

The SEFI Guides

1998 saw the welcomed arrival of the first volumes of the 4th edition of the SEFI Guide on Engineering Education in Europe: 569 pages, 37 European countries, 1036 HEE Institutions, each one presented through a comprehensive set of data: name, address, contact person(s), fax, telephone, e-mail, web site, a short description of the institution, a list of the main disciplines provided, a list of degrees, the course structure, both undergraduate and postgraduate, continuing education programs, international cooperation. More than 1500 copies of this 4th - and last - issue were sold.

The very first "SEFI Guide" had been published in 1978 already - Editor: Claude Comina, SEFI Information Committee, Ecole Polytechnique Fédérale de Lausanne - whose idea had been launched during the 1975 SEFI Annual Conference in Lausanne. At that time, Europe counted 700 engineering institutions from 20 countries.

The preparation of such Guides represents a real "tour de force" from several points of view. The information was always collected locally in each country by one or two members contacted by the committee, which has ensured that the data are up-to-date and that responsibilities are shared: omissions and/or mistakes must be kept at the lowest possible level, but are unfortunately inevitable in such an ambitious project. The amount of information judged suitable has varied and the 3rd edition of the Guide was probably the most restricted. Moreover, it had to be produced at different times, which resulted in two volumes, one for the West-European institutions and the other for the East-European institutions. Claude Comina, edited the first three editions,

17 European and Global Engineering Education

whereas Sirkka Pöyry of the Finnish Association of Graduate Engineers was in charge of the fourth edition together with Françoise Côme. In the context of the E4 project (see later) a pilot version of a web based SEFI Guide has been designed, taking into account of general European HEE context that since 1978 has evolved to around 2000 institutions of HEE existing now in a Europe in about 47 countries!

SEFI News and News@sefi

A simple information bulletin had of course been available from the beginning. In an editorial in November 1977 President Niels Krebs Ovesen (†) asked for a more dynamic and widely distributed information bulletin and the first issue of it with the new name of *SEFI News* was released in March 1978. It was a bimonthly publication edited by SEFI's SG with the financial support of UNESCO. The layout was modified - to become similar to the one many amongst us still remember - by the guest-editor C.G. Rasmussen of TU Denmark starting with the 23rd issue in 1986 and the periodicity became quarterly. Starting with the 44th issue (September 1992) SEFI News has been the "creature" of the Head Office. For years - its publication has been interrupted in July 2002 - SEFI News was THE Magazine of HEE in Europe. In the autumn of 2000, further to a decision of Administrative Council, the monthly distribution of our electronic information bulletin has been initiated. The "News@sefi" has evolved over the years, from a lay out and contents point of views. It now contains in addition to news about our Society, a large overview of recent achievements or discussions on HEE in Europe and in the World. The "News@sefi" is prepared by our Head Office in Brussels, and circulated to all the members of SEFI as well as to special partners and sister organisations.

SEFI Documents and Books

Most of the "SEFI Documents" published essentially in the 90' resulted from Seminars and Workshops organised by our WGs. The WG on Curriculum Development has been one of the most productive since its early stages under David Jenkins and Huib van Oort assisted by the invaluable Vernon John. Still today, under the chairmanship of Urbano Dominguez, the WG CD regularly publishes report on symposia they organise - "Innovation and Quality in EE" in 2012 for instance. The long list of SEFI Documents available on SEFI web site includes in-depth studies of some of the most important key issues of HEE. The space of this contribution is too short to give them justice. We cannot however avoid mentioning one of the most successful of such publications, namely « Core Curriculum in Mathematics for the European Engineer » which resulted from the work of the Mathematics WG and was translated into many languages. In the autumn of 2013, the 3rd edition of the "Core Curriculum in Mathematics" will be published. The WG on Continuing Engineering Education also published a noticeable series of documents and books, such as in 2009 "European CEE - Conceptualising the Lessons Learned". Amongst the recent publications, let's mention here the "Knowledge Triangle: Re-Inventing the Future" that is a collaborative book (2013) of the Aalto University, Polytechnic University of Valencia and SEFI.

SEFI Position Papers

Since 2000, SEFI regularly publishes Position Papers on the Bologna Declaration (in 2000 and 2001), followed in 2001 by a SEFI, CESAER, CLUSTER[18] Joint Letter to Ministers before Prague, in 2002, a SEFI Opinion on the Bologna Declaration, a SEFI Discussion Paper, in 2003 and in 2005 SEFI-CESAER Communication and Position Papers, in 2007 a SEFI Position Paper on the Doctorate in Engineering Education, followed in 2009 by a SEFI-IGIP Bologna process Communication -, the last one published in 2012 in cooperation with BEST. A SEFI Position paper on the creation of the European Institute of Technology was also published in 2005. In 2012, a new[19] SEFI Position Paper on the Accreditation of EE was also published.

18 Consortium Linking Universities of Science and Technology for Education and Research
19 The former PP on the Accreditation of EE had been published in 2001 by SEFI former President T. Hedberg.

Communication tools and social media

Since the beginning of 1995 SEFI has been equipped with its own web site. This milestone in making the information about SEFI more easily and effectively available has been made possible thanks to the enthusiasm of our late colleague H. Hodel of Buchs University of Applied Sciences. Since 2006, the SEFI web site is hosted in Belgium (KU Leuven) and maintained by the Head Office. The web site has steadily progressed since its creation and has become truly informative and well organised. It contains a portrait of SEFI in many languages, relevant administrative information, an international calendar of HEE events, news about recently published documents, lists of members and publications, information about Working Groups activity and about the major projects currently being developed. Since 2011, and notably thanks to the assistance of BEST students working at the Head Office during their summer holiday, SEFI and SEFI Student Facebook pages have been created as well as LinkedIn groups.

Projects

SEFI has coordinated or participated in so many projects, financed by the European Union or by the UNESCO (in the 90s), that we hereby would like to apologise for possible omission!

In 1990, SEFI established the *Task Force for Eastern Europe* (TFEE) that was chaired by Manfred Horvat, at that time Director of the University Extension Centre (Vienna University of Technology). During its existence, the TFEE was one of the most active bodies in East-West cooperation in HEE. In its first year, activities concentrated on initiating joint East-West projects in the framework of the EC programme TEMPUS (Trans European Mobility Scheme for University Studies); developing a concise plan for the further strategy of cooperation in HEE. The first SEFI TEMPUS Joint European Project (JEP) was called IMPACT for IMProvement in Automation and Control Technology; it started in September 1991 coordinated by the University Extension Centre of the Vienna UT. A "Plan for Cooperative Actions in the Restructuring Process of Engineering Education in Eastern-Central Europe" was presented at the SEFI Annual Conference in Marseille (1991). One year later the TFEE had initiated 7 TEMPUS JEPs and 3 TEMPUS Action 3 projects, enlarging its activities geographically to include representatives from other countries and establishing a subgroup for the Baltic States.

A project in which we were directly involved was *ETAP*, the *European Thesis Abroad Project*, proposed by the Internationalization WG way back when mobility of students was not taken for granted as it is today and the ERASMUS Programme was in its infancy. The main idea was to publish every two years a list of opportunities for students to have their final thesis work done abroad in a well-recognised research group in the field of their choice. The first edition of the ETAP Book was sponsored by the EC. The Internationalization WG repeated this exercise two more times, after which it was judged obsolete because of the success of ERASMUS, which was developing - *inter alia* - the same kind of activity. The example of the *ETAP* project is a good one to illustrate the innovative - precursor - mind that characterizes the active members of SEFI!

The WG on Continuing Engineering Education was always successful in being funded within the LEONARDO Programme for projects related to the need to provide some sort of accreditation for CEE activity such as *EuroRecord, EuroRecord Extension* and *Progress* or in the context of the distance learning, the *Facile* project.

A project which resulted from the collaboration between SEFI and CRE, formerly the European Rectors Conference that became in 2003, EUA, the "Association of European Universities", has been successfully finalized in 1998: its name is *SVESS* for *Software for Validation of Engineers Skills in Statistics*. It has seen the joint efforts of the Mathematics and the former Computers in EE Working Groups, together with experts provided through CRE, EADTU[20], and SEFI.

20 European Association for Distance Education

Already in 1995-1996, growing evidence of a decline in the interest taken by young high school graduates in HEE studies was observed in several European countries and induced the European Union to finance an intensive research project on this phenomenon. This was a first example of collaboration between SEFI and CESAER. The resulting report[21] pointed out that the problem was far from being fully understood and that further work needed to be done to improve the situation of the decreasing number of students in HEE. A few months later this theme was included as one of the working groups of a Thematic Network project for which support was asked within the EC SOCRATES Programme. The title given to the project was *Developing the European Dimension in HEE (DEDHEE)* and it included three other topics and corresponding working groups: Quality Assessment and Mutual Recognition, Internationalization of HEE, and Lifelong Learning. An ad-hoc European Economic Interest Grouping, called *H3E*, was formed by the three associations involved in the project, BEST, CESAER and SEFI. In order to manage the Thematic Network efficiently, and on request of the European Commission, other projects were incorporated, such as the *JEEP Teams, Joint European Engineering Project Teams,* aiming at establishing an organisational framework for allowing small teams of students from different parts of Europe to work together towards the completion of a Master Level (or equivalent) research project.

In parallel, other projects were initiated during these years: *Pie (*Plastics in Engineering*),* and *Protect*, in the textile engineering field.

In the period of 2000-2003, H3E "DEDHEE" was followed by a new Thematic Network project, coordinated this time by the University of Florence, and that was called *E4 - Enhancing Engineering Education in Europe*. The three-year project was later followed in 2004-2008 by TREE Thematic Network *Teaching and Research in HEE* and for the period of 2009-2012, by EUGENE - *European and Global Engineering Education*. The 100 partners of this important project, successfully coordinated by the University of Florence, dedicated a lot of time and efforts in analysing and producing reports on *Ph D. Studies/ Structure and Bologna Follow-up ; Promote EE in Europe as a true research field; Improve transnational mobility of engineering students/graduates and professionals within EHEA and on a global scale; LLL and CE as a tool to improve competitiveness and enhance innovation capacities of European engineers* and *Increase attractiveness* . Three transversal actions were also developed: *Involvement of industry; Promote establishment of European Engineering Deans Council* and *Sustainability tools*.

In those years, SEFI also became a partner of "genSET" *Building institutional capacity for action on gender dimension in science,* in the context of the EU Framework Research Programme 7.

SEFI participated in many other projects, such as *EuroPACE 2000* and *Eurascope*, EDWIN - *Education with the Industry* - a LEONARDO project in cooperation with FEANI, VIOLET - *Virtual Infrastructure for Open Learning in CEE*, TRANSFINE - *Transfer between formal, informal and non-formal education*. It is also in the context of these projects that in 2002 SEFI signed the *EU Memorandum of Understanding on Multimedia Access to Education and Training - Partnership for a Common Approach to the Production and Delivery of Learning Technologies, Content and Services*.

More recently, SEFI was engaged in the EUR-ACE[22] (2004-2006) and EUR-ACE Implementation (2006-2008) projects that aimed to design the European quality label for engineering degree programmes at Bachelor and Master level, in LEPAC (Accreditation in Lebanon), in Techno TN initiatives, in ECCE - *Engineering Observatory on Competence based Curricula for Job Enhancing;* ECDEAST - *Engineering Curricula Design aligned with EQF and EUR-ACE (2010-2013);* QUEECA - *Quality Assessment in Engineering Education in Central Asia,* MODERN - *Establishing a European Platform for the Education Modernisation; EU-Drivers - European Platform for a regional Innovation Platform; ...*

21 Authors: Ph. Grosjean, Secretary General of CESAER/F. Côme, Secretary General SEFI
22 European Accredited Engineer

Honours bestowed by SEFI

The highest distinction that SEFI can bestow is the *Leonardo da Vinci Medal*, awarded by the Administrative Council of SEFI to «living persons who have made an outstanding contribution of international significance to engineering education ». The Medal was instituted in 1983 and the first recipient that same year was Jacques Delors (former French Minister under F. Mitterand, and President of the European Commission). In a powerful speech he paid tribute to engineers, pointing to the key roles they play in today's world as well as in the future, mentioned the need for enhancing the European dimension in HEE, and that of learning to learn. His final words were flattering for SEFI: « I would like to have reflected the award of this distinction to all of you, engineers of today and tomorrow, to you, [....], as the animators of SEFI who have really understood this central and strategic role of the engineer.[23]»

SEFI Leonardo da Vinci Medal Recipients

Jacques Delors, Heinz Zemanek, Sir Monty Finniston, John Klus, Antonio Ruberti, James Dooge, Hubert Curien, Sir Robert Telford, Sven Olving, Ladislav Cerych, Jean Gandois, Fritz Paschke, Olgierd Zienkiewicz, Teuvo Kalevi Kohonen, Niklaus Wirth, Senator Pierre Laffitte, Niels L. Meyer, Santiago Calatrava, Joaquim Ribeiro, Giuliano Augusti, Gulsun Saglamer Ingemar Ingemarsson, Paul Soros, Ole Vinther, Jean Michel, H.R.H. Prince Friso van Oranje-Nassau, Konrad Osterwalder, Luis Ignacio Lula da Silva, Joseph Sifakis, Frank De Winne.

It has become traditional in more recent years to involve the organisers of the Annual Conference, during which the Medal Ceremony takes place, in the choice of the recipient. Obviously the recipient is not required to be a member of SEFI and not even an engineering graduate as a matter of fact. This allows for a greater freedom of choice, which is reflected by the impressive list of recipients.

Since 1995 SEFI has introduced another level of recognition of meritorious service to HEE in Europe: the *SEFI Fellowship* - "F. SEFI". The initial proposal was made by Keith Davies, SEFI Industrial Vice-President in the early 90s, and revised in the final form by Gaston Wolf of Winterthur University of Applied Sciences, then SEFI Vice-President. The nominees are normally SEFI individual members who have worked in the field or in the promotion of HEE for at least the previous 5 years.

SEFI also awards on the occasion of its Annual Conferences a prize for the best conference papers.

In 2002, in the context of our Annual Conference held in Florence, SEFI awarded Dott. Domenico Lenarduzzi, EU Honorary Director General for Education, of the SEFI-University of Florence "Career Prize". SEFI also gave its Honorary Membership to persons who eminently marked the life of our Society through their specific action or support, namely Mrs. Ackermans, Prof. Heitmann, Prof. Szentirmai, Prof. Gobin, Dr. Marjoram and in 2013 to Mrs. Maffioli.

In 2013, to commemorate our 40th anniversary, the "SEFI Prize for the Best PhD Thesis in Engineering Education" will be bestowed.

International cooperation

Since the creation of SEFI in 1973, European cooperation has always been seen as a crucial aspect of our activities. A Vision statement was signed among others with IGIP, an organisation with whom SEFI organised joint annual conference, in Prague in 1995, in Miskolc in 2007 and in Trnva in 2010. SEFI also contributed to the creation of ENAEE and recently of the EEDC as already mentioned before.

23 The full allocution of Jacques Delors is available on the SEFI web site

More or less since our establishment, contacts have been developed and maintained with ASEE[24] and since 2001-2002, at the time of the organisation by SEFI and TU Berlin (Prof. Heitmann) of the First ASEE International Colloquium (that had to be held in 2001 immediately after the SEFI Annual Conference in Copenhagen, but was postponed to 2002 due to the events of September 11) strong impulse was given to cooperation with organisations from all over the world. It also led to the participation of SEFI in the creation of IFEES[25] in 2006 (with former SEFI President Prof. Borri, as the founding President of IFEES), and since that time, a series of cooperation agreements have been signed with associations such as ASIBEI[26], LACCEI[27], JSEE[28]. Strong contacts with GEDC[29] are in establishment too.

Last year (2012), SEFI and ASEE signed a new Memorandum of Understanding fixing the terms of their mutual cooperation.

SEFI Statement of Concern

The members of the community of engineering education participating in the 2001 SEFI annual conference in Copenhagen on September 12-14 express their grief and concern about the recent terrorist attacks in the USA.While training future engineers in the assumption that technology is to the benefit of mankind, we are painfully aware that this assumption does not go unshaken.

We will strive at contributing in all ways we can to the furtherance of conditions in the world that may diminish the possibility of negative effects of technology in ways consistent with universal principles of ethics and justice.

SEFI, General Assembly,
Copenhagen, 14 September 2001

Before, SEFI had supported the creation of IACEE[30], an organisation with whom special contacts have always been ensured notably through our WG CEE, and through the participation and organisation of the European and World Fora on Continuing Engineering Education.

In 2011, SEFI and IFEES created together the International Institute for the Development of Engineering Academics "IIDEA". IIDEA is a leadership training institute focused on establishing a global network of engineering faculty development programmes to disseminate learning about the transformation of engineering education worldwide. IIDEA provides all the engineering education associations, institutions and other engineering education stakeholders a clearing house of high caliber and world-class engineering faculty leadership training workshops/courses/seminars, helping to broker the offering of these around the world.

The list of other organisations with which SEFI has relationships and which can result, as has happened already, in joint projects is quite long: we can find ABET, UNESCO, FEANI, EFMD[31], the European Cultural Foundation, EUA, ACOFI[32], ABENGE[33], SPEED[34], European Commission, Council of Europe, CAEE[35], AEEE[36],OECD, WFEO[37], CLAIU[38] amongst many others.

24 American Association for Engineering Education
25 International Federation of Engineering Education Societies
26 Association Iberoamericana de Institociones de Ensenza de la Ingenieria
27 Latin America and Carribbean Consorium of Engineering Institutions
28 Japanese Society for Engineering Education
29 Global Engineering Deans Council
30 International Association for Continuing Engineering Education
31 EFMD - European Foundation for Management Development
32 Asociación Colombiana de Facultades de Ingeniería
33 Associaçao Brasileira de Educaçao de Engenharia
34 Student Platform for Engineering Education Development
35China Association for Continuing Engineering Education
36 Australasian Association for Engineering
37 World Federation of Engineering Organisations
38 Conseil des Associations d'ingénieurs de cycle long, d'Université ou d'Ecole d'Ingénieurs

Towards our future

To conclude, let us quote our colleague Markku Markkula when in SEFI Annual report 2011-2012, he reflected on the role of engineering universities in achieving the targets of the Europe 2020 strategy: "2012 is" - *and this is still valid in 2013* - "the right time for science-society dialogue. The economic crisis has created challenges both for people's everybody lives and for societal decision-making. Although the transformation brought about by digitalisation and globalisation has been recognised years ago, its revolutionary force was neither early enough nor taken seriously enough. The engineering universities" -*and therefore networks such as SEFI* - "can and should have something new to offer".

What SEFI could and should do, is developed in this book.

CHAPTER III

EUROPEAN ENGINEERING EDUCATION: SEFI'S VALUES AND REFLECTIONS

An Introduction

*By **Ladislav Musilek**, SEFI Administrative Council member, Czech Technical University in Prague*

The history of engineering is much longer than the history of the institutionalisation of engineering education.

The men who designed and supervised the construction of the Seven Wonders of the Ancient World, and the "magistri operis" in charge of the construction of medieval cathedrals, were engineers par excellence. Leonardo da Vinci, who was not only a painter but also an outstanding engineer, received only an informal education in Latin, geometry and mathematics, and at the age of fourteen, he was apprenticed to the workshop of the artist Andrea Verrocchio. Sébastien de Vauban, whose innovative designs of fortifications were later imitated all over Europe, got his grounding in mathematics, science and geometry thanks to the Carmelite prior of Semur-en-Auxois, who undertook his education. Even when the first technically-oriented higher educational institutions were established, many engineers had more a classical education than a technical one. As an example, Isambard Kingdom Brunel, probably the greatest English engineer, after studying at the College of Caen and at the Lycée Henri IV in Paris, was deemed ineligible as a foreigner to enter the École Polytechnique in Paris, and he then studied under the master clockmaker and horologist A.-L. Breguet.

However, this situation has changed, and engineering educational institutions have become an integral part of the academic world.

The importance of good-quality engineering education in the modern world is now beyond any doubt. Even those people who question the significance of sciences and technologies for human well-being have no qualms about using the results of technical progress, or about enjoying the comfort provided by the achievements of civilisation.

SEFI, as the largest European network of institutions and individuals engaged in engineering education, therefore sets out to express the values that characterize the long-term development of engineering.

What does this involve?

In the first place, we must mention the high professionalism of engineers, accompanied by their responsibility for the results of their work. This is an age-old issue, which emerged in early times, when engineering experience was handed down from generation to generation, from master to apprentice. Lack of experience can, on the one hand, sometimes lead to interesting and innovative solutions. However, it can also sometimes lead to disasters that endanger or even destroy a piece of engineering work. Methods based on trial and error are accompanied by a series of bigger or smaller engineering errors. As a random choice of famous disasters, we can point to the collapse of the vaulting of the choir during the construction of the cathedral in Beauvais in 1284, the sinking of the warship Vasa immediately after its launch in 1628, and the failure of the newly-built Dale Dike Dam in 1864, resulting in the so-called Great Sheffield Flood. There is no shortage of examples of engineering triumphs, on the one hand, and catastrophes, on the other.

SEFI can make a substantial contribution to the professionalism and creativity of engineers in Europe, forming a platform for exchange of experience among teachers and students at various institutions in European countries, promoting examples of good practice, linking engineering educational institutions and thus extending the opportunities for students to see their field of study in an international context. The word "excellence", nowadays so frequently, and often superficially, pronounced in speeches by politicians, is a real and sincere aim for European engineering education, and it is certainly what SEFI aims to give its full support to.

However, SEFI feels that engineers cannot be strictly limited by the framework of their profession; they must also be generally educated people with a broad cultural and societal horizon. Examples of good practice should therefore also include promoting multilateral study programmes, containing a balanced mixture of mathematics, physics and other exact sciences, engineering disciplines, social sciences and communication skills. Mankind's knowledge today is so deep and so wide that it is no longer possible to aspire, like some Renaissance scientists and engineers, to master practically all fields of contemporary knowledge. Nevertheless, a modern engineer should have not only a deep knowledge of his field of specialization, but also some cognisance of the scientific and societal context in which he works. This results in collaboration and overlapping among various engineering disciplines. Multidisciplinarity is increasingly necessary for solving many present-day problems.

European civilisation is not homogeneous. It has various cultural traditions, emerging predominantly from the Ancient world, Jewish culture and Christianity, but with strong influences of Eastern cultures, especially in the countries of the former Soviet Union, Moorish influences, which are still alive in Spain and Portugal, influences of North Africa and the Near East in the Mediterranean countries, Norman and Viking traditions in the North, etc. This cultural diversity is respected by SEFI. The Society wants to form a bridge linking the various parts of Europe, to contribute to mutual recognition and understanding. As the exact sciences and technologies are independent of geographical area, politics and religion, SEFI can also act as an important tool for bringing together people from different cultural backgrounds, and for enriching the people in various European countries with various cultural elements from all corners of Europe.

Moreover, the geographical area of activity of the Society reaches beyond Europe. Collaboration with non-European societies of engineering education, the participation of experts from the USA, Brazil, Africa, Australia, and other areas outside Europe at SEFI conferences, and at other activities organised by the Society, gives a global character to SEFI.

Equal opportunities in relation to gender, and the role of women in engineering and engineering education, are widely discussed in many fora, and are also a matter of interest for SEFI. We are convinced that not only the humanities, but also many fields of engineering can be attractive for women. We probably should not expect, for example, mining or the steel industry to become domains for women engineers, though these fields should offer a good welcome to women who want to enter them. Many other fields of engineering are already attracting increasing numbers of women students and graduates, for example interdisciplinary topics in biomedical engineering, environmental engineering, radiological physics and technologies, and to some extent also information sciences and technologies

Engineering education cannot be a matter only of teachers at technical universities and engineering faculties. Two-way interaction with students, feedback from students to teachers and vice versa, leads to better human relations in the institution and helps in modernising existing programmes and in preparing high-quality new programmes. SEFI therefore places great emphasis on student participation in its work, and on students sharing in the presentations and discussions at the annual conferences. However, teachers and students are not the only stakeholders in engineering education. Graduates from universities need to make a smooth entry into the "real world" of engineering. They should be well prepared for the world of industrial companies, public authorities, business and entrepreneurship. The participation of industrial companies and representatives of business and commerce in the activities of SEFI therefore helps the Society to support improved engineering education.

Close links with researchers and research institutions are also necessary, as highly qualified engineers should acquire the way of thinking and the inventiveness that characterize researchers. All engineers need to be open to implementing research results and to engaging themselves creatively in research and development.

SEFI also takes on responsibility for spreading awareness about the importance for our society of engineering education, research and development. Although this idea is taken up by practically all governments and other official representatives, it always seems to retreat into the background when it comes to distributing the state budget.

SEFI cannot be a closed academic society. It must be open to the outside world, propagating the value of education and of developing human intellectual resources, so that progressive technologies will be studied, developed and applied.

Last but not least, ethical aspects of engineering need to be a focus of attention for SEFI. With the development of science and engineering, technical applications may not be promoted without carefully considering their usefulness to human society. An ethical assessment needs to be made alongside considerations of technical factors and profitability. Engineers should be comfortable not only when seeking technical solutions, but also when considering the human and spiritual dimension of engineering.

Engineers should also be able to deal in an intelligent and competent manner with irrational, anti-scientific attitudes and tendencies that often appear outside the scientific community, and also to deal with various lobbying pressures on behalf of the interests of only a small group of individuals motivated by their political orientation or by the pursuit of financial gain.

SEFI aims to define, enunciate and promote the values of the whole engineering community, which have been formed by centuries of careful and exact engineering work and reflect the development of human knowledge and human values. These aims may seem idealistic, but idealists who are creative and who set ambitious targets have always been a driving force for progress.

SEFI particularly supports the education of engineers who set themselves ambitious targets.

Supporting Professionalism and Creativity in Engineering Education

*By **Wim Van Petegem**, SEFI President 2011-2013, KU Leuven - **Michael Hoffmann**, SEFI Administrative Council member, Universität Ulm/4Ing*

Introduction

We all agree that future engineers may be and should be drivers for technical innovation. Therefore, modern engineering education must prepare engineers not only to act highly professionally in a technical and social sense, but also to develop their creativity. Numerous attempts have been made to include creative components in our engineering curricula. Finding references on this topic is not that difficult – it just depends on how broad we interpret 'creativity'. Striking however is that we mostly find publications or presentations about engineering *students* to be creative: we want them to think out of the box. Much less is to be found on *teachers* and their relations to creativity. In this contribution we will mainly focus on this aspect: who are they and how are they different from other teachers, how can they develop the necessary skills and competencies, and how can a network like SEFI contribute to this professionalization process?

Creativity

It is beyond the scope in this contribution to come up with a broad discussion on scientific definitions of creativity. In colloquial English, as for instance cited in Wikipedia (which admittedly is not a scientifically rigorous source, nor a creative reference of ours), we may define creativity "*as the process of producing something that is both original and worthwhile*", and that is "*generally perceived to be associated with intelligence and cognition*". However, such "definitions" do not really help to better understand how to *develop creativity*.

How many aspects must be taken into account when attempting to scientifically define creativity, is demonstrated by a paper of Runco[1], where the author writes: "Creativity is expressed in different ways in different domains. […] Clarifying these differences is one of the most important impetuses in the [psychological] literature."

Meanwhile, there has been an attempt to define independently from a domain what creativity is about[2]. The definition is based on a cognitive model of learning. There it is required that as a prerequisite for being creative, individuals must have acquired *competencies*. I.e., they must have been trained to assess whether a set of events and episodes follows given rules, and they must be able to find further rules actively and autonomously, based on formerly acquired knowledge on rules that govern events and episodes. As a consequence, they must be able to plan what to do in particular situations. Even more, since they know the rules, they must be able to interpret them in completely new situations in a way that sensible solutions for problems may be found. If novel limiting conditions occur, they must be able to adapt the rules to the new conditions.

Based on this definition of competencies, we may now explain what we understand by creativity. Instead of simply adapting rules to changed situations, one might think of transferring rules from one context to a completely different context. In many cases, this will not yield useful results. However, from time to time, such a procedure could result in surprisingly useful outcomes. An example for such a successful case is the transfer

1 M. A. Runco, "Creativity," Annu. Rev. Psychol, vol. 55, no. 1, pp. 657–687, 2004.
2 M. H. Hoffmann, "Fairly Certifying Competences, Objectively Assessing Creativity," in Proc. of EDUCON 2011, Amman, 2011, pp. 270–277

of the shape of a bird's wing to an airfoil wing. Some thirty years ago, this was considered to be an absurd idea. Meanwhile, nearly all wings of large airplanes have been changed using ideas taken from the example of bird life.

Still more revolutionary are some results that have been found by thinking on bending or breaking some rules of a set of rules. In most cases, this is of no use or even corruptive. However, there are some cases with exciting results, where an educated guess on bending or breaking rules creates a whole universe of results. The invention of the special theory of relativity is such a case. Based on the observation that light in vacuum had always the same velocity, no matter whether it was emitted from a body that was moving in relation to the observer or not, caused Einstein to give up the rule that velocities must be added linearly, which caused enormous changes in our understanding of mass, time, and energy.

Creativity might thus be seen as the result of a sublimated learning cycle, where learning means experiencing and memorizing a highly complex chain of ideas, and where new ideas appear as results of a careful simulation concerning transfer and change of rules, which have been found by that learning process. Interestingly, these new ideas are not necessarily and not always found as results of logical thinking, as it is demonstrated by creative arts.

Creative Engineering Educators

Applied to engineering education, this means:
Learners must first be guided to systematically achieve competencies first, such that they develop a deep understanding of rules behind technical contexts. Professionalism in recognising rules can only be achieved, if similar rules in different contexts will be made visible.

And this is where creativity of educators is required, on a systems level as well as on a personal level.

Educators must recognise that curricula are not invariable, unalterable, solid blocks that are given by some mysterious authority ("what worked well twenty years ago will work well in the future"). They must recognise that there are rules governing curricula, and that these rules may be subject to changed boundary conditions. Being educators, let us dare to ask questions, dare to doubt, dare to question which knowledge, skills, and competencies a submodule, or a module, or even a complete curriculum is to convey. If in doubt, let us dare to suggest a change to our colleagues.

Creativity on a systems level (in engineering education) is thus the smart process of developing original engineering curricula and according teaching/learning activities that in the end leave the students with new, valuable skills and competencies to enter the labour market. A creative engineering educator is thus someone who does not only master the competencies that we expect from a well-educated engineer, rather teachers should also be able to suggest hypotheses (e.g. what if we transform our curriculum completely in PBL?), they should be able to generate and extend ideas (e.g. how can we introduce the flipped classroom?), they ought to apply imagination (e.g. what about a MOOEC, a Massive Open Online Engineering Curriculum?), and to look for alternative innovative outcomes (e.g. is it possible to grant our students a more universal degree?), just to mention a few examples of adapting, bending and breaking much-loved rules.

These examples are just a few illustrations and more ambitious ones are welcomed to spark further discussion. However, if they already sound too challenging, a more conservative view is that a creative engineering educator is able to identify new problems, rather than depending on others to define them (i.e. engineering curricula should flexibly adapt to changing global trends), is able to transfer knowledge gained in one context to another in order to solve a problem (i.e. instructional design principles should be easily applied in engineering education), believes in learning as an incremental process, in which repeated attempts will eventually lead

to success (i.e. any new curriculum implementation process should be evaluated step by step to give feedback from all stakeholders and new insights a chance) and has the capacity to focus attention in the pursuit of a goal, or set of goals (i.e. curriculum development is a continuous process embedded in an overall quality assurance culture).

Admittedly, not all of us, involved in engineering education, can qualify fully to the above definitions. This is not mandatory even (Think of a world full of Einsteins) It is even more favourable to think about *creative engineering education teams*, where individual teachers bring together their own skills and competencies, and where they collaborate in new creative ways towards the common goal. Such teams of excellence could only be examples to our students, how group and team competences are more than just the sum of individual competences.

How Can Engineering Educators Grow in Creative Competences?

Having said that not all engineering educators should have the same (high) level of creativity (imagine how chaotic the engineering world could become), does not imply we should leave it here. We believe that teachers are learners as well: they can grow in creative skills and become more creative engineering educators.

In higher education institutes professionalization of teachers is usually organised by the Teaching and Learning Departments (or alike). In the training programmes we should foster creativity and provide room for creative thinking and sharing of knowledge and expertise. We should include techniques and methods of creativity in the trainings for individual teachers in order to let them experience first-hand what is all about, how they can learn the skills and more important, how they can implement the same principles in setting up curricula, designing courses or implementing learning activities for the students. Inspiration can be found in the literature, where tools and guidelines, ranging from simple brainstorming to more advanced gaming and role playing, are described for growing in creativity as individual teacher and as member of an educational team.

The latter is important, as already indicated above: impact will be larger when teams of different creative brains and capacities are formed and embedded in an overall culture of creativity and innovation. Therefore, also the organisation, the higher education institute itself, should grow in creative competence. Such an organisation is certainly characterised by a shared and recognised belief in creativity as an asset for teachers and students and possible other stakeholders. The challenge is thus to install a culture where risk-taking, exploration of boundaries, flexibility in mind, divergence in thinking and a certain level of non-conformity (going beyond the rules) may flourish, rather than to stick to traditional values and principles like standardised curricula for all students, obedience in a hierarchical teacher-student relation, relevance of formal degrees or immediate success in the labour market. This culture demands for an engaging and tolerant learning environment, where teachers are the key but students are at the centre of the stage, where all stakeholders are able to know when to be original and when to conform, where individual ideas, interests and opinions, both from teachers and students are welcomed, where everyone can take part in the learning process and in the co-construction of new knowledge, where hard work is rewarded but where fun is allowed. In short, we need an institutional culture where creativity is seen as a source of deep knowledge for all.

We hardly believe that initial teacher training and continual professional development should address and promote this kind of culture in engineering education. It should be emphasized that in many cases the best trainers in creativity are found outside the conventional Teaching and Learning Departments.

And what is in this for SEFI?

As a network of individuals and institutions SEFI is well placed to stimulate and to help its members in their journey towards more professionalism for creative engineering education. We see several opportunities, in line with the regular services SEFI is offering:

SEFI is bringing people, both teachers and students, together into one large community of stakeholders in engineering education, both face-to-face as in the virtual world. This mix of highly talented individuals, each with their own creative capacities, must undoubtedly lead to an interesting clash of ideas, where new teaching and learning concepts can emerge and find their way to real implementation in innovative curricula, to the benefit of future engineering students.

To this end, SEFI is organising a lot of events, like meetings, workshops, and conferences, is publishing a scientific journal and other relevant documents, and is active on the web in different ways. These are all occasions for knowledge sharing, co-construction of new knowledge, and fostering innovation in engineering education.

And last but not least, SEFI should bring the message of creativity, in the first place to its members. Individual teachers should be convinced there is something in for them, and institutions should be persuaded to evolve into open, innovative communities where creativity and innovation are enabled and valued appropriately. SEFI should also address the outside community, i.e. our (political) governments, the European Commission, relevant bodies and other networks, in order to make clear what creative engineering education could bring to them and which impact this might have on the broader society.

These are just a few suggestions. The real creative power of SEFI lies in the people, teachers and students, and it is unpredictable where they are leading us. If their creativity is well cherished, they will guide us towards a better future for us all, no doubt.

Responsibility and Engagement - An Inclusive and Open Organisation

*By **Xavier Fouger**, SEFI Vice-President, Dassault Systemes, **Kamel Hawwash**, SEFI Incoming President, University of Birmingham*

Beyond sound operating practices, SEFI's commitment towards its membership consistently breaks down in two key pillars:

"Responsibility" reflects the multiple variations of the qualities expected from engineers: an instinctive sense of the effects of our decisions and a systematic willingness to make things happen and to account for their consequences. Whether towards employers, economy, regulation, society or planet, engineers all have to exercise this sense and to display this willingness, sometimes in bold manners, at various moments of their careers Educators and educational institutions have this same responsibility towards their students. SEFI has it also when it comes to help its membership developing responsibility in teaching and teaching of responsibility.

"Engagements" reflects our attitude of challenging the status quo in a constant manner, to enhance engineering pedagogy, to evolve institutional schemes and to improve our own practice as a society. We do so by continuously, yet rigorously, questioning our practices through scientific approaches, constructive criticisms, benchmarking, international networking and global intelligence about our field of innovation.

SEFI sees itself as an inclusive scientific society, welcoming members from all constituents of our diverse European engineering education systems. It is our belief, repeatedly proven during the last decades of our history, that exchanges of ideas between institutions of various natures, only can generate the holistic "talent chain" needed in our complex socio-technical economies. This is why, from technical institutes to research universities, from governments to businesses, all stakeholders of our ecosystem are invited to contribute in our debate to promote and reinforce engineering education in Europe.

SEFI is constantly orienting its efforts towards the development of an educational system which produces more employable engineers. Members, scholars and leadership representatives systematically address the cognitive, scientific and organisational dimensions in engineering education, with a specific focus on the competences of collaborative and inter-disciplinary engineering. It is the responsibility of SEFI to question strongly established academic traditions of specialization and to disseminate models and successful practices of globally collaborative innovation. To tackle these challenges beyond conferences, SEFI restlessly promotes mobility and its instruments –accreditation, international workplace learning and students projects- through its government', membership' and corporate's interactions.

Ahead of us are multiple challenges! Ethics questions and quality assurance issues originating in the overall expansion of on-line education will require our Society to engage in defining a position acceptable to the European population and appropriate to engineering disciplines. Engineering voices in the society will need to be audible and press should become an instrument of interest for our community. The economic weakening of the continent calls for a sustained focus on competitiveness and creativity in our curricula.

The fragility of natural environments and an explosive global demography will require the educational community to develop engineers capable to imagine human action with global magnitude.

A programme for the coming decades!

Respect for Cultural Diversity

*By **José Carlos Quadrado**, Instituto Superior de Engenharia Lisboa, Former SEFI Vice-President, IFEES President*

One of the key values of the European Society for Engineering Education (SEFI) is the respect for diversity and different cultures.

By cooperating with different regions all over the world, with specific social and economic settings, with different educational environments, and with different ways of thinking and communicating, SEFI has progressively transformed and expanded.

In a short period of forty years, the SEFI project has opened up its horizons and frontiers, by interweaving new cultural realities in its space. In this context, it was imperative in our society to articulate the way we interact with each other, and how we receive the distinctive traits and identify with a common root culture that is increasingly and irreversibly more heterogeneous.

The notions of "multiculturalism" and "intercultural dialogue", "cultural pluralism" or "intercultural education" are part of the SEFI day-to-day functioning, with which all involved in SEFI identify and celebrate. The "SEFI identity" is thus aimed at inculcating in its members a sense of belonging to a group, to a place, to a set of values, to a modus vivendi that sustain the human relations and gives way to identity affirmation in a globalised world.

SEFI has set forth various efforts, conveyed by its different working groups, in order to create a cultural agenda, resorting to an assortment of initiatives. These seek to stimulate the cultural promotion among the members and the intercultural dialogue between them, by exchanging experiences and results.

The significance of intercultural education in a plural society, which endeavours to reach consensus has some cultural concerns that are a recurrent subject in today's society, at a time of confrontations, impositions and intolerance. Bearing in mind that cultural freedom is an indissoluble part of development, allowing the individual to choose an identity, it becomes urgent to encourage the cultural coexistence in the European space, which necessarily implies respecting the identity choice of the other, not forgetting the several national cultures while leveraging a common cultural heritage.

Respect for the cultural diversity is a key value for the SEFI we built!

Promoting Openness and Multidisciplinarity

*By **Anne-Marie Jolly**, SEFI Administrative Council member, Polytech'Orléans*

This value particularly characterizes and distinguishes SEFI and has an impact on the way all the actions are conducted.

First, in SEFI, engineering education is considered at all the levels from bachelor to doctorate and so, exchanges of best practices happen in this frame; it is very important because according to the countries in Europe, the meaning of the term "engineer" is not always the same!

Diversity of ages is also a factor taken into consideration in SEFI: at the SEFI Annual Conference in Rotterdam (2009) for instance, junior teachers from engineering universities were on the scene to debate the future of engineering: surprising, because we are much more used to ask these questions of senior teachers.

Multidisciplinarity in the careers of participants in SEFI meetings and working groups, sometimes coming from education science, social sciences, ergonomics, whilst others are research oriented specialists in a narrow field of technology, all these people interact quite well together to progress in their own discipline.

Diversity also thanks to the links established not only with colleagues across Europe and in the world, but also with students, particularly from BEST, whose contribution is enriching the life of SEFI. Since students for some years had the opportunity to contribute to the evaluation of the quality of our higher education institutions, it is natural that they play a key role in discussing the present and future of education in engineering.

Innovation is very often a consequence of pluridisciplinarity. Working with people coming from another domain of expertise leads to imagine new application to this knowledge. The multidisciplinarity in SEFI is a key factor for presenting, discussing, and improving new approaches to engineering education.

The importance given both to enhance the attractiveness of engineering education to young people and to the progress to be made relating gender equality, resulted in the creation of working groups on these two subjects. They are the key tools for opening engineering as a career to new groups in our societies.

Yes, it is not only in words but in facts that SEFI demonstrated its real impact on diversity, and we like it!

Supporting Ethically Motivated Practice

*By **E. Alpay**, Chair SEFI WG Ethics, Imperial College London, **H. Zandvoort**, former Chair SEFI WG Ethics, TU Delft*

There is increasing international acknowledgement of the need for a global dimension in engineering education to address current and future social and environmental challenges. Such a dimension is associated with the skills and knowledge for ethical decision making, action and leadership. Practical understanding of ethics provides grounding for the global engineer, supporting activities that range from business management, development and strategy to international policy making. SEFI recognises the important role of such education and has been actively involved in its promotion and dissemination. This is particularly exemplified by the set-up and remit of the Ethics in Engineering Education (EiEE) working group (WG).

Established in 1998, the purpose of the EiEE WG has been to stimulate discussion, opinion formation and decision making about the needs and opportunities for ethics in the engineering curricula, share experiences, practices, developments and teaching resources in ethics and ethical leadership education, establish a network of educators and practicing engineers who want to develop ethics education, engage students in the development of initiatives for ethics education and awareness, share and support scholarly activity in assessing the nature and impact of ethics education

The WG holds regular annual meetings as part of the SEFI Annual Conference and coordinates presentations under the conference theme of engineering ethics. The working group has also been a proponent for wider international dialogue through its involvement in the organisation of international ethics workshops and meetings. The topics of such sessions have included: responsible conduct of research for scientists and engineers (Bradford, 2012), social responsibility and engineering education (Delft, 2010; Uppsala, 2006), and teaching ethics and peace to science and engineering students (Hamburg, 2008).

The EiEE WG aspires to endorse and promote professionalism, responsibility, respect, transparency and openness in engineering, thus closely mirroring the core values of SEFI. In this sense, SEFI in itself can be seen as a model for ethical practice, motivated by, for example: social responsibility in the advancement of graduate and teacher skills; institutional inclusiveness for the understanding of stakeholder and societal needs; and cross-discipline exchange to identify and disseminate good practice. A particular strength of the EiEE working group has been to provide educators, employers and students with practical approaches and stimulus for ethics education. Furthermore, the working group strives to support SEFI members in their efforts to promote student learning experiences that have ethical awareness or development as an outcome.

Lifelong Learning and Continuing Engineering Education

*By **Kirsti Miettinen**, Chair SEFI WG on CEE, Director Aalto University Professional Development*

During the last decade most of the European Universities have formulated their Lifelong Learning (LLL) strategies. In many cases this has been required by the national governments as part of the Universities "third mission" along knowledge transfer and services to society. Core in these strategies is the overall goal of preparing the university students to awareness of the need and the skills to be able to learn all the way through – not only, but especially - their professional life. For some universities this seems to be enough to meet their obligation. However, most of us are also providing further education programmes and other activities to support the ongoing competence and continuous professional development (CPD). In engineering universities this activity is often called Continuing Engineering Education (CEE).

A huge university reform is taking place globally. While the competition for the best students, researchers, funding or position in the global ranking lists is becoming tougher, mergers, strategic alliances, new funding and legal models are taking place in different parts of the world. All this has implications also on Continuing Engineering Education. There are examples where CEE units are distributed to the faculties, or vice versa all the CEE activities are collected to centralised units, Research universities are building strategic alliances with polytechnics or universities of applied sciences, university CEE centres or part of them are being made limited companies. In any case the common trend seems to be, that funding models for the CEE activities are becoming tougher than before especially in situations where universities are forced to cut their own budgets due to the economic situation. Today most of us providing CEE need to be self-sufficient and profitable.

At the same time income or funding from outside the universities is becoming harder. Businesses and organisations are cutting their education and training budgets or even arranging their CEE and CPD by themselves. Increasing competition from outside Europe, especially through digital means is also taking its share from the market. Project based funding from EU or national funding organisations is getting harder to get and in many cases has proven to be risky for long-term sustainability of a CEE organisation. Governmental support for academic unemployment training interventions is alleviating the situation, but there is also a limit to these financial sources as well.

One would think that amidst all these challenges there would not be a very prosperous future for university CEE in Europe. On the contrary! The challenges are only there to force us to change and renew ourselves. We have to understand the changing needs of the businesses, organisations and individual professionals and look at new opportunities to provide for their needs. This means new programme, as contents, new delivery methods and new learning concepts and also totally new skills and attitudes from us university education and training providers.

The everlasting and even increasing battle to engage faculty into CEE activity demands us to create new incentives and concepts. These could be for example getting better involved with research projects to develop programmes that support the dissemination of results. We could also utilise much more parts of degrees as CEE programmes, where course design could be done in hybrid. In other parts of the world, especially in US, a large part of continuing education offers are Master's programmes to engineers in industry. Naturally it always helps, if we can truly be considered as a source for outside funding for the faculties.

In many universities, the CEE activity is not limited to providing education and training but also encompasses other development activities e.g. education development, community and SME development, organisation and business development and other university-industry cooperation. Through this wide variety of activities

creating platforms and facilitating co-creation the CEE should take a very active role in the implementation of the knowledge triangle[3], the interaction between research, education and innovation, which are key drivers of a knowledge-based society.

The revolutionary force of digitalisation and globalisation will change the way learning takes place. The times are not far away, when most of the needed learning content is accessible by everyone through networks (digital, people, organisations). Work place, home, free time i.e. the life itself becomes the environment for learning. CEE "programmes" become enabling in the forming and strengthening of networks and connections. The role of educators and trainers becomes to facilitate the transfer of information, skills and learning into valuable implementations. The focus moves towards achieving competencies and recognising prior learning.

University CEE providers cannot do all this alone in the future. We need alliances and partners. Not only those who form the meaningful network of content and support provision. The users need to be fully engaged into the co-creation of learning contents, process and mobilisation of networks. Engineering and industry organisations as well as professional societies representing customers and users will continue to have a core role in the future CEE service design and delivery.

3 The Knowledge Triangle highlights the importance of jointly fostering research, education and innovation. In 2013, SEFI, the Aalto University and the Polytechnic University of Valencia published 'The knowledge Triangle - Reinventing the Future", Ed. Pia Lappalainen, M. Markkula, ISBN 978-2-87352-006-9, a book examines how innovation could be fostered, promoted and enhanced more intensively through and in education and research.

Mathematics and Engineering Education

*By **Burkhard Alpers**, Chair SEFI WG Maths, Aalen University of Applied Sciences, **Marie Demlova**, former Chair SEFI WG Maths, Czech Technical University in Prague, **Leslie Mustoe**, former Chair SEFI WG Maths, University of Loughborough*

There is no doubt that working with mathematical models and solving problems using mathematical procedures forms an essential part of engineering work.

One of the main differences between a handyman and an engineer is the ability to understand and use such models to plan and design in advance instead of applying a trial and error approach.

Therefore, the mathematical education of engineers is of paramount importance for high quality engineering education. Acknowledging this fact, the European Society for Engineering Education set up a special working group for this issue in 1982, the SEFI Mathematics Working Group. It is the main intention of this group to provide a forum for the exchange of ideas amongst those interested in the mathematical education of engineers and to develop useful material for providing orientation. The principal means of doing so are the group's bi-annual seminars. The proceedings of these seminars from 2004 on can be found on the group's website at http://sefi.htw-aalen.de. The contributions to the seminars in Vienna (2004), Kongsberg (2006), Loughborough (2008), Wismar (2010), and Salamanca (2012) provide an excellent overview of the issues that are considered important among those who are the "drivers" in the mathematical education of engineers. These key issues are summarised below.

The main document developed by the group for providing orientation is the curriculum document. Its first edition was published in 1992: "A core curriculum in mathematics for the European engineer" (Eds.: M. D. J. Barry & N. C. Steele). It essentially contained a list of topics to be covered in any engineering degree programme. Ten years later, in 2002, the second edition was issued: "Mathematics for the European Engineer. A Curriculum for the Twenty-First Century" (Eds.: L. Mustoe & D. Lawson). This edition brought the document more in line with current developments in curriculum design where instead of topics to be treated learning outcomes play a major role. Therefore, this document describes what a student should be able to do as a result of studying mathematics.

Currently, the third edition is under way which will be published in 2013: "A Framework for Mathematics Curricula in Engineering". This edition uses the concept of mathematical competence in order to include higher-level learning goals which emphasise the ability to do and use mathematics in context. It intends to provide a framework to facilitate the specification of concrete curricula for specific types of engineering study courses. Engineering study courses are so diverse that a "one fits all" approach is not considered as adequate.

The following issues regarding the mathematical education of engineers are considered by the group to be very important, currently and in the years to come:

"Transition": All over Europe a decline in the mathematical knowledge of students entering university has been recognised. The diversity of students covering a wide range of abilities makes the provision of an adequate mathematical education even more challenging. Answers to these problems are bridging courses, additional tutorials, foundation semesters, and individual support in mathematics support centres.

"Activation": The passiveness of students predominantly in lectures with a larger audience constitutes another major obstacle to successful learning. There are methods for activating students by using concept tests for testing conceptual understanding. Electronic voting systems (EVS) can be used to generate feedback in a very

time efficient way guaranteeing the anonymity of the voter. Other learning scenarios like larger home assignments and projects can also be very activating but require a lot of resources.

“Curriculum”: Specifying a mathematics curriculum for a certain type of engineering study course is a challenging activity when mathematical competencies like “reasoning mathematically” or “modelling mathematically” must be identified in more detail. It is a major task for the near future to create a set of curricula for different types of study courses such that curriculum specification is considerably facilitated by the provision of examples which can be modified, extended or reduced.

“Integration”: In order to offer a high quality engineering education, the mathematical education must be well integrated into the study course of which it is part. Aspects of this integration are the choice of mathematical concepts and procedures according to the needs of application subjects in the engineering modules, aligning the way of presentation with the usage of concepts in these modules, a suitable timing that is coordinated with other subjects running in parallel, and a timely refreshing of subjects located later in the course.

“Use of technology”: Whether and how to use mathematics technology such as Computer Algebra Systems or numerical programmes within the mathematical education of engineers has been the topic of a large and often very emotional debate. There are certainly chances of using mathematics technology like improving understanding by extended means of visualization or enabling a more experimental approach and working on larger, more realistic projects. But there are also risks regarding the loss of essential abilities to compute simple examples by hand for control purposes.

“Assessment”: The statement “What you get is what you assess” captures the importance of assessment in education. Many students are extremely assessment driven such that essential learning goals must be reflected in the assessment procedure in order to guarantee that students spend time on achieving the goals. Assessment schemes beyond the classical written examinations must be found and tested for addressing particularly the higher-level goals regarding mathematical competence.

The list of key issues above shows that the mathematical education of engineers is a very lively and developing area of investigation and trial. The Mathematics Working Group will promote the discussion of these topics and disseminate information on ideas and concepts for successfully addressing the issues. The next opportunity for contributing and discussing will be the group’s seminar in Dublin in 2014.

Physics and Engineering - What is the Link?

*By **G. Langie**, Chair SEFI WG Physics, KU Leuven, **S. Bohrmann**, former SEFI Vice President, Mannheim University of Applied Sciences*

The electronic engineer Michael Steven (1993) makes a representative statement: "What has physics got to do with me and my job? 'Nothing much' was my first response but, as I thought about it, it actually has a very great deal. My speciality is radar, and I am currently working on a new radar system for detecting and identifying aircraft for air traffic control. As I mentally listed all the facets of my design I realized that it is riddled with physics."

The most widespread and commonly accepted answer is: physics is the basis for understanding the material world, consequently physics is the prerequisite for the development of techniques for controlling and mastering this "outer world", in other words: physics' understanding is the gate opener for technological development.

This sounds like a philosophical (or rather ideological?) statement, with its - for a non-physicist eventually-sophomoric style it may as well have been used by a politician in a Sunday speech - good to hear, nice to agree - and rapidly forgotten, because hardly being of significance for everyday life.

What, however, is this all about when it comes to Engineering Education?

We live in a world of readily available, rapidly growing, fast and reliably accessible (by means of computer technology), ubiquitous knowledge. "The age of knowledge" is the term that is said to characterize our era.

In this context: how would you solve the following problem: "Please, describe precisely/numerically all possible trajectories for a stone thrown from the top of a tower."?

The knowledge age solution would be: have someone do the experiment repeatedly, have her/him throw a stone several thousand times from the top of the tower; in each case, follow the trajectory with a high precision, high speed optical scanning device, finally store all registered trajectories in a multi-terabytes-database, have them keyed with precise data on the initial conditions (magnitude of velocity, thrust angle), and with an advanced data mining software, you will be able to extract the exact shape of trajectory for any given initial condition. (Fig. 1)

Fig. 1

A high technology solution, isn't it? At the same time, however: doesn't it appear to be a pretty dumb solution? Because we have precisely described what we saw - with not the slightest understanding of what happens to a stone thrown.

We have collected data, without evaluating, interpreting, using them.

The explosive expansion of knowledge in our era corresponds to an imminent implosive collapse of understanding, comprehension - competence!

This is where we suppose physics comes in. The grand masters, the initiators of contemporary science, Galilei and Newton, teach us that it is a most simple equation that governs all motion near the surface of earth (agreed: when neglecting air resistance):

a=g (Fig. 2)

Skillful use of this formula enables every expert in the world to precisely describe flight trajectories for any given initial condition - because she/he not only knows but truly understands what is going on.

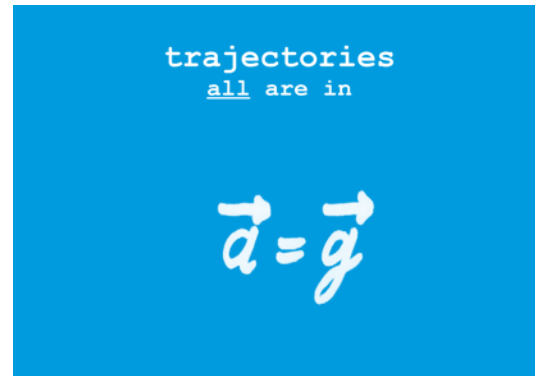

Fig. 2

And more: In any unexpected situation with altered (boundary) conditions (like, e.g., consideration of air resistance) the competent expert will be able to expand and supplement her/his methodology to master the new challenge successfully. The human being who has developed competence beyond knowledge is prepared for the unexpected and ready to step out into future, self-reliant, independent, and strong. Creative engineers need a sound grounding of physics (Zhou, 2012).

This precisely is what we want to mediate for Engineering Students when teaching them physics: we want to equip them with core knowledge and methodologies, with skills and abilities to be strong and successful in a highly technology dominated modern world. We want them to go upright - and not to be "fit" into any (political, "human resource") requirements.

We want to elucidate that kinematics -as another example- is not just a surprise bag filled with funny and colourful formulas to be applied randomly (Fig. 3), but that the total contents of kinematics is expressed with just two formulas (Fig. 4) - once you have understood their meaning, you are ready to specialize and apply them to any given case and master any kinematics problem.

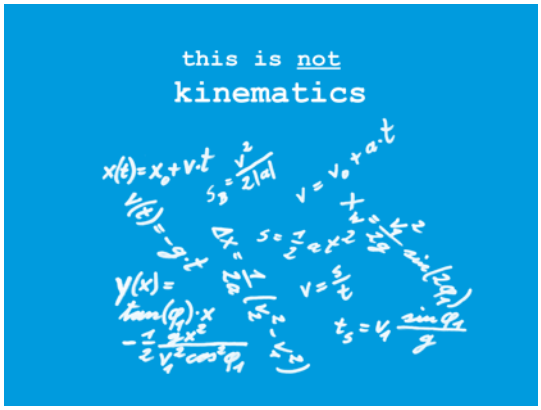

Fig. 3

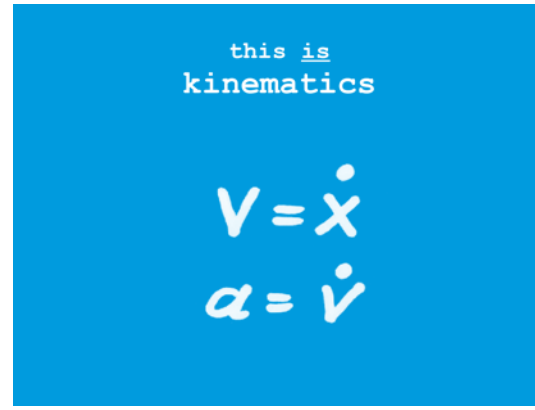

Fig. 4

This gives the impression that 'teaching physics to engineers' is a stable, well-defined field of study. The contrary is true. The topics which are discussed are settled indeed since it is core knowledge, but the methodology one uses to motivate students and to help them learning in an effective way are subject to research (Kautz, 2006). Research in engineering education focuses for example on conceptual learning in physics courses in engineering education during lectures and in the laboratory (Coppens, 2012).

Physics as a model "playground" to develop and strengthen competencies way beyond mere knowledge - this is what consider as the crucial role of Physics in Engineering Education.

In a way, this understanding of the role of Physics derives from the much more general philosophical project of the Age of Enlightenment (Immanuel Kant may be the most prominent philosopher then, to name one).

The pivot in this project is denoted by the German word "Bildung", a short word for the complex triangle "formation-education-training" in English. Or as Stevens (1993) mentions "When still at school it is difficult to know just what industry has to offer that will be personally interesting and challenging. A physics education is one of keeping the options open."

Following the philosophers of this era, Bildung is a necessary prerequisite for freedom: educated people cannot be cheated by propaganda, they know better, their thinking is free, and freely thinking people cannot be subordinated to dubious rulers. Bildung also liberates you from elementary fears: learning that lightning is just an electric discharge, you will forget about feeling threatened by furious gods and having to pacify them by sacrifice of goods, animals - or even human beings.

Again you read: the philosophers of the Era of Enlightenment want humans to be strong and successful in their world, they want them to go upright and not to be "fit" into any (political) requirements.

This exactly is how we see the role of Physics in Engineering Education.

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Developing Innovative Curricula for Employability

*By **Urbano Domínguez**, Chair SEFI WG on Curriculum Development, University of Valladolid*

The SEFI Curriculum Development Working Group (CDWG) was set up as a discussion forum for students, institutions, companies and teachers, interested in the development of Engineering Education in Europe. It consists of people highly involved in all aspects of modern engineering education. The Group promotes discussion and involvement on diverse themes through various activities. Through sharing our experiences we all gain in insight and knowledge.

As explained in Chapter II, the CDWG was the first Working Group to be created in SEFI. It came from a circle of persons who met regularly in the early days of SEFI, and the Group took its present name in 1976. The first seminar took place in February 1978, so the Group is now celebrating the 35th Anniversary of its formal birth.

The lines of interest of the working Group were defined by the end of the seventies as: *New teaching ideas and the development of teachers - Environmental influences on Curriculum Design Methods for adapting course structures -The engineer's profile*. Interesting references to the initial period of the CDWG can be seen in the SEFI´ s 25th Anniversary Commemorative book, where a detailed account of the group´ s life until 1998 was given by John Vernon, its former Secretary.

People leading the activities of CDWG as Chairpersons were David Jenkins (†), Evan Petty, Jan- Olof Hjalmered, Huib van Oort, Otto Rompelman, Joanna Daudt, Erik de Graaff and, finally, myself since September 2008. It has been thanks to the efforts of my predecessors and of many other members of the CDWG that I have received the stimulus for keeping the Group active and have projects for the future.

Since the early times up to now, members of the CDWG have been actively working not only in internal events but also in major projects in which SEFI has been involved. Curriculum development has been, and still is, a major field of interest among those involved in Engineering Education not only in Europe but also all over the world.

It is for that reason that for many years that it has been a relevant issue at SEFI Annual Conferences. Many of the sessions on curriculum development have been under the responsibility of the CDWG members, both in the reviewing of the papers submitted and in the chairmanship of the sessions of presentations. The CDWG has also been running regularly workshops on curriculum development matters at the occasion of those conferences.

On the other hand, CDWG Seminars have been organised at different places thanks to the efforts of some of its members belonging to the host university. The documents of these meetings have been published either as SEFI papers and documents, sometimes in the European Journal of Engineering Education, and others as books of Proceedings. At times these Seminars were co- organised with other WGs or in cooperation with Thematic or Academic Erasmus Networks.

By looking at the topics discussed in CDWG´ seminars and workshops a change in orientation can be noticed. Up to 1996, most of the meetings were devoted to limited and particular aspects of curriculum development, and often focused on contents. Since then, the main interest has been on general issues like, innovation, assessment, quality, and others, emphasizing the role of teaching and learning methods. In this line, the University of Valladolid has been receptive to CDWG´ s compromises by hosting four of its Seminars between

2003 and 2012, and by publishing the books with the Proceedings. The last of them, entitled *Innovation and Quality in Engineering Education,* was published in June 2012, jointly with the University of Valladolid, TREE and SEFI- CDWG.

Many members of the CDWG have been involved in major European projects on engineering education in which SEFI has taken part. Let as mention here Higher Engineering Education in Europe (H3E), Enhancing Engineering Education in Europe (E4), Teaching and Research in Engineering Education (TREE), and European and Global Engineering Education (EUGENE). By looking at the books of proceedings, the importance of curriculum development as a topic, and the relevant contribution of members of CDWG can be noticed.

Some of the main topics in which CDWG is currently involved are:
- The integration of science and technology advancements in engineering education;
- Mobility and exchange in engineering education at the European level;
- Incorporation of new demands like life- long learning, distance learning in EE and others related;
- Implementation of active learning methods in the engineering curricula;
- Enhancing EE by new technologies and methods;
- Quality and accreditation;
- Faculty development and teacher training.

Looking forward, CDWG is working on Innovation, Mobility, Sustainability in Europe, and New Skills and Jobs. The Group is active in SEFI´ s projects for the near future, in line with Europe 2020 initiative flagships, and beyond (see later in this book).

Engineering Education Research in SEFI : A 40th Anniversary Reflection

*By **Robin Clark**, Chair SEFI WG on Engineering Education Research, University of Aston*

Research is a major part of what we do in Higher Education.

Yet when we consider the relationship between engineering education practice and engineering education research, it has only been within the last 5-10 years that the research element has become more prominent in our SEFI community.

In looking to the past, the paper by Maura Borrego and Jonte Bernhard entitled 'The Emergence of Engineering Education Research as an Internationally Connected Field of Enquiry' that appeared in the Centennial Issue of the Journal of Engineering Education in 2011[5] demonstrates that, although somewhat disjointed, Engineering Education Research (EER) has been a consideration in academia for over 100 years. The article clearly and skilfully constructs a timeline for the global activity in EER, yet despite the first thesis defence in Europe taking place in Dresden in 1954, the European element is firmly rooted in more recent history. The European Journal of Engineering Education (EJEE) emerged in 1975 and the SEFI Working Group in EER was born at the Annual Conference in Aalborg, Denmark in 2008.
Research papers have been included in SEFI conferences throughout the 40 years, yet perhaps the difference today is that our community is becoming more cohesive.

In looking to the future, this is an important feature that needs to be nurtured such that the community identity is established, and such that the European voice is a strong voice in the wider global environment.
Supporting the SEFI commitment has been the emergence of national and regional groupings of EER researchers, groupings that have more locally explored the challenges of EER such that a more coherent presence is seen at European and international events. Two such examples are the UK Special Interest Group in EER and the Nordic Network for Engineering Education Research, both forming in 2009.

These two national groupings perhaps illustrate one of the biggest challenges for the EER community.
The Nordic Network has received funding to allow its participants to meet and for the network to flourish. The meeting held in Gothenburg in May 2013 is evidence for this development. Conversely, the UK community, which is also thriving, has grown and functions with minimal funding, relying more heavily on the passion of those involved to see the community move forward. The challenge therefore is that of funding the EER activity, whatever form it takes. Identifying the means to continue the development of the research activity is difficult. The potential sources, national and European funding bodies, are easy to identify, yet it is the standing of the community, the perceived value of the projects and the willingness to understand the objectives and potential of the community to deliver that need to be addressed. EER may not have the immediate appeal of photonics, bioengineering or novel IT research, yet the potential to impact our society is equally as great. Hence it is equally worthy of funding.
The recently completed EU- EUGENE Academic Network Project[6] administered through the University of Florence in Italy is a positive example of where research, practice and the consideration of the wider society can be brought together in a meaningful way that establishes the credentials and value of exploring the area of engineering education. As the outputs of this project continue to be developed, disseminated and used by the community, we must now search for further opportunities to come together and collaborate.

5 Borrego, M. & Bernhard, J. (2011). The Emergence of Engineering Education Research as an Internationally Connected Field of Enquiry. Journal of Engineering Education, Volume 100, No 1, pp 14-47.
6 EUGENE Project. (2013). http://www.eugene.unifi.it/ Accessed 1st July 2013

Horizon 2020, the next generation of EU research funding, is imminent. As the first programmes are announced in this 40th year of SEFI, we must ensure that our message is as compelling as it has ever been such that grants are successful, work is performed and impact is felt across Europe.

The work conducted by the SEFI EER community is developing in three key areas – in terms of its relevance to society, the way it engages the subjects of the study and the research community and with regard to the quality of the research performed.
The European approach to EER has always been very pragmatic, with a keen eye for how the ideas and interventions studied can be adopted in practice and how learning and teaching will help industry to build a skilled and knowledgeable workforce that will drive the economy. The practical approach extends to the value placed on students and colleagues, and how the engagement of both promotes action and understanding in a way that satisfies the goal of providing the best engineering education experience.

Recently, the quality component has become very much the focus of attention. A workshop exploring the 'Quality of Research in EE' was facilitated at the 2012 SEFI Annual Conference held in Thessaloniki, Greece. The workshop, based on a paper by Jonte Bernhard and Caroline Baillie[7], challenged the community to consider how quality needs to be considered within the context of EER.
The active workshop programme at recent SEFI conferences has enabled networking, exchanges and learning that are fundamental to creating an identity for the EER community in Europe.

In the UK, the EER community has firmly established an approach to the research sessions at the biannual Engineering Education (EE) conference that has promoted greater dialogue, critique and support for participants[8]. This approach will be introduced to the SEFI conference in September 2014 when it takes place in Birmingham in the UK in order to promote greater discussion amongst participants.

The UNESCO Chair Research Symposia in Problem Based Learning (IRSPBL) are an example of where innovation in both engineering education itself and in dissemination is being led by Europe. Support for the symposium continues to grow, with the 4th event sharing a week alongside the Research in Engineering Education Symposium (REES) biannual event in Kuala Lumpur, Malaysia in 2013.
Despite the passion and the commitment of individuals wanting to engage in EER, along with the funding challenge, the second 'elephant in the room' is that of acceptance within the researcher's institution. Many who conduct research in engineering education are seen as 'mavericks' and are often alone or part of small groupings that conduct their work 'in addition' to their discipline research. The challenges in this area were explored in a recent European Journal for Engineering Education paper by Esat Alpay and Mervyn Jones[9].
There is much ground to cover to establish EE researchers as part of the institutional fabric, yet the existence of a strong SEFI research grouping can only help to bring about this culture change ensuring that colleagues feel adequately supported. This is the role of the SEFI EER Working Group.

As researchers participate in events around the world, the European contribution is growing ever stronger. The SEFI research voice is evident within REES, the American Society for Engineering Education (ASEE), the Australasian Association for Engineering Education (AAEE), the Conceive Design Implement Operate (CDIO) community and in several other corners of the globe. There are many areas of common interest, a recent example being the consideration of a taxonomy for Engineering Education Research. Work led in Europe by Lauri Malmi as part of EUGENE[10] is now being joined by a US project at the University of Michigan[11].

7 Bernhard, J. & Baillie, C. (2012). Standards for quality of research in engineering education. Presented at 40th SEFI Annual Conference. Thessaloniki, Greece. September 2012.
8 Clark, R. (2011). "Editorial". Engineering Education, Volume 5, No 2, pp 1-3, (Guest Editor).
9 Alpay, E. & Jones, M. E. (2013). Engineering Education in research-intensive universities. European Journal of Engineering Education. Volume 37, No 6, pp 609-626
10 Malmi, L et al (2013). Methodological Analysis of SEFI EER papers. Presented at 41st SEFI Annual Conference. Leuven, Belgium. September 2013
11 A Taxonomy for the Field of Engineering Education Research (University of Michigan). (2013). http://taxonomy.engin.umich.edu/ Accessed 1st July 2013.

These common interests, methodological approaches being another, offer opportunities. The challenge in the coming years will be to continue this type of work, develop the coherent European voice to support Europe and to contribute globally and ensure the credibility of the area continues to grow as EER comes of age.

Quality Assessment and Accreditation of Engineering Education

*By **Angéla Váradi**, Chair WG on Quality Assurance and Accreditation, University of Miskolc*

"The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them (...) The engineer simply cannot deny he did it. If his works do not work, he is damned." [Herbert Hoover]

Quality. It is a simple word with complex meaning. It is also a very fashionable word today. What is "good or high quality"? What is "poor quality"? Buying a dress, we see the quality of it immediately in the fitting room of the shop, opening the water tap we see clear, odourless, colourless, translucent water flow and we can hope we drink a good quality water. Whether we sense the quality of the electricity by the same way when we switch the lamp on? Probably not, though its quality has some long-term effect on human health. And how the quality of education, particularly engineering education effects to the society in short and long term meanings?

The quality of goods, including the electricity can be accurately measured using well defined methods. How to define quality of engineering education? What is the correct approach to define quality parameters in engineering education and research? How global higher education performance indicators serve engineering interests? How university ranking systems include results of research and educational achievements, as well engineering education specialities?

SEFI as the largest European organisation of engineering education provides a wide platform to discuss the above mentioned questions and it also provides international visibility and publicity to special quality and accreditation issues of engineering education.

The SEFI community recognises a colourful palette and a wide range of professionals without making any difference or ranking in importance of different professionals and fields of higher education.

Nevertheless SEFI aims to focus attention to the fact that higher engineering education institutions play vital role in the world because currently more than 50% of economic growth is directly or indirectly attributed to technological progress. Engineers, although they represent less than 1% of total employees, contribute by 20% to Gross Domestic Product (GDP) by innovation in highly developed countries.

So engineers are important players in the knowledge-based society revolving around four pillars:
-the production of knowledge through research,
-its transmission through education and training,
-its dissemination through information and communication technology (ICT),
-its exploitation in the process of technological innovation.

On the basis of this policy and commitment, in the last decade, SEFI aimed to strengthen its activity in the field of quality assurance and accreditation (QAA) at three levels:

- At European and global level
SEFI intends to publish quality assurance and assessment specialities of engineering education and to validate these special issues on European and Global level. University world-wide ranking systems are mostly to be somewhat mono-dimensional (focused primarily on research and scientific publications) and do not fully cover dimensions such as teaching and learning quality of knowledge and technology transfer. Such mo-

no-dimensional systems use indicators that discriminate only among the most research-intensive institutions and hence do not always provide useful feedback on ways forward for the majority of European engineering educational universities.

SEFI participates in all available European fora and projects where quality issues are discussed, like projects for European Standards and Guidelines (ESG), the U-Multirank project of European Commission, OECD's AHELO[12] project, cooperation with EUA, FEANI, industries and others in order to lobby in the interest of its members.

-In process of accreditation
SEFI's position on accreditation was renewed in 2012 under leadership of Professor Francesco Maffioli. In this Position Paper, SEFI states: "During the last decades Higher Education (HE) has been characterised in most European countries by a strong growth in the number of students, and by a large diversification of HE institutions, usually not supported by an increase of governmental budget funding… As a result of these trends HE has been moving towards "mass studies", with a strong competition for resources and students, and an obvious risk of lowering the quality of education and research. This fact raises the need to define "standards" of minimum (and/or average) quality criteria in HE, for "first level" and "second level" degrees, as introduced in the Bologna Process... SEFI is a founding member of European Network for Accreditation of Engineering Education (ENAEE), which manages the EUR-ACE System and is the owner of the EUR-ACE label. SEFI strongly supports the further development of the EUR-ACE System. SEFI wishes to ensure its strong support and involvement regarding ENAEE activities, and in particular supports the idea of submitting to the European Commission a new application to further advance the European system for accreditation of EE, in which SEFI intends to play an active role".

More details on ENAEE's activities and on the EUR-ACE label can be found in the later contributions of its founding president, Professor Giuliano Augusti, and of its current president, Mr. Iring Wasser.

- At inner organisational level
In the above described intensification process, SEFI set up a Task Force on Accreditation, and this Task Force was turned into a Working Group in 2012. Professor Francesco Maffioli's leading activity and encouragement in these groups are highly appreciated and shall be remembered.

The WG aims to provide platform to SEFI members for discussion of quality assessment questions, to study best practices in the field and also to participate QAA related projects like ECDEAST or QUECCA.

Future activity of the WG includes special issues of quality assurance in each levels of the linear education. The higher we step on the Bologna system's ladder, the more complex problems in QAA arise. The first and second (BSc, MSc) levels have more or less well defined assessment methods, but quality assurance of the doctorate level still poses many questions to discuss.

12 Assessment of Higher Education Learning Outcomes

Sustainability in the Engineering Curriculum

*By **Anne-Marie Jolly**, Chair SEFI WG Sustainability and Engineering Education, Polytech'Orléans*

The work of engineers and scientists has significant impact on the outlook of our world. The tools designed by engineers contribute to increased production and general wealth. At the same time some engineering innovations are known to cause large scale disasters. The work of the American mechanical engineer and chemist Thomas Midgley (1889 – 1944) provides good examples. During his successful career he coined well over a hundred patents. One of his inventions was the addition of tetra-ethyl lead (TEL) in order to make car engines run more efficiently. Another contribution he made was the development of chlorofluorocarbons (CFCs) to be used as refrigerants, propellants (in aerosol applications), and solvents. Both inventions were highly praised at the time. However, nowadays his legacy is perceived quite differently. The lead in the gasoline caused massive pollution and the CFC's contributes to ozone depletion. This provides evidence that a strong and global education on environmental issues should help engineering graduates adapt to permanently new scientific and technical knowledge.

We are faced with a number of ominous signs demonstrating that our human society is contributing to the planet's collapse: there are huge wealth imbalances and numerous people who are not able to cover their basic needs, a growing environmental burden and an ecological footprint that is exceeding the earth's carrying capacity, resulting in climate change, etc. These effects increase year after year. Humans are a dominant force in the health and well-being of the earth and its inhabitants. We belong to the first generation that is capable of completely destroying the habitability of the planet for humans and for other species. Engineers have played a key role in contributing to the un-sustainability in our society and they should now strongly contribute to its recovery.

Sustainable Development (SD) is recognised as the path to amend un-sustainability, analogous to the definition of health as the absence of illness. SD constitutes a developmental process:

- that leads to a society in which all present and future humans are healthy and have their basic needs met and in which everyone has fair and equitable access to the earth's resources, a decent quality of life, and celebrates cultural diversity,

- where current and future generations are able to pursue meaningful work and have the opportunity to realize their full human potential both individually and socially,

- where communities are strong because they celebrate cultural diversity, encourage collaboration and participation in governance and emphasize the quality of life over material consumption,

- in which globalization is humanised by solidarity to support democracy, human rights, and economic opportunity for everyone.

Our society needs scientists, engineers, and business people who design technological and economic activities that sustain rather than degrade the natural environment; activities that enhance human health and well-being. It needs a kind of technology inspired by the biological models operating on renewable energy, where the concept of waste is eliminated because every waste product is a raw material or nutrient for another activity or species or returned into the cycles of nature, and in which management of human activities restores and increases the biological diversity and complexity of the ecosystems on which we all depend.

A society in which humans could live of nature's interest, not its capital, for generations to come. In this context, *a new kind of engineer is needed, an engineer who is fully aware of what is going on in society and who has the skills to deal with societal aspects of technologies*.

Technology is a source of many problems, but it could also provide solutions for these problems. Therefore it is important that engineers are becoming aware of sustainability issues and solutions. Consequently, sustainability principles become an important aspect of the engineering curriculum. The European Society of Engineering Education (SEFI) stresses the importance of learning about sustainability in all engineering curricula, not by adding on separate courses, but through integrating them throughout the curricula.

SEFI working groups like those on Curriculum Development, Ethics in Engineering and New Learning Technologies contribute to the debate from different perspectives. Recognising the importance of this issue for engineering education, SEFI has created a Working Group focusing on this issue. This Working Group promotes debates between members of SEFI but contributes also to the dissemination of its reflection towards the youngest population: SEFI took part in the seminar of BEST dedicated to those questions in September 2012 in Vienna and will participate again in September 2013.

The mission of this Working Group is to investigate the field of sustainability with respect to impact on engineering education. The objectives of the initial Task Force that later became the WG were to: i) make an inventory of key players in this field; ii) debate the position of sustainability in the engineering curriculum; iii) make proposals on how SEFI can best operate in this field in relation to other parties - the example of the enquiry led by Leeds University shows the necessity to work with partners having a good view on the subject, other European countries having perhaps realized the same kind of work for engineering studies; iv) work out an action plan and prepare a position paper concerning SEFI position on sustainability in engineering, in regard to European directives. Those objectives could be completed all along the time, the preoccupation of sustainability being now an important item in engineering curricula adapting to evolution of knowledge in these fields in accordance to the European Union global reflection.

Gender and Diversity in Engineering Education

*By **Susanne Ihsen**, Chair[13] SEFI WG on Gender and Diversity, Technical University of Munich*

In the first period of time[14] the topic "women in engineering" took into account the under-representation of women in fields of technology and natural science. First discussions in SEFI started in 1983, when Claude Comina (EPF Lausanne), together with the SEFI Information Committee, prepared a statistical survey and evaluation of female enrolments in engineering institutions in Europe. After four years of discussions and consultations, SEFI was assured to integrate the topic into its fields of activity. In June 1987 the SEFI Working Group on Women in Engineering Education was established.

The first meeting of the WG on Women in Engineering Education was held in January 1988 in Lisbon. In the centre of the working group activities in the next years stood the aim to improve the participation of women in engineering education both quantitatively and qualitatively. For this, a scientific basis was established (collecting and studying statistics and study-career patterns of women in engineering education, developing strategies for change, promoting information on engineering education among girls and other relevant groups and promoting information on strategies for change among technical schools, universities and other relevant institutions, e.g. industry). Main activities entwined around the early motivation of girls for engineering professions and fields. Concrete concepts and course offers for engineers, teachers and students were presented at the annual conferences of SEFI.

Around 15 years later the topic of "women in engineering" developed in a new dynamic way, due to the demographic change and the European discussion about a raising lack of experts. It reached not only companies but education institutions as well. The European Union and many member states started systematically the development of quantitative and qualitative changes in engineering. In the focus were special measures to integrating more men and women in technical study programmes and professions. Possible cultural changes in engineering came into focus. SEFI and the WG on Women in EE took this opportunity to widen the aims and activities to new fields of interest concerning gender relevant aspects in engineering education concepts, in the changes of the professional image and in methods to raise technical innovations in the engineering education. At the SEFI Annual Conference 2005 in Ankara, a first international workshop with 18 participants from Europe and the USA worked on the question of "Best practice: What can we learn from changes in higher technical curricula to attract more female students?" One of the conclusions was the relevance to combine technology with social questions, design, and international components.

In 2008, the working group became the Working Group of Gender and Diversity in Engineering Education. Co-operation with other working groups link gender and diversity topics with e.g. questions of ethics, curriculum development and engineering education research. Especially the diversity approach in engineering education concepts is a relevant aspect of each SEFI Annual Conference. Sessions dealing with the topic "Gender and Diversity in engineering education / in the engineering profession" analogue to the other working sessions, with invited speakers and reviewed articles, show the raising scientific relevance for engineering education each year.

Up from the beginning of the working group's activities also, co-operation with EU programmes and stakeholders was and is important. Furthermore, the European Journal for Engineering Education (EJEE) publishes

13 Chairwomen of the WG: 1987 – 1990 Ellen van Oost, University of Twente, Enschede; 1990 – 1994Sirkka Pöyry, Finnish Association for Graduate Engineers, Helsinki; 1994 – 1995 Sandra Cairncross, Napier University, Edinburgh; 1995 – 1997 Sissel Ravnsborg, Norwegian Institute of Science and Technology (NTNU), Trondheim; 1997 – 1999 Janne Oddaker, Norwegian Institute of Science and Technology (NTNU), Trondheim; 1999 - 2005 Paquita Pérez Salgado, Open Universiteit Nederland (OUNL); 2005 – 2008 Joanna Daudt, University of Technology, Delft; 2008 - Susanne Ihsen, Technische Universität München (TUM)

14 Special thanks to Janne Odakker and Paola De Costa, who wrote a paper about the first time of the working group, published in: Société Européenne pour la Formation des Ingénieurs: The first 25 years, SEFI, Brussels, p. 47-48

articles in this field continuously[15]. Two special journal issues regarding gender and diversity in engineering education were published so far. These publications bundle the international discussion as well as concrete projects and approaches on this aspect to present them as best practice to the public. Between 2005 and 2011 we had 60 papers and 33 articles from 225 Authors from 30 different countries, covering the following topics: Gender and Diversity relevance in Engineering Education; Cultural change in engineering education and professional practice; Women career and leadership; Models of work-life balance.

Gender and Diversity will get more and more importance for engineering education, professions, products and technology. The working group accompanies this change process with scientific and practical experience inside SEFI, but also in the international context.

15 Special thanks to Ulrike Sanwald and Isabelle Kürschner (TUM), who work on an overview about the different aspects of gender and diversity articles and papers of SEFI and EJEE.

University – Business Collaboration

*By **Xavier Fouger**, Dassault Systems, SEFI Vice-President - Chair Committee on University-Business Cooperation*

Principles and practices at the centre of an improved dialogue

During the last decade, the European labour market in engineering has seen tensions which translated in increased demand disparities across countries. Such disparities originated in economic discrepancies, sometimes amplified by demography, leading to an increased intra-European mobility of young graduates, epitomized by the current migration flow from Spain and Portugal to Germany.

A second structural trend in engineers' employment is the imperative to better align competences with the needs of employers:

"A central issue for the success of Innovation Union is for Member States to adapt their (tertiary) education systems in view of substantially increasing the number of available researchers and engineers while ensuring a better match of their skills with the needs of the business sector and improving the attractiveness of research careers for top talents from around the world."[16]

Geographical and disciplinary competences' realignment calls for a more effective university-business dialog in identifying the type of competences needed within economic regions and in determining which new competences are required from new graduates. Both are delicate, forward looking exercises in which SEFI has an essential role, to mitigate risk through in depth prospective studies and through an active promotion of action-oriented initiatives.

In the May 2006 Communication on modernising higher Education the EU commission argued that "Business has a contribution to make in three areas:

***Governance**: business models could be imported to the university world;*

***Funding**: enterprises have a potential role to play in funding university activities in both the education and the research fields; and*

***Curricula**: students need to receive the kind of education which will prepare them for the world of work of the future, enterprises can both help to define that and can offer the kinds of placement which will help students make the transition from study to work. Enterprises must also feel encouraged to release their staff for further learning and updating of their skills throughout their working lives."*[17]

The intrinsically predictive nature of planning the curricular content which will produce employable engineering skills challenges the nature of university-business relations. Competences of new engineering graduates can be classified in multiple manners. However a simple segmentation specifically relevant in view of employability[18] consists in two categories:

16 Innovation Union Competitiveness report - 2011 edition - EC - Directorate-General for Research and Innovation

17 Commission staff working document accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. "A new partnership for the modernisation of universities: the EU Forum for University-Business Dialogue". Impact Assessment

18 A compact definition of employability has been formulated by J Hillage and E Pollard in 1998: "Employability is about having the capability to gain initial employment, maintain employment and obtain new employment if required

Knowledge and skills relating to engineering *principles*

This category represents the scientific knowledge which has been subject of curricula since the early ages of engineering education. It often consists in isolating observations, facts and mathematical models of the real world in order to provide understanding of individual fundamental phenomena. People in general or students, as future engineers, are often not a subject of this knowledge and skills category.

Knowledge and skills relating to engineering *practices*

Unlike purely scientific activities, engineering implies that professionals master critical execution methods -ways of conducting activities in the context of an industrial business, or more broadly, in the context of a social environment. It often consists in combining observations, facts and abstract models of the real world in order to provide understanding of complex multi-disciplinary phenomena. People in general or students, as future engineers, are often a subject of this knowledge and skills category.
While engineering practices require human/behavioural skills - often referred to as "soft skills"-, they also require knowledge and operative behaviours reflecting recent practices in industry. Such practices may relate to collective working (e.g.: methods and tools to design a complex product without prototypes, or methods and tools to work across geographically dispersed teams/time zones) or to cross disciplinary working (systems engineering, mechatronics, design in broad context...).

Only a limited number of institutions have included formal courses about these practices for several reasons:
- Such practices have been essentially pioneered in industry where the conditions for their emergence are present (creation processes of complex products, numerous, dispersed participants working on the same project, business imperative to optimize products in all their aspects …). These conditions are difficult to recreate in an educational environment.
- Such practices are emerging and proliferating in a time frame of 2 to 10 years, which in view of curriculum evolution is seen by academic institutions as very fast, and mechanisms to have educators learn, understand and teach them within such timeframes are often not in place.
- It can be difficult to discriminate practices which are specific to an industry and those which are generic enough to justify consideration in curriculum,
- Governance of universities does not necessarily favour cross-disciplinary activities.

As the competences to operate along new practices are essential to business performance, they can meet rapid adoption in diverse industries and therefore create a strong justification for inclusion in curricula. Fruitful collaborations between curriculum designers and industry lie essentially in interactions with those corporate employees who are involved in designing and implementing practices and methodologies in their organisations (typically: senior engineers, product line managers, process managers..). The nature of joint curricular work with these professionals should go beyond organisational engineering. It should contemplate the individual competences which are at work when modern engineering methodologies are successfully implemented in operations. The determination of required human and procedural competences will emerge from such dialogue.

As part of its participation in the recent EUGENE Academic Network Project, SEFI has produced an inventory[19] which collects conclusions of three years of active discussions with academia and industry on the subject of adapting engineering curricula to employability requirements. It is designed to provide academia personnel in charge of industry relations and curriculum design with a set of practical observations to facilitate their curriculum related conversations.

The challenges posed by engineers' employability are at the core of the Society's efforts to promote an effective university-business dialog. The decades ahead of us promise to make the need for such dialog more acute and economic pressures will position it at the centre of our concerns. SEFI takes the challenge.

19 EUGENE, "European and Global Engineering Education" - Curriculum Responsiveness to Employability Requirements - Transversal Activity Line T1, Deliverable 41: "Handbook of practices"

CHAPTER IV

THE EUROPEAN JOURNAL OF ENGINEERING EDUCATION

The European Journal of Engineering Education

*By **Erik de Graaff**, EJEE Editor-in-chief, University of Aalborg*

Introduction

The European Journal of Engineering Education (EJEE), the Official Journal of SEFI, is published six times a year in print and electronic editions and provides an essential forum for dialogue between researchers and specialists in the field of engineering education, in Europe and all over the world. The European Journal of Engineering Education is universally recognised as one of the leading journals in engineering education.

The founders of SEFI recognised early on the importance of a journal as a means to advance engineering education. As early as 1976 SEFI decided to publish a quarterly devoted to the presentation and discussion of important developments in higher engineering education, focusing on the European scene, but open to contributions from everywhere in the world.

Since then, the EJEE has developed into one of the leading journals in the field (Osorio & Osorio, 2004). This chapter will present a brief overview of the history of the journal over the past 37 years, highlight the present and anticipate future developments

The Past

From the very beginning (Vol. 1, 1976) the EJEE aimed to establish a platform for scientific publications on Engineering Education. At the very beginning Alec Marshall was appointed as Editor supported by a small Editorial Board of six members, all from West-European countries. The first years of the journal were rather instable. Gabriel Fragnière was appointed as new, temporary editor (1978-1980), and there were some changes in the Editorial Board. During this period the journal's appearance was unbalanced with several double issues. In 1980, Jean Michel was appointed as the new Editor, supported by an Editorial Board of 11 members. Jean Michel kept his position as editor of the EJEE until 2008. During his 28 years editorship the journal gained its present reputation as one of the leading scientific peer reviewed journals in the field of Engineering Education. In recognition of his contribution, SEFI awarded him in 2008, the Leonardo da Vinci Medal. In colophon of the journal he is honored as 'Founding editor' of the EJEE.

Under the leadership of Jean Michel the editorial board expanded in several steps, increasing the number to 11 in 1980, 17 in 1988, still all from West European countries. In 1993, the editorial board was again expanded, to 27 members, among which 3 from East-European countries and 3 from outside Europe and in 1998 there were 30 members, including five from outside Europe.

From 1980 until 2006 the journal appeared regularly with four issues a year. In 2006, the number of issues was increased to six per year, bringing the number of papers to be published each year to 50-60. At the same time the editorial burden was relieved by the appointment of an editorial committee consisting of four associate editors, chaired by the editor-in-chief.

In 2008, Jean Michel resigned from his position as editor-in-chief of the EJEE. Erik de Graaff, former chair of the Curriculum Development Working Group (CDWG) and former vice-president of SEFI replaced him. During the first years of the editorship of Erik de Graaff, with the support of Taylor and Francis, online reviewing was introduced for the EJEE, allowing for a smooth process from submitting a paper to publication in the journal.

Main themes

Overlooking the publications in the EJEE, a few topics stand out both in terms of individual papers as in the form of theme issues.

The following overview gives an impression of popular topics, although it is by no means exhaustive: PBL and project organised learning; assessment of learning outcomes; e-learning and new educational technologies; communication skills in the engineering curriculum; curriculum development; mathematics in engineering; physics in engineering; sustainability in engineering education; gender and diversity; ethics in engineering education; laboratory work in engineering education; engineering education research; innovation in engineering education; professional identity of engineers; teachers and student perspectives on engineering education.

Past theme issues have been focused on topics like:

Theme	Guest editors
New Perspectives and New Methods in Engineering Education	Adisa Azapagic, Slobodan Perdan and David Shallcross
Engineering Education – Pedagogic and Didactic Aspects of the Emerging Knowledge Society	Federico Flueckiger
Preparing Engineers for Social responsibility	Henk Zandvoort
Engineering Curricula in Sustainable Development	Karel Mulder
Globalization and its impact on Engineering Education and Research	Maria Fernanda Ramalhoto and Adhan Akay
Genders Studies in Engineering and Engineering Education	Susanne Ihsen
Educational Research Impacting Engineering Education	Caroline Baillie and Jonte Bernhard
Geotechnical engineering education: promote links with research on engineering education	Marina Pantazidou

The Present: Profile of the Journal

Presently the EJEE has an editorial committee of four associate editors, chaired by the Editor-in-Chief. The editorial Committee works with the Editor-in-Chief in formulating the policy of the journal. The associate editors also take responsibility for managing theme issues. The present composition of the Editorial Committee is as follows: Editor-in-Chief - E. de Graaff - *Aalborg University;* Associate Editors : E. Alpay - *Imperial College London*, J. Bernhard - *Linköping University,* S. Ihsen - *Technical University of Munich,* A. Kolmos - *Aalborg University.*

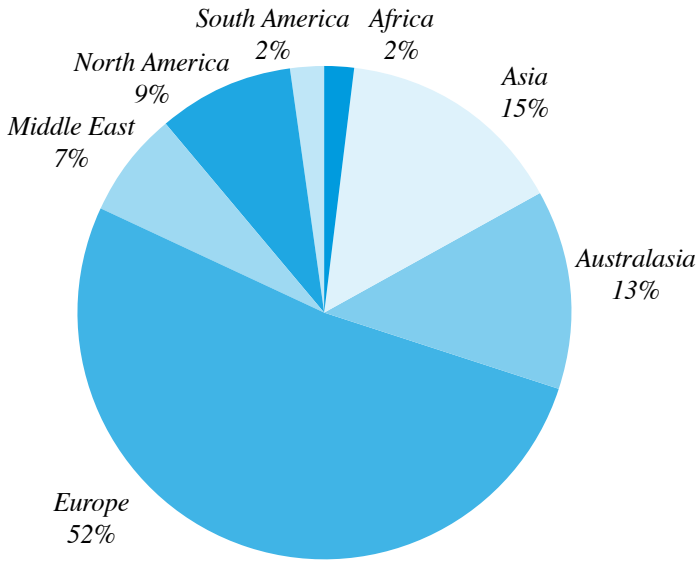
Once a year, during the annual SEFI conference there is a meeting with the editorial board, consisting presently of 39 members, representing experts from West and East Europe, Australia and America.

The European Journal of Engineering aims to publish papers on research and innovation in Engineering Education. The broad variety of cultures and educational systems in Europe provides an excellent breeding ground for new developments in Education. The EJEE is proud to represent a European perspective in the

international engineering education community. However, the European perspective is not limited to studies done in Europe. As it can be seen in the graphic representing the geographical distribution of first authors in the year 2011, almost half of the contributions came from outside Europe, notably from Australia, the USA and the Middle East.

Over the years the character of the journal has become more research oriented. In the early years many publications were so called 'position papers', allowing an expert to elaborate opinions on a relevant topic. During the past year we have witnessed a revival of engineering education research, initiated in the USA and spreading around the world (Jesiek et al, 2011). Following the trend in the scientific community towards an evidence-based approach, the EJEE developed a stronger research profile, visible in a shift in the type of contributions. More and more authors submit papers reporting empiric research based on an analysis of the literature (Malmi et al 2012; Malmi et al 2013).

Geographical distribution of submissions



The Future

At short range the future will be an extension of the present. We need to consolidate the good reputation the journal has established among researchers in the field in terms of the quality of reviewing and addressing topics of interest. One of the positive comments about the EJEE is that the journal does have a high scientific standard, but we are not rigid in terms of requesting particular methods. In fact, the EJEE aims specifically to support the development of Engineering Education Research (EER) as an Interdisciplinary field of research, applying a mixture of quantitative and qualitative methods (De Graaff & Kolmos, 2010).

There is no reason to expect a change in the constant flow of manuscripts submitted for publication in the EJEE in the coming years. In the near future we will continue the policy of inviting guest editors to work with relevant themes. Prospective theme issues that are somewhere in the pipe-line are:

Theme	Guest editors
Assessment of Learning outcomes	Anne Gardner & Keith Willey
Engineering Education on Geosciences in a Changing World	E.V. Taguas, Ruth E. Falconer & Ana M. Tarquis
Engineering Education: Challenges for Innovation	Maria T. Restivo, Juarez B. Silva & Gustavo R. Alves
Engineering Education Research	Robin Clark & Jonte Berhard

In the longer run, the future is full of unexpected changes. If someone had tried to predict the future of intercontinental travelling at the beginning of the 20th century the world would have been full of massive ocean going steamers and maybe some large airships. No one would have been able to predict the jumbo jet. However, one thing is for sure: innovations in communication technology will deeply affect the scientific community. Printed-paper is already making place for online access. Search engines allow researchers to select resources without actually seeing the contents; generating reference lists with one push of a button.

The impact of a journal will more and more depend on the number of citations from the papers it publishes. For the EJEE this means we need to increase our focus on high quality research papers and we need to develop strategies to allow wide access to these publications to researchers from around the world.

As the official scientific journal of SEFI, the EJEE has the advantage of close collaboration within the SEFI network. Besides that we – and our readers - should participate in formal and informal communities of practice, sharing the experience that it is worthwhile to publish your research on engineering education in the European Journal of Engineering Education.

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CHAPTER V

FACING OUR FUTURE CHALLENGES

Engineering Education and Europe 2020

*By **Wim Van Petegem**, SEFI President (2011-2013), KU Leuven*

Background

The European Union is working hard to move decisively beyond the crisis and create the conditions for a more competitive economy with higher employment with its Europe 2020 strategy[1]. The strategy is about delivering growth that is: *smart*, through more effective investments in education, research and innovation; *sustainable*, thanks to a decisive move towards a low-carbon economy; and *inclusive*, with a strong emphasis on job creation and poverty reduction.

The strategy is focused on five ambitious goals in the areas of employment, innovation, education, poverty reduction and climate/energy. Concretely, the EU has set five ambitious objectives - on employment, innovation, education, social inclusion and climate/energy - to be reached by 2020:

1. Employment 75% of the 20-64 year-olds to be employed
2. R&D 3% of the EU's GDP to be invested in R&D
3. Climate change and energy sustainability: greenhouse gas emissions 20% (or even 30%, if the conditions are right) lower than 1990 - 20% of energy from renewable - 20% increase in energy efficiency
4. Education: Reducing the rates of early school leaving below 10% - at least 40% of 30-34–year-olds completing third level education
5. Fighting poverty and social exclusion: at least 20 million fewer people in or at risk of poverty and social exclusion.

Each Member State has adopted its own national targets in each of these areas. Concrete actions at EU and national levels underpin the strategy. In particular the EU has identified new engines to boost growth and jobs. These areas are addressed by *7 flagship initiatives*.

Smart growth

- *Digital agenda for Europe*: The aim is to deliver sustainable economic and social benefits from a Digital Single Market based on fast and ultra-fast internet and interoperable applications, with broadband access for all by 2013, access for all to much higher internet speeds (30 Mbps or above) by 2020, and 50% or more of European households subscribing to internet connections above 100 Mbps.
- *Innovation Union*: The aim of this is to re-focus R&D and innovation policy on the challenges facing our society, such as climate change, energy and resource efficiency, health and demographic change. Every link should be strengthened in the innovation chain, from 'blue sky' research to commercialisation.
- *Youth on the move*: The aim is to enhance the performance and international attractiveness of Europe's higher education institutions and raise the overall quality of all levels of education and training in the EU, combining both excellence and equity, by promoting student mobility and trainees' mobility, and improve the employment situation of young people.

Sustainable growth

- *Resource efficient Europe*: The aim is to support the shift towards a resource efficient and low-carbon economy that is efficient in the way it uses all resources. The aim is to decouple our economic growth from resource and energy use, reduce CO_2 emissions, enhance competitiveness and promote greater energy security.

1 See for more information: http://ec.europa.eu/europe2020/index_en.htm

- *An industrial policy for the globalisation era*: The aim is to draw up a framework for a modern industrial policy, to support entrepreneurship, to guide and help industry to become fit to meet these challenges, to promote the competitiveness of Europe's primary, manufacturing and service industries and help them seize the opportunities of globalisation and of the green economy. The framework will address all elements of the increasingly international value chain from access to raw materials to after-sales service.

Inclusive growth

- *An agenda for new skills and jobs*: The aim is to create conditions for modernising labour markets with a view to raising employment levels and ensuring the sustainability of our social models. This means empowering people through the acquisition of new skills to enable our current and future workforce to adapt to new conditions and potential career shifts, reduce unemployment and raise labour productivity.
- *European platform against poverty*: The aim is to ensure economic, social and territorial cohesion, building on the current European year for combating poverty and social exclusion so as to raise awareness and recognise the fundamental rights of people experiencing poverty and social exclusion, enabling them to live in dignity and take an active part in society.

Within each initiative, both the EU and national authorities have to coordinate their efforts so they are mutually reinforcing. Most of these initiatives have been presented by the Commission in 2010.

How Can Engineering Education Help?

In SEFI, we believe that the engineering community can contribute to achieve the goals set by this Europe 2020 strategy, and in particular all stakeholders in engineering education could play a role in this.

However, we notice it is not an easy discussion: some of the EU initiatives or flagships can be targeted directly, but some others can only be addressed by us in an indirect way. Following are a just few thoughts and reflections collected at several occasions where we could exchange ideas on how we could contribute to the Europe 2020 strategy.

- In all engineering curricula we have to define learning outcomes or competences to be achieved by our students in order to better prepare them for the European labour market (and beyond). We should think about the new basic and applied skills future engineers need to have, to make their and our future more prosperous. We cannot deny that in many of the developments engineers will play an important role and it is our duty to equip our students with a toolkit full of competences they will badly need. Just to name one, we could do a lot more on intercultural competences (e.g. by promoting more student mobility), as future engineers will most probably work in global teams with a mix of different backgrounds.

- Engineers should be trained to use all available resources (human capital, natural resources, finances, infrastructure and space, time,…) in an efficient and effective way. They should learn how to balance pro's and con's, to take into account possible risks, to make informed decisions and to communicate sometimes difficult messages to a larger community. Nothing new, as sustainability in all its definitions has been introduced in the curricula already for a long time, though in view of the EU's ambitions the sense of urgency has increased and forces us to pay even more attention to sustainability in an interdisciplinary approach.

- Equally important is the social dimension in engineering. Focus should also be placed on the societal role of engineering and the potential added value of technology for organisations in the social profit sector and for vulnerable groups in society. On a more general level we should guide our students in the role they could play in societal innovation. We tend to forget this huge opportunity, for research and development, and for employment.

- At the other hand, we should do more on a better understanding of engineering, engineering problems and engineering solutions by the society at large. All too often we are faced with complex societal challenges where engineering (or technology) is involved and decision makers lack the necessary knowledge or competence to cope with the situation. A more two-way interactive discussion between the engineering world and other societal stakeholders (including the political level) should be established to foster mutual understanding and increase the quality of the decision making process.

We leave it to the reader to link these thoughts with the different actions and activities in the Europe 2020 strategy. We are convinced that they are intertwined and mutually reinforcing, and that is in line with how the EU thinks about its strategic plan as well.

It must be clear from the above that we are already on the right way, but there is still a long road ahead of us.

SEFI accepts to go this long way, with all its members, partners and stakeholders. With our rich history of conferences and other scientific meetings, with our various publications from our scientific journal to a set of policy papers, with our professional office team and our enthusiast volunteers in working groups and task forces, with our partners and stakeholders in higher education, industry and other organisations all over Europe, we believe we are well placed and well equipped to tackle the challenges of Europe 2020.

Keeping in mind the students of today will be the engineers of 2020, we recognise our important, but also privileged position as a network for the future.

On the Problems, Challenges and Prospects for the European Higher Engineering Education arising from the global economic Crisis

*By **Antonia Moropoulou**, SEFI Administrative Council member, National Technical University of Athens; **Pieter de Vries**, Chair SEFI WG on New Educational Technologies, TU Delft*

The "*global*" economic crisis has affected multiple aspects of the daily life in all member states of the European Union and beyond. In this article we would like to take a closer look at the consequences of this crisis on European Higher Engineering Education (*HEE*). In this analysis, the focus is on the financial, structural and institutional consequences while the concerns are at the educational level. Our purpose is to clarify the actual situation and to inform the discussion as there is no doubt that the current crisis will continue to challenge the educational structures and institutions.

The political dimension of the challenges in HEE

As a result of the crisis, significant budget cuts have taken place in many European countries (EUA, 2012). The toll on HEE has been high while the aftermath and problems spawned by the global financial crisis have yet to be clearly recognised. The EU's statistical main indicators and indexes all underline the significant shrinkage of public funding for Higher Education (EU, 2012). This *"shrinkage"* takes no common form for all affected parties since it is heavily dependent on many aspects of each European country's institutional framework, context, cultural background, and economy; yet, it is certain that very few national higher education systems are unscathed while most will require to (*or be* even *forced to*) heavily "*restructure*" during their country's struggle with austerity and the deficit.

The public funding cuts affect first and foremost the quality of education, teaching, research and even the very nature of the autonomy of the Institutions themselves (EUA, 2011). As a consequence, private funding is being considered to contribute to the Institution's financial wellbeing and overall sustainability; yet these income streams pose entering uncharted waters in some countries, diverting and forcing the character of HEE from a service of public interest to a commercially-based and profit-driven venture. An important issue in this context is the matter of student loans being institutionalized as such, in the form of "*scholarships*", "*stipends*" or educational "*coupons*" towards the completion of studies and gradually repaid back. The loan experiences and current predicament in the USA clearly illustrate that student loans are economically unsound moves, financially unbearable and overall unaffordable as a means to an individual's education (Johnson, i.e., 2012). At the same time, EU policies are being formed to further facilitate student mobility and "*ease*" the portability of funding (*ensuring student grants and loans can be used throughout EU Member-States and affiliated countries*); the very nature of student scholarships in the form of loans being or becoming unbearable should be first and foremost addressed, knowing that these *"loans"* (*and thus: "student debt", amounting to a bachelor student having a debt of >$100.000 upon completion of his/her degree)* are not a viable alternative to public funding. In the European tradition, the public character of universities and of education as good for society has always been a stronghold which will be profoundly altered when education -either through private funding or via student loans- turns into a commercial product as it has become a for-profit industry in the US (Wigger, i.e., 1999; Touryalia, 2013).

Budget cuts have quantitative aspects, ranging from economic, quality and social services' matters (such as no provisions for student care/health services, restricted or no accommodation, limited access to knowledge due to lack of courses' resources or scientific journals' subscriptions), but also built a qualitative risk in relation to

the Engineer's knowledge, skillset and competences. Based on the European Qualification Framework (EQF) these comprise of: *a*. Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles, *b*. Advanced skills, demonstrating mastery and innovation, *c*. Managing complex technical or professional activities or projects. The overlay in this framework is a niche oriented high-level training with an applied 'hands-on' approach in the context of unpredictable environments, complex and specialized problem solving skills under the scope of risk-assessed situations and decision-making. It is this approach that constitutes the special case of engineering where private funds find it difficult to invest as needed, for proper and functioning infrastructures. The engineering curricula of European universities consist of a proper amount of basic sciences, along with engineering lessons and lessons of deepening and application. These curricula can serve the demands for the exercise of the engineering profession at the highest level of technical responsibility (Kärkkäinen, 2006).

On another level the newest allowances that new didactical insights and information technology provide, as problem-based learning (*PBL*) as well as active and collaborative learning and online learning, can facilitate advanced studies at lower costs. At this moment though these cannot yet substitute the actual/physical confirmation, unattainable via digital "*lessons*" and e-courses. The inherent danger of the EQF in the "*summing up*" of competences not framed in a complete studies programme is the reason why all challenges brought forward by new technologies are examined thoroughly under the scope of the CDIO (*Conceive — Design — Implement — Operate*) innovative educational framework, with the requirements of social services provision being fulfilled. In this instance, the lack of e.g. lab infrastructures which private sector investors deem as "non-profitable" (*due to an unfavourable return on investment*) and thus are not sufficiently (*or even at all!*) funded, reinforces our cause for *quality assurance and accreditation* in order to deal with the challenges addressed to higher education without allowing them to disintegrate or degrade the qualitative character of higher engineering education.

Engineering higher education's institutions are faced with the same challenges and problems as other public universities in Europe and in the World and forced to operate as a "*testing ground*" and melting pot for the implementation of policies that *–due to the idiosyncrasy of the training at hand-* downgrade their offered studies. As a consequence this may have led to an exodus of a large mass of "*engineers*", Bachelor holders at a lower cost, albeit significantly less qualified. Fifteen years after the implementation of these policies, the critique against Bologna's "*success*" in declining degrees, certifications and such does not especially hold water when referring to HEE because so far the offering of either Master of Engineering or Master of Science choices of studies has been the most characterizing norm of engineering programmes. Also industry has not been in favour of the "*bachelor as engineer"* reform, and continues to favour the 4- and 5-year-duration studies (*Master of Engineering – MEng, Master of Science – MSc*). This also justifies the needed reform of the Bologna Process, since Engineering has to face the above challenges and in order to do so, the society alongside the End-Users (*who will put the services of engineers to use*) as well as the professionals, technical chambers and academic community should clearly define the engineering qualifications; in this way, the quality of engineering professional services will be exercised for the public benefit and the universities will be able to further improve the quality of educational services offered.

In line with this pledge for quality is the demand for a strategy of HEE to provide graduates with the necessary competences useful and required in order to plan implement and operate development as the pathway for an exit from the Crisis. In this light, another challenge for universities is intrinsically connected to the capability of HEE to successfully apply new knowledge, research and innovation in the real economy, cultivating and e-educating entrepreneurship, fostering management of the works as well as bringing forth the evaluation of the actual social impact they (*and their engineers*) develop. This constitutes a major challenge for all; governments and the European Union alike, but in all cases it is the innovative capacity of HEE that needs to be activated in order to tackle the crisis and the mergers and eliminations of HEE's structures.

In the 40 years of SEFI 1973 – 2013, HEE passed from the era of regeneration of the university, with the critical reconnection of engineering and development which was characterized from the controversy of May 1968, and the revolution of Greek students on 1973 at National Technical University of Athens, to the era of a new redetermination within the frame of global economic crisis. HEE can make a significant contribution in educating engineers that will contribute to solving the global crisis with HEE and European societies working together.

The educational dimension of the challenges in HE

Next to the rather formal approach on the political, institutional and financial level, which very much reflects the current situation in HE, there is a dimension that *- due to societal developments -* poses a fundamental question about the needs of today's society in relation to education. The number of students demanding education is increasing rapidly, as well as is the need for higher productivity, more flexibility, rising costs for and of students, decreasing state support and multiplying debts of institutions. The outlook on change in education has been very much an institutional endeavour with a self-referential character; the financial crisis though is not just about some bankers who misbehaved, but indicative of a fundamental major shift in society from national, analog, industrial economies to a global, digital, information economy. This transition process also has major consequences on the actual educational level on which institutions operate. The innovation cycles, particularly in the technological fields, are so swift that current institutional structures can no longer keep up with the developments. Therefore institutions are increasingly looking for ways to stay on track and have discovered that online learning, in a combination of new pedagogical insights, organisational changes and learning technologies can help to make the organisation more capable of dealing with these demands (Daniel, 2012, 2013).

Up until recently, online learning was considered as an added advantage. The rather fundamental public discussion about the mere existence of higher education due to seemingly incompetent institutions unable to cope with today's learning demands, spurred another level of dealing with learning innovation. It is known to the public, the students and an increasing number of "*educators"* that HE has a hard time to deal with the very different dynamics of education in the 21st century. Most institutions are based on the factory model of mass instruction that was so successful in the previous century. An important defect of this model is that most universities and colleges are rather traditional and conservative, not being able to react to the constant changes in our society in an appropriate manner (Wheeler, 2012). Today's reality is that new models of education are emerging, initiated by a selective group of high class institutions and investing companies with a history in education, publishing and public media (Daniel, 2012). This is quite a different arrangement with a strategy focusing on online student centred approaches and the exploitation of smart personal technologies for anytime and anywhere learning. This is what can be considered as the educational dimension of the crisis, which forces change on HE at a much higher speed than ever experienced before. Generally speaking the changing situation for HE is decades old, but seems to pick up speed much faster and therefore performs more in line with the general societal developments.

The British Open University started in 1971, the for-profit University of Phoenix is online since 1989 and Massachusets Institute of Technology (MIT) and lots of other universities including the Delft University of Technology have been posting free online "open courseware" for a decade (Economist, 2012). These developments were not considered disruptive for the existing HE system, but with the emergence of multiple online and blended learning programmes, flipped classroom initiatives, Open Educational Resources and others like Massive Open Online Courses (MOOCs), this seems to change rapidly. In most cases, institutions try to utilize *"*online*"* for the purpose of becoming more efficient in teaching and learning related activities in search of a business model that allows for change and innovation within the boundaries of the existing budget and organisational models. A nice example is the "flipped Classroom" approach, in which lectures are no longer part of what happens in class. The class session is about interaction and the lectures most commonly are being done

using teacher-created videos that students view outside of class time. Flipping the classroom has proved to lessen the dropout rate among students and increase the amount of information that the students learn, which is promising (Tucker, 2012). The new developments though, lack a research base that convincingly proves that this is the way to go. This is no surprise since matters change so rapidly that the discussion also includes the question "what research is needed", since formal research seems to underperform as well. Alternatives mostly indicate an extension of the tooling with for example 'learning analytics' to make the research fit for purpose in a timely manner (Siemens, 2012).

Most attention nowadays goes to MOOCs which are free online classes for large numbers of students who watch short high quality video lectures, complete assignments and are graded by machines or other students. There is a minimal involvement of teaching staff and a professor can handle a class with thousands of students. The first to introduce these courses on a large scale were leading universities like Harvard, MIT and Stanford operating in conjunction and investing large sums of money. In the meanwhile others have joined this trend by engaging in initiatives like edX, the non-profit venture from Harvard and MIT, Udacity set up by a former Stanford employee and Coursera, initiated by some other colleagues from Stanford. And sure there are other initiatives from small colleges, the training business and from individuals, but most attention goes to the big ones. The Open University in the UK started a consortium of British universities to develop a new platform for free courses called Futurelearn, which is expected to be online competing with the American initiatives. Where universities tend to take years to decide about anything, the MOOCS initiative seems to push decision making to another level. No wonder this phenomenon gets a lot of attention, certainly also because the media partners in this online endeavour know how to raise attention and sell a product (Daniel, 2012, 2013; Jacobi, 2013).

Management in general and other stakeholders in HE are challenged by the idea of having to compete with free courses from some of the world's most exclusive universities. It is still unclear if and how much the movement will change the education landscape, and there are plenty of sceptics. The fact is that MOOCS are more than just smartly taped engaging lectures. The real innovation comes from integrating academic talks with interactive coursework, the use of automated tests, quizzes and games. Students learn at their own pace, discuss, share and collaborate in a networked environment that feels like "home", due to profile matching techniques to create groups of students that have lots in common. The MOOC concept makes learning more feasible and greatly attractive for students worldwide. Just to get an idea of the size: a Harvard course on 'How to reason and argue' attracted over 180.000 students. A Udacity course by Google's director of research Peter Norvig, attracted 160.000 students. A group of 155.000 students registered for MIT's prototype 'Circuits and Electronics' course. Only 45% was aged between 18 and 25 and most students came from America, India, Britain, Columbia and Spain and some 7.200 passed the course (Economist, 2012, p. 90; Daniel, 2012, 2013; Jacobi, 2013).

It is not yet clear what we will see in the near future, but looking at the discussion and the examples of new MOOC-like initiatives, it seems that this movement opens up new possibilities for institutions to cluster and pool resources, to provide credible qualifications, to supply reviews for credit equivalency. The expectation is that most universities will develop a blended model, with next to the traditional an online, virtual university, creating a business model that thrives for flexibility and innovative new learning settings that need to be more participative than ever before to make it work. However, in parallel with the growth of MOOCs, an argument has been put forward as well, criticizing the MOOCs' hype and ultimate peak of inflated expectations since these cannot readily and completely substitute universities and the academia as institutions of knowledge-transfer, new knowledge creation and development in the eyes of society.

The problems, challenges and prospects

It is true that the number of students in need of an education is rising and putting a lot of pressure on the current system to become more flexible. At the same time institutions are trying to deal with rising costs, decreasing state support and raising debts. The political dimension of the crisis for HEE seems to offer no alternative to deal with the problems unless private investors decide to enter the HE market as the MOOC story reveals. The general reaction of the institutions seems to have a predominantly self-referential character, but this is just one side of the story.

The educational dimension of the issue has been introduced to allow for a broader look at the current situation. The educational innovative approaches seem to be an opportunity for universities to illustrate their educational excellence and attract more and diversified students groups, to enhance international competitiveness and to appeal as attractive as possible in order to sustain HEE in the European continent. The costs for students are relatively low in Europe compared to the US, but there is a huge shortage of engineers that obviously cannot be met by the current system, causing both an inner-European white-collar immigration from the south to the north as well as an influx of foreign workers. The online learning hype could therefor very quickly turn into a solution provider for these kinds of deficits on the European educational system. The learning providers though are not necessarily European and this means that the European institutions should take the prospect of being daringly innovative using their academic freedom and creativity to develop new educational models, new learning arrangements and new opportunities for knowledge reliance with the Industry. This should not be limited to a MOOC-like approach, but combine the opportunities of new educational insights, new learning concepts and educational technologies. At the same this development is valuable as we are in need of a discussion that allows for a multitude of considerations. Education is too precious and too costly to ignore supposedly disruptive movements, but use the opportunity to compete the shortcomings in the existing educational landscape, ultimately supporting and upholding the public university and higher education as a public good for the benefit of society.

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Preparing for a Global Profession

*By **José Carlos Quadrado**, Instituto Superior de Engenharia Lisboa, President IFEES, former Vice President SEFI; **Hans J. Hoyer**, Secretary General IFEES, Executive Secretary GEDC*

In today's era with rapid technological, industrial and economic developments, it is a challenge to build a career in engineering. Engineers who enter today's workplace can be assured that many of their skills will become obsolete in the lifetime of their careers. Therefore the challenge of future engineers is not about mastering technical skills, but rather learning how to think and solve complex challenges in a global context. This approach is the cornerstone of the International Federation of Engineering Education Societies (IFEES), who aims to prepare the future engineers for global challenges to come.

Global engineering education organisations, such as IFEES, are fundamental in the globalization of engineering and science and the promotion of the social impacts of engineering. However, IFEES was neither the first nor the only organisation with these goals. The Federation has benefited from SEFI's four decades of experience, particularly in developing its mission, vision and strategic objectives. Because of dedicated SEFI members, European values have always been represented in IFEES. In particular, SEFI has contributed to IFEES' effort to broaden its global reach with its extensive European network of students, academic institutions and corporate partners.

SEFI has also contributed greatly in these ways to the formation of the Global Engineering Deans Council (GEDC), the world's only global network of engineering deans. This specialized group of engineering education leaders provides a platform for exchanging information, discussing experiences and challenges, and sharing best practices in leading an engineering school. The future generations of engineers and their ability to address global challenges is at the forefront of the GEDC's vision.

One of the attributes of a global engineer is a grasp of professional and management skills. This includes the ability to perform contextual analysis (STEEP: social, technical, economical, environmental and political), needs assessments and feasibility studies, as well as design and project management skills. Increasingly, systems thinking and systems engineering together with full life cycle analysis are key in preparing for a global profession. The new "must have" global skills in any engineering degree include cultural sensitivity, adaptability, multiple language communication skills; working in teams; critical thinking; creativity and innovation.

Another aspect of global engineering is the business and enterprise skills fundamental in today's globalized world. Awareness and knowledge of the complex issues related to governance, human rights, transparency, accountability and corruption are essential in preparing for a global profession. Engineering-intensive corporations are now responsible for the social and environmental impacts of business, impacts and trends of globalization, new global concepts such as "socially responsible investments," as well as fair and ethical trade. It is necessary that a global engineer is able to align stakeholder and social values, while understanding conflict-sensitive business practices. It is important to understand the relationship between innovation and enterprise and the application of emerging technologies to global challenges, while keeping in mind potential ethical issues arising from those technologies.

A growing interest in the global engineering community is social awareness. Issues concerning poverty alleviation are increasingly present in the global engineer's agenda, specifically through enterprise solutions based on emerging business opportunities in developing countries. Facing challenges in developing countries, which include working in conflict and crisis prone regions, and engaging marginalized and disadvantaged groups in developing solutions, is mandatory in preparing for a global profession. This social dimension in

engineering requires stakeholder analysis and dialogue as well as public engagement, while keeping in mind local, regional and international politics.

As these issues and necessary skills are identified, the engineering community can address them by revising curriculum and extra-curricular activities. The understanding of these needs and wants leads to cooperation at the global level. New course materials, methodologies and approaches are already being piloted in the global engineering education community. A prime example of success in the development of new methodologies and approaches is the joint initiative between IFEES and SEFI in the creation of the International Institute for Developing Engineering Academics (IIDEA). Together, these two institutions, based in the United States and Europe, turned the idea of providing a world class offering of seminars and workshops into reality, and held their first event in Asia in 2011 and, since that time, have offered a series of capacity building workshops in China, Portugal, Argentina, Austria, Greece, Mexico, Colombia, and India. Many more are expected to be offered in other countries over the coming years. This one initiative truly exemplifies what IFEES members are able to accomplish in collaboration with one another.

The latest developments in engineering education for the global profession involve seeking opportunities to link course components together so that learning builds upon prior learning, and so that cross disciplinary themes such as ethics, business responsibility and sustainability become integrated into the engineering education curricula.

The future of the engineering profession will be shaped by the changes we are instituting today by piloting, monitoring and evaluating course innovation and by measuring its effectiveness against course learning outcomes. Blended and digital learning approaches are changing and challenging traditional and outmoded class-room learning approaches. Opportunities that are threatening "business as usual" engineering education, but are globally driven, like the Massive Open Online Courses (MOOC's) and others, can give birth to a new era of engineering education. However, we must continue to ensure that professors have adequate time to monitor, evaluate, and reflect on course innovations. They should also be offered the opportunity to share their learning with colleagues and invest in professional advancement in course assessment and development. IFEES with its operating arms, the GEDC and IIDEA, strive to support a multiple series of environments where this can occur.

Employment as a Challenge for Engineering Education

*By **Ludo Froyen**, SEFI Administrative Council member, KU Leuven; **Luis Manuel Sánchez Ruiz**, SEFI Administrative Council member, Universidad Politécnica de Valencia*

Being unemployed is one of the worst situations a person can find himself/herself in due to the economic and self-esteem consequences it usually brings with. On the other hand the right of access to higher education is mentioned in a number of international human rights declarations: higher education shall be made equally accessible to all, on the basis of capacity, by every appropriate means, and in particular by the progressive introduction of free education. There is a clear relationship between HE and unemployment since in front of high rates of unemployment as we are suffering nowadays, especially between the young population that reached above 55% in some European countries. Indeed this rate drops to less than half of it when we restrict our data to the group of the young population formed by graduate students.

This drop may be due to a number of factors such as the need for educated people, the need for professionals and the fact that young graduate students may have acquired some transversal competences such as entrepreneurship, leadership, working in team,… that may facilitate either finding a job or an active attitude that may make them self-hiring. Also the common existence of company internships in undergraduate programmes that also facilitate the student's ulterior hiring.

In fact engineering education aims to train professionals that are able to apply scientific and technological knowledge in order to design, build and maintain structures, machines, devices, systems, materials and processes in our modern society.

SEFI's values, on which the contributions of chapter III have been written are creativity and professionalism, engagement and responsibility, respect for diversity and different cultures, institutional inclusiveness, multidisciplinarity and openness, transparency and sustainability. From all these, let us here point out "sustainability" that refers to working efficiently and effectively with technological achievements and with available environmental, economic and human resources, to the benefit of future generations.

But this sustainability must be understood not just for the benefit of future generations, but also for our present generation. One of the biggest challenges is the fight against unemployment. Increasing employability is either dependant from other stakeholders or from the self-employment because of the immediate benefits of the professionals affected. Moreover it is well known that employment attracts employment while the big unemployment rates, such as the ones we are suffering nowadays in Europe (average above 11% and in some European countries even above 25%) are hazardous for the whole society.

This challenge must be faced handling all its facets without losing any of them. A non-closed set of measures to be considered in HE in order to fulfil this goal should include the following ones:

- ensure that students get the right scientific and technological competences to become efficient professionals;
- ensure that students get the right transversal competences and skills to become efficient professionals in the actual working conditions and to reduce any unemployment status period;
- embed the students into the lifelong learning culture so that they become continuously and timely updated reducing the chances of failure and in case of need facilitating their incorporation into labour market once again;
- introduce visits to companies and industries during their educational period;
- facilitate adequate internships;

- provide recruitment opportunities for students and graduates;
- offer professional and career guidance and job events in cooperation with companies;
- provide incentives promoting entrepreneurship among students and graduates;
- use of well-established alumni relations in developing graduate employability.

In conclusion, it is necessary to identify criteria for selecting and spreading best practices in promotion and monitoring of graduate employability in higher education.

Accreditation and Mobility of Engineers in Europe: SEFI and ENAEE joining forces

*By **Iring Wasser**, President ENAEE, President of the European Alliance for Subject Specific and Professional Accreditation and Quality Assurance (EASPA), Managing Director of the German Accreditation Agency for Study programmes in Engineering, Natural Sciences, Informatics and Mathematics (ASIIN)*

In the next chapter of this publication, the Founding President of ENAEE and former President of SEFI, Professor Augusti, has recollected the origins concerning accreditation of engineering education, spanning all the way from the various tuning initiatives of the 1990s, the creation of the European Standing Observatory for the Engineering Profession and Education (ESOEPE) at the beginning of the last decade, the various "European Accredited Engineering" ("EUR-ACE")-projects, which eventually culminated in the creation of the European Network for the Accreditation of Engineering Education (ENAEE) in 2006. He also pointed to the institutional contributions of SEFI (founding member of ENAEE) and the personal contributions of Francesco Maffioli in this process. ENAEE will always commemorate him.

Today ENAEE and the "EUR-ACE" system have developed in one of the most viable field specific, disciplinary accreditation networks in Europe and indeed on a global scale. In spite of its voluntary character, in the past couple of years more than 1200 Higher Education programmes from all across Europe, Latin America, Africa, Asia and Australia have applied to be evaluated against the "EUR-ACE" learning outcomes and the European Standards and Guidelines (ESG). On the basis of self-assessment report followed by a peer review on site, these programmes have been granted the "EUR-ACE"-Bachelor and/or Master accreditation seal in recognition of their quality and in acknowledgement of the fact, that respective achieved programme learning outcomes fulfil the entry requirements of their graduates for the exercise of the engineering profession.

The "EUR-ACE"-system, identified by the European Commission as Best Practice in European Quality Assurance and as engine of professional and academic quality in the European Union and the European Higher Education Area respectively continues to flourish with several hundreds university programmes being reviewed every year. Apart from authorized national agencies in France, Germany and Great Britain, Italy and Ireland, Portugal and Romania, Russia as well as Turkey, countries like Spain, Switzerland, Poland, Finland and Estonia are on their way to introduce the "EUR-ACE"-system. Under various EU TEMPUS and Lifelong Learning project lines the "EUR-ACE" quality assurance scheme is also currently introduced in (Central) Asian and Northern African countries.

These dynamic developments have been fostered by a number of important endorsements and decisions of key stakeholders in the European engineering realm: an example in case is the recent unequivocal SEFI endorsement vis-à-vis Higher Education Institutions to associate themselves with the "EUR-ACE"-philosophy. In addition, the European Federation of National Engineering Associations (FEANI), which maintains the FEANI index of recognised institutions of engineering higher education in Europe and their engineering programmes, has decided that all accredited "EUR-ACE" Bachelor and Master engineering programmes are automatically included in the FEANI index while at the same time fulfilling the mandatory educational requirements of the professional EUR ING title.

It is also essential to note that in the current revision of the European Directive on the Recognition of Professional Qualifications, the idea of introducing a "professional card" for engineers in Europe is contemplated, which again is a strong link to the "EUR-ACE" accreditation scheme. For applicants in some countries like Germany, where the professional card has already been introduced, the educational requirements are automatically recognised, if he/she has graduated from a "EUR-ACE" accredited programme.

On the level of academic recognition of qualifications, it has become evident that the "EUR-ACE" scheme is/will continue to equally be instrumental in fostering academic mobility in the so far 47 countries of the "European Higher Education Area" (EHEA). In the past decade the political focus of the Bologna process has been on developing structural elements of compatibility in the EHEA such as a coherent system on the Bachelor, Master and (more and more also) on the Ph.D level by introducing the European Credit Transfer System and a Diploma Supplement for each European graduate. Today the political focus has shifted and now focuses on the development of pan-European learning outcomes and competence profiles. This will also be one of the major recommendations of the upcoming report of the European Commission on new developments in European HE Quality Assurance until 2020.

SEFI and ENAEE together with FEANI, will continue to join hands in promoting the ideas and values of the "EUR-ACE" accreditation scheme and its contribution to promote academic and professional mobility in Europe. As President of ENAEE and on behalf of all its members, I sincerely thank SEFI for its commitment to our joint ideals and wish it another successful 40 years to come.

Innovation, Sustainability and Employability: Challenges to be faced

*By **Antonia Moropoulou**, SEFI Administrative Council Member, National Technical University of Athens*

Employability in Europe nowadays

Despite a weakening economy and the continuing struggle in construction, the employment rate for new engineering graduates has improved and unemployment has dropped, in the UK, according to research published by the Higher Education Careers Services Unit (HECSU). The figures show revival in engineering, which has experienced poor employment outcomes since the start of the recession. Employment rates for architecture and building (65.9%), civil engineering (62.8%), electrical and electronic engineering (63.9%) and mechanical engineering (65.6%) were higher than the average of all graduates from first degree disciplines (61.8%). Career prospects had also improved since the previous year with 65.8% of employed mechanical engineering graduates (59.4% in 2011), 36.2% of electrical and electronic graduates (30.9% in 2011) and almost three in five civil engineering graduates (54.6% in 2011) all working as engineering professionals in January 2012 (six months after graduating)[2].

These data concerns the UK and the countries that do not face a severe crisis (Germany, Scandinavian Countries, the Netherlands, Austria etc), and shows that employability rates are improving. In some cases so rapidly that some of the above mentioned countries need engineers and that they are offering jobs. In South European countries and Ireland on the other hand, unemployment rates are at their highest levels, especially among the young scientists.

Among the EU Member States, employment rates reached highs in the range of 72 % to 74 % in Austria, Germany, Denmark and Sweden, peaking at 74.9 % in the Netherlands. At the other end of the scale, employment rates were below 60 % in ten of the EU Member States, with the lowest rates being recorded in Italy (56.9 %), Hungary (55.8 %) and Greece (55.6 %). The bad news is that engineering professionals have to work harder than ever to earn those slightly higher salaries, and they are feeling more pressure than ever to keep up with rapid advances in technology[3].

Professionals' immigration

Someone could imagine that when you say the word "migrant worker" in USA or Europe, it usually evokes images of Mexican farm labourers, or people from the Middle East or Asia. But now when financial and political leaders are meeting, the concept reared its head in a surprisingly different way: it is linked to the eurozone.

A Brazilian leader, during a financial meeting made a plea. "There is such high unemployment in Spain and Portugal, they should send their people over here [to Brazil] to get work – they can work and then send money back home [to Europe] and then go home themselves after 10 years!" he earnestly explained. After all, he added by way of example, Brazil currently needs about 60,000 engineers a year – but only 40,000 are graduating inside Brazil. So why not get those European engineers, or other young graduates, to travel as migrant

2 http://www.eurograduate.com/article.asp?id=4210&pid=2
3 *http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Employment_statistics*

workers? “We have a need for 20,000 more engineers! We have a need for migrants!” he explained. Why not use Latin America as a source of remittances for eurozone families starved of cash?[4]

Today, the migration of professionals takes another direction, from South Europe to Northern Europe, and from Europe in general to Asia (China and India) and Latin America.

Open borders - for the highly qualified

As the economy recovers and the number of projects increases, the skills shortage is going to be much more noticeable as the number of vacancies increases. There is lack of “qualified” engineers. The typical continental European model of engineering education can be described as consisting of two parts:

i) Short cycle engineering programmes of 3 or 4 years duration to produce technological or production engineers.
ii) Long cycle engineering programmes of 4 - 5 years duration and producing “theoretical” or research/ design engineers.

The market, the industry needs graduates from Long Cycle Engineering Programmes, 4 -5 years of studies. In a Europe of crisis, a modification of curricula is needed: The 5 years “integrated and uninterrupted” curriculum of Engineering, followed in Greece and other countries, (i) is broad enough in order for the graduate to adapt himself to the variability of the Market, and (ii) it is scientifically based, as to offer the possibility to overcome the inevitable obsolescence of knowledge.”

Student placement in Industry during a Degree Programme

Industrialists, who make contributions to discussions on engineering education, almost always place a high value on providing engineering students with the opportunities to work in industry as part of their education programme. The objective of such a placement is to enable students to learn about the application of engineering principles to the manufacturing or design process.

The following matters are important to bear in mind about such student placements: (a) The objectives must be clearly articulated and understood by the employer, the student and the university, and should be such that the student must learn about engineering applications in that industry during the placement. (b) The performance of the student in achieving the specified learning outcomes should be assessed and graded as part of the placement. (c) The minimum duration of placement should be one semester or six months. A shorter period does not allow either for adequate training of the student, or for the student to be of value to the employer. The summer vacation period(s) during the engineering education programme may form part of the placement. (d) Students should receive satisfactory payment for their work from their employers.

In summary, in considering the implications of the Bologna Declaration, we must consider the following

(a) Industry requires increasing numbers of engineers, therefore, engineering must be more attractive to young people, (b) Industry requires both short- cycle “applied” engineers, and long- cycle “theoretical” engineers, (c) Students should be able to transfer from one programme to another, and from one country to another, while receiving appropriate credit for previous learning using the ECTS credits system, (d) European engineering education programmes should be more attractive to non- European students, so that they will study in Europe, thereby increasing the viability of engineering programmes, (e) Academic standards must be set and main-

4 http://www.ft.com/cms/s/2/bee6089e-b5b6-11e1-ab92-00144feabdc0.html#axzz2OvS4fCRr

tained at a level appropriate to the requirements of industry and research universities, (f) Engineering degree programmes in Europe must meet the criteria in international agreements and indices such as the EURACE Label, the Washington Accord, the European Mobility Forum and the FEANI Index.

Innovation

From physics and chemistry to cars and consumer products, Europe is a world leader in innovation, with leading universities and research institutes alongside major cutting edge industries. Moreover Europe has significant advantages, among which the urban and build environment or its cultural heritage. Therefore, Europe's innovative efforts should focus on new fields of science and technology that have high development and sustainability potentials. A range of EU-funded projects, coordinated by European companies, universities and research institutes, highlight the diversity of European science and technology innovation even within the field of 'Information and communication technologies' (ICT).

Innovative researches can be mentioned, in all aspects of engineering fields. From materials to construction, from nano-technology to informatics and computer engineering, from protection of cultural heritage to zero energy modern buildings, environmental projects, etc... The main question here is how much of the EU budget for research is for programs that have a clear link with the industry and finally the consumer. The figures show that even though the projects are increasing, especially in engineering activities the numbers are still low[5].

The benefits of inter-disciplinary research cover all aspects of society for its benefit: - Economic Benefits - Social Benefits - Environmental Benefits - Cultural Benefits. The progress of science and technology is crucial: To help European companies to innovate and stay competitive; To create more and better jobs in Europe; And to keep improving the European way of life.

This is why the European Union decided that investment in research should increase in Europe. At present, less than 2% of Europe's wealth (GDP) is devoted to research, which compares poorly with 2.5% in the USA and more than 3% in Japan. Our goal is to approach 3% of GDP for research. This is an important part of the so-called "Lisbon strategy", which consists of a partnership between the European Union and Member States to transform Europe in a vibrant knowledge economy, in order to boost economic growth, create more and better jobs and ensure lasting prosperity in Europe. The initiatives for investing in research are closely linked with actions to promote innovation in Europe. The European Commission proposed a "Common Approach" to promote both research investment and innovation. But the International Financial Crisis and the consequences in Europe once more overturned this goal. This is why universities and especially engineering universities should play an important role in research, reshaping Engineering curricula, transforming themselves into carriers of innovation and introducing sustainable development for the common benefit. In all ranking systems, and in all methods and criteria used, engineering universities are in the best positions. US universities on most of the cases, but also a significant number of EU universities, are in the best 20 or 50 places. But Europe and European universities must also play an activate role in Research and Technology Development (RTD) because of a number of developments inherent to the RTD sector itself: high level research is increasingly complex and inter disciplinary; high level research is increasingly costly; high level research requests a constantly increasing "critical mass".

Hardly any research team or research laboratory, hardly any company can reasonably claim to be able to respond to these challenges. Even entire member states find it increasingly difficult to be active and play a leading role in the many important areas of scientific and technological advance. Organising co-operation at different levels, co-ordinating national or European policies, networking teams and increasing the mobility of individuals and ideas is therefore a requirement resulting from the development of modern research in a

5 http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=8572

global environment. Without determined actions at European level the present fragmentation of Europe's efforts cannot be overcome[6].

Sustainability and Crisis

Hundreds of millions will be cut from higher education budgets across Europe, as almost every country has resorted to reducing funding for academia as a result of austerity measures. On the other hand, new information/communication technologies provide possibilities to enhance the quality of education. Interactive education software, open access digital libraries and new forms of interaction between students, teachers and the community are just a few ways in which education can be enriched by integrating such technologies into traditional classroom activities. These tools provide a powerful resource for teachers to assist them with the teaching and learning processes. Teachers and higher education researchers play an important role in integrating technology into education as coaches in the technological/information-rich environment in which students now live[7].

If education is not supporting sustainability then it is not sustainable itself
Education is an essential tool for achieving sustainability. People around the world recognise that current economic development trends are not sustainable and that public awareness, education, and training are the keys to move society toward sustainability. Beyond that, there is little agreement. People argue about the meaning of sustainable development and whether or not it is attainable. They have different visions of what sustainable societies will look like and how they will function.

It is curious to note that while we have difficulty envisioning a sustainable world, we have no difficulty identifying what is unsustainable in our societies. We can rapidly create a list of problems - inefficient use of energy, lack of water conservation, increased pollution, overuse of personal transportation, consumerism, etc[8].

An important distinction is the difference between education *about* sustainable development and education *for* sustainable development. The first is an awareness lesson or theoretical discussion. The second is the use of education as a tool to achieve sustainability. More than a theoretical discussion is needed at this critical juncture in time. While some people argue that "for" indicates indoctrination, we think "for" indicates a purpose. All education serves a purpose otherwise society would not invest in it. Education should give people knowledge and skills for lifelong learning to help them find new solutions to their environmental, economic, and social issues.

Thresholds of Education and Sustainability
In many countries, the current level of basic education is so low that it severely hinders development options and plans for a sustainable future. A higher education level is necessary to create jobs and industries that are "greener" (i.e., those having lower environmental impacts) and more sustainable. The relationship between education and sustainable development is complex. Generally, research shows that basic education is essential to a nation's ability to develop and achieve sustainability targets. Research has shown that education can improve agricultural productivity, enhance the status of women, reduce population growth rates, enhance environmental protection, protect the build environment, conserve the cultural heritage in a proper way and generally raise the standard of living. But the relationship is not linear. For example, four to five years of education is the minimum threshold for engineering.

6 http://ec.europa.eu/research/era/docs/en/areas-of-actions-universities-assessing-europe-university-based-research-2010-en.pdf
7 *http://www.educationincrisis.net/learn-more/articles/item/570-higher-ed-in-jeopardy*
8 *http://www.esdtoolkit.org/discussion/default.htm*

Education directly affects sustainability plans in the following three areas:
Implementation. An educated citizenry is vital to implementing informed and sustainable development. In fact, a national sustainability plan can be enhanced or limited by the level of education attained by the nations' citizens. Nations with high illiteracy rates and unskilled workforces have fewer development options;
Decision making. Good community-based decisions - which will affect social, economic, and environmental well-being - also depend on educated citizens. Development options, especially "greener" development options, expand as education increases;
Quality of life. Education is also central to improving quality of life. Education raises the economic status of families; it improves life conditions and improves the educational attainment of the next generation, thereby raising the next generations' chances for economic and social well-being.[9]

9 8th International Conference on Higher Education and Research, Buenos Aires

The New Learning Environment is Personal

*By **Pieter de Vries**, Chair SEFI Working Group on New Learning Technologies, TU Delft*

In a traditional sense the learning environment is qualified as the institutional setting for the teaching and learning to take place. This comprises the students, the teachers, management, the services and all the buildings, the classrooms, the equipment, the tools and laboratories that constitute the social and physical environment. This ignores the fact that learning is not confined to the institution, but is taking place all the time and everywhere also in connection to the institutional curriculum and even more so in an interconnected world. The factory model of mass instruction that worked fine for ages cannot cope with the rapidly changing landscape of higher education (HE) due to the increasing demand for HE, the changing technology, the changing expectations of the students, the demands of the global workplace and the Europe 2020 ambition to become a smart, sustainable and inclusive economy (EU, 2013). Although most institutions are trying to preserve their legacy model, a good number feel forced to review their educational policy and to date most schools are involved in what can be labeled as 'reengineering the learning environment'. This chapter wants to augment the discussion on the characteristics of the 'new learning environment' and the consequences for higher education (HE).

The learning environment in transition

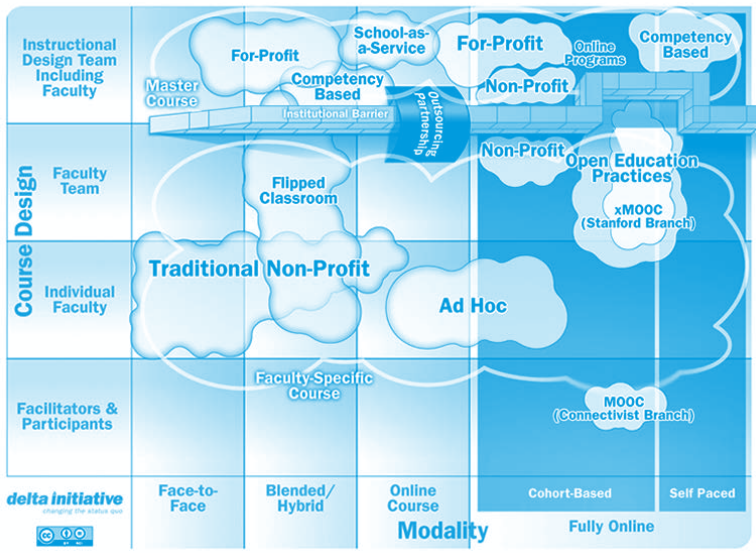
As written before in this book, institutions are experimenting or actually moving to blended and fully online environments and contribute their share to open educational resources while wrestling with something like Massive Open Online Courses (MOOCs), a recent and somehow overestimated expansion of the open education movement. The variety of environments that seem to develop is a challenge for the schools from an organisational and pedagogical perspective and certainly for the staff and students. There is not much research yet to proof that these innovations work well in general and if these are a viable solution for the challenges HE is facing. A side effect of this new interest in educational innovation and educational technology is the false public discussion about the dichotomy of traditional vs. online which ignores the variety of many residential learning environments versus online models and blended or hybrid approaches.

The three major developments in the learning environment perspective are, next to the existing residential one, blended learning, often qualified as a mix of classroom and online activities and seemingly the most common choice. Secondly fully online learning as being the online alternative for the traditional classroom bound courses and thirdly open education, with open educational resources, open educational courseware and the MOOCs as the learning environment that receives most attention to date. The reason is that MOOCs can be seen as an extension of existing online learning approaches, in terms of open access to courses and scalability. MOOCs aim to open up education and provide free access to university level courses for as many students as possible (Moropoulou & De Vries, 2013). No barriers there, but there are concerns about the pedagogy and quality of the numerous new delivery models and the lack of systematic research. So the question still is: can the new technologies and the new pedagogical insights help to make education more productive, serve more students, develop better courses and achieve a higher completion rate? The urgent question therefor is the level of readiness of institutions to cope with these changes. The pace of transformation in HE has been slow and most institutions have only started to scratch the surface of online learning, which is highly demanding and requires a dramatic change and therefor an innovation capacity rather uncommon in HE.

The characteristics and key trends

The emerging landscape of different learning environments is, omnipresent, changing rapidly and pervasive; therefor Hill (2012) tried to capture the primary models to reduce confusion in the public discussions. The overview in figure 1 shows the models ranging from face-to-face to fully online. A few observations: Course design has a very prominent role in depicting the models. In this landscape the primary models are: face-to-face, blended and hybrid, online courses and programmes, fully online programmes, educational partnerships, open education practices with the open educational resources and lately the different kind of MOOCs. The more traditional models require less teamwork to develop than the blended and online courses, for the simple reason that the face-to-face environment consists of an individual teacher with a fixed cohort of students.

FIGURE 1. **Educational Delivery Models, 2012**



In any of the other models, course design and flexibility are major issues. The face-to-face has no room for flexibility from an organisational point of view; the pedagogical flexibility though depends very much on the competencies of the teacher and is mostly ad hoc and not transferrable. The cohort based instructive MOOC is an online endeavour, cohort-based, but with a restricted flexibility on the organisational and pedagogical level. The for-profit and not for profit initiatives represent another dimension, which is rather new in the European context. The fact is that the competition is no longer just around the corner, but is vividly present on the internet 24/7.

So where are we going from here? Although we cannot predict the future the assumption can be made that an analysis of emerging educational technologies helps to identify key developments. The key features summarized below were published in the Educause Horizon Reports (Johnson, a.o. 2012, 2013) and is the result of a thorough discussion looking at short and long term developments:

Openness. Concepts like open content, open data, and open resources, along with notions of transparency and easy access to data and information is becoming a value.

The already mentioned MOOCs. These will be widely explored as alternatives and supplements to traditional university courses.

The global workplace demands skills from college graduates that are more often acquired from informal learning experiences than in universities.

There is an increasing interest in using new sources of data for personalizing the learning experience and for performance measurement.

The role of educators continues to change due to the vast resources that are accessible to students via the Internet.

These trends summarise what is happening in the increasingly busy world where learners must balance demands from home, work, school, and family leading to the need for flexible and mobile learning opportunities. People want easy and timely access not only to the information on the network, but also to tools, resources and real-time analysis and commentary. In other words people expect to be able to work, learn, and study whenever and wherever they want to. This coincides with the development of browser based software that is device independent, so you can communicate, collaborate and learn with an array of devices at the moments of need. The overwhelming change taking place is increasingly challenging our roles as educators. Information is everywhere and therefor sense-making and the ability to assess the credibility of information are paramount.

Conclusion: The new learning environment is personal

One of the consequences of living in this connected world is that students are no longer a student number that nicely fits in the cohort oriented organisational schedule, but is an individual demanding for active, student oriented learning approaches allowing to take control of how to engage and related to intrinsic motivation coming from their interest and their communities. The new learner is an increasingly self-directed individual connected with the surrounding world in numerous ways on a very personal base.

Therefor the future learning environment is personal.

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CHAPTER VI

SPECIAL CONTRIBUTIONS AND MESSAGES

Accreditation of Engineering Education and SEFI: the origins

*By **Giuliano Augusti**, Founding President, European Network for Accreditation of Engineering Education (ENAEE); President, Italian Agency for QA and EUR-ACE accreditation of engineering programmes (QUACING); former SEFI President*

Accreditation of higher education (HE), and in particular of engineering education (EE), is today a fashionable word, much used (and sometimes abused) with various meanings. It was very different a few years ago, when the European Commission circles suggested avoiding the word, probably fearing that it could implicitly advocate some form of regulation of a subject (education) outside the European Treaties.

As in many other occasions, Francesco Maffioli was long-sighted and felt in advance the change of attitude, which allowed SEFI to be in the forefront of the European initiatives toward accreditation of HE. I have a personal recollection about this: when in February 2004, two EC experts, namely Guy Haug (a former SEFI Secretary General!) and Peter van der Hijden (formerly DG EAC), convened a meeting in Brussels to solicit applications for a round of projects on the development of the Bologna Process, Francesco urged me to participate and to present our ideas on accreditation of EE and the first step we had taken by setting up the 'European Standing Observatory for the Engineering Profession and Education' (ESOEPE).

That meeting was indeed the start of the EUR-ACE adventure.

The EUR-ACE ("European Accredited Engineer") project was quickly but accurately prepared: the partners included SEFI, FEANI and several concerned Engineering national organisations (ESOEPE had no legal status and could not formally participate).

The kick-off of the project took place in London in September 2004. In the following 18 hectic months, sound basis for future implementation and development of EUR-ACE were set (I sometimes wonder how this was possible in such a short time).

The "EUR-ACE Framework Standards for the accreditation of engineering programmes" (now well-known as "EUR-ACE® Standards") were compiled, essentially as a synthesis of existing standards; in fact, a preliminary detailed survey of the standards used by the partners had revealed striking similarities behind different façades, which made this task comparatively easy.

The EUR-ACE® Standards, like all recent Standards but unlike the old national rules that prescribed inputs in terms of subject areas and teaching loads, define and require learning outcomes, that is, what must be learned rather than how it is taught. This approach has four direct advantages:
- it respects the many existing traditions and methods of engineering education in Europe;
- it can accommodate developments and innovation in teaching methods and practices;
- it encourages the sharing of good practice among the different traditions and methods;
- it can accommodate the development of new branches of engineering.

The first text of the "EUR-ACE Framework Standards" was finalized in 2006 after successive versions had been commented on by the project partners and other stakeholders, both academic and non-academic, and 'trial accreditations' were run in a number of countries. The current text, with very minor modifications, was approved in 2008.

In accordance with the European Qualification Framework, the EUR-ACE Standards distinguish between First and Second Cycle (or "Bachelor" and "Master") degrees, and identify 21 outputs for accredited First Cycle (FC) degrees and 23 for Second Cycle (SC) degrees. Moreover, the EUR-ACE Standards contain guidelines and procedures that include the assessment, among other requirements, of the human resources and facilities available for the programme.

But in those crucial 18 months, also the main lines of the EUR-ACE system were indicated: a decentralized accreditation system in which a common European quality label (the EUR-ACE® label) is added to the accreditation awarded by a national agency (the idea of setting up a European Accreditation Agency, like the American ABET, was very quickly dismissed).

In order to run this system, ESOEPE was transformed in March 2006 into the international not-for-profit association 'European Network for Accreditation of Engineering Education' (ENAEE). Again, thanks to the leadership of Francesco Maffioli, SEFI was among the promoters and founding members.

In November 2006, ENAEE assessed that six accreditation agencies that had been active partners of the EUR-ACE project (the French CTI, the British Engineering Council, the German ASIIN, Engineers Ireland, the Portuguese Ordem dos Engenheiros, the Russian Association for Engineering Education, now AEER) already fulfilled the requirements set by the Framework Standards and were authorized to award the EUR-ACE® label for a period of two years. Their authorization was renewed in 2008 after a rigorous re-assessment process including site visits by multi-agency teams.

The first EUR-ACE® labels were awarded in 2007: now they are already more than 1000, and the six initial EUR-ACE-authorized agencies have grown (at the time of writing) to nine.

In the first years of ENAEE, Francesco participated actively in many meetings. I want to close this short paper with another personal recollection. In 2008, we were looking for a new slogan to substitute the initial "accreditation of European engineering programmes" and open EUR-ACE to other parts of the world without losing its "European" character: Francesco suggested the sentence that is now on the EUR-ACE logo "European Accreditation of Engineering Programmes".

A message from a former Secretary General

*By **Guy Haug**, Universidad Politécnica de Valencia, SEFI Secretary General 1986-1988*

Let me first of all congratulate SEFI on the occasion of its 40th anniversary. It was still much younger when I had my first contact with the SEFI community, in 1986, and became Secretary General shortly afterwards, under Presidents Georges van der Perre and Giuliano Augusti. The same as my predecessors Edward Prosser and Alan Smith, I am not an engineer; all three of us met SEFI when working on the development of what would become the COMETT and ERASMUS programmes. My encounter with SEFI at that time was thus rather accidental, but it was not my first one with engineering education: a few years before, I was instrumental in developing one of the first really "joint" programmes (4-year common curriculum between 4 universities in 4 countries, double degree for all graduates) in management education, while from the Ecole Centrale Paris my opposite number Bernard Marin was developing a somewhat similar experiment in engineering education, the well-known TIME programme, and there were contacts between the two initiatives.

From then on, I have maintained contacts with SEFI and the engineering education community in Europe all along the various stages of development of what we now call the European Higher Education Area (EHEA):

- During the ERASMUS/COMETT days, by means of contact to the international offices of many technical universities/universities of technology, in order to explain the new programme for the development of exchange schemes and inter-university cooperation programmes of all types.

- When TEMPUS was launched, mainly in order to understand the structures of engineering education (and higher education in general) in the new democracies in Central Eastern Europe and later in the countries of the former Soviet Union; engineering education was one of the star sectors in the development of "trans-European" ventures for curricular development and modernisation.

- Then came an eight-year parenthesis in my involvement in intra-European higher education. It was devoted to the development of large scale student mobility between Europe and (mainly) the USA, in particular through work-abroad, internship-abroad and study abroad programmes where again technical, technological and engineering education were major players – in spite of the difficulty to arrange reciprocal schemes and attract more American engineering students to engineering schools/faculties in Europe.

- With the pan-European, intergovernmental Bologna Process and the EU's complementary "Agenda for the modernisation of higher education" (Lisbon Strategy), European higher education entered a new era marked by the dream of a strong, compatible, understandable, coherent, effective and yet diverse European higher education. I was centrally involved in designing and initiating both the Bologna Process and the Lisbon agenda for universities. In engineering education, these change agendas were received – depending on persons, institutions and countries – with a mixture of caution, resistance, curiosity and some enthusiasm in each of the strands of the change programme, be it the new degree structure, the emphasis put on employability, the combination of cooperative attitudes with a more competitive posture in the national, European and worldwide context, the building up of quality assurance and accreditation criteria, procedures and agencies, etc. As part of these developments, I was lucky to be involved in the setting up of EUR-ACE, as a European quality seal for bachelor and master degrees in engineering. EUR-ACE was set up in stages by means of a series of EU-supported projects (notably the TREE project) coordinated from the University of Florence, with 3 former SEFI presidents (Giuliano Augusti, Francesco Maffiolli and Claudio Borri) as main actors and negotiators and with the cooperation of SEFI, industry, the engineering professional bodies and a large number of leaders of engineering schools/faculties and whole technical universities. Looking retrospectively at this 10-year long endeavour, I believe it represents a major development, the importance

of which has not yet been fully acknowledged in the majority of countries, quality assurance agencies and engineering education entities in Europe.

- In recent years, the policy of the European Union ("EUROPE 2020") and several member states has put ever more emphasis on the links between science/technology/innovation, economic/regional development and employment. Together with the impact of international university rankings, this has eventually led to initiatives aimed at enhancing the quality, visibility (e.g. in rankings), attractiveness and competitiveness of national higher education systems and universities. Again, engineering education was strongly involved in these developments, not least thanks to projects like EUGENE, which I also had a chance to monitor as member of its "International Advisory Board". EUGENE for the first time placed the whole system of European engineering education in the worldwide context – in the wake of the already mentioned TREE and EUR-ACE projects.

What does this brief historical review mean with respect to SEFI's anniversary? Certainly it shows that my continuous involvement with SEFI has had a bearing on my professional and personal life – maybe it is not a pure accident that I am currently serving as personal advisor to the Rector of one of Spain's leading university of Technology, the *Universidad Politécnica de Valencia (UPV)*.

It also recalls that engineering education has been a central theme in the overall transformation of European higher education: I remember a discussion with members of the EUR-ACE Board which came to the conclusion that if European higher education can achieve compatibility and coherence in the engineering education area, it will be able to achieve these goals across all other disciplines!

Finally, this brief historical review shows that SEFI, either directly as an association or via some of its current and former leaders and members, has been involved in all main initiatives and discussions for the creation and improvement of the EHEA. Let me therefore conclude this brief message by wishing SEFI and its various constituencies that the coming decade, which will lead to its 50th anniversary, will again be at the forefront of change and innovation in European engineering education.

SEFI and Innovation in Engineering Education – Reflections from UNESCO

*By **Tony Marjoram**, PhD, CPEng, FIEAust, SEFI Honorary Member; Guest Professor University of Aalborg - Head of UNESCO Division ond Basic and Engineering Sciences Division(2001-2011)* [1]

Engineering is the most radical profession, driving social and economic development in the provision of infrastructure, creation and application of knowledge and innovation of technology – most innovations derive from engineering, not science (Metcalfe, 2009). Engineering is also highly conservative – while the last 50 years has seen significant change in modes of knowledge production, dissemination and application (Gibbons et al, 1994), there has been limited change in engineering education. The perception that engineering education is boring and hard work, that engineers are poorly paid and that engineering is part of the problem of environmental sustainability are the main factors in the decline of interest, enrolment and retention of young people in engineering, reported shortages of engineers in many countries and brain drain from lower income countries. These are major issues and challenges for engineering - engineers are innovators and also need policies and plans to innovate in engineering education. Fortunately, these issues are connected - young people, especially young women, are attracted to engineering when they see curriculum change toward innovative learning and teaching methods, such as problem-based learning, and when they see engineering as a vital part of the solution to sustainability, climate change and poverty reduction (De Graaff and Kolmos, 2003; UNESCO 2010; Beanland and Hadgraft, 2013). Young engineers with a background in problem-based learning and humanitarian engineering are also favoured by employers in terms of graduate attributes and professional competencies.

These and related issues of research, quality assurance, accreditation, continuing education and mobility are the concern and focus of SEFI, as reflected in the names of working groups, committees, task forces and annual conferences. They are also the concern of UNESCO, the UN organisation responsible for science and engineering. It is indeed timely, therefore, that the 2013 conference honouring the 40th anniversary of the birth of SEFI in 1973 reflects past achievements and reviews future challenges and needs over the next 40 years. SEFI developed informal relations with UNESCO in the 1980s and 1990s, official relations in 1996 and operational relations in 1998, renewed in 2003, 2008 and 2013 (the author is happy to have facilitated this until his retirement in 2011). Most of UNESCO's programme work is carried out in conjunction and cooperation with professional NGOs, in engineering education such as SEFI at the regional level and WFEO internationally, and their national members and institutions. Without such symbiotic partnership, much of this work would be difficult if not impossible. SEFI activities with UNESCO include the organisation of a seminar with UNESCO in 1992 on engineering education and the environment, and the publication of a guide to education for engineers. More recently, SEFI contributed to the UNESCO Report, "Engineering: Issues, Challenges and Opportunities for Development" published in 2010 – the first ever international report on engineering. SEFI was to be a partner in the proposed "International Engineering Programme" that was in process of approval at UNESCO Executive Boards and General Conference from 2009 to 2011, when the proposal was transformed into a "cross-cutting thematic 'UNESCO Engineering Initiative'", and effectively collapsed with the financial crisis following the withdrawal of US funding consequent to Palestine membership of UNESCO in 2011.

1 The author, who worked for UNESCO from 1993-2011, and was Head of Engineering from 2001-11, would like to thank SEFI for inviting this reflection and outlook on the future, and looks forward to continued activity in transforming and promoting the role of engineering and technology in development.

The future

Given the role of engineering in driving social and economic development through the creation and application of knowledge and technological innovation, engineering and engineering education are vital in addressing the global challenges we face. These include the continued need for poverty reduction, sustainability, climate change and related Millennium Development Goals (MDGs), which will be built upon in the post 2015 development agenda by a set of Sustainable Development Goals (SDGs). Despite the importance of engineering in social and economic development, however, neither engineering nor science were mentioned specifically in the eight MDGs, eighteen quantifiable targets and 48 indicators - the closest mention relating to ICTs, knowledge and "S&T" in MDG8, target 18 (the last target). There is clearly a need to get engineering and engineering education on the development agenda! This should be a particular goal for SEFI in Europe and the EU.

Looking at engineering education over the next 40 years, when the graduates of today will be retiring, it is first useful to look at the world of the next generation. What will that world look like? What engineering will be needed to get there, what sort of engineers, and what sort of engineering education? In 40 years climate change will be a pressing reality, with higher temperatures, changing weather and ecosystems. Peak oil and climate deniers will be gone, population will have increased from 6.5 to 9.1 billion, with most growth in less developed countries (UN). Poverty, inequality and political divide will still be with us, and lots of new technology, for those who can afford it. At the broader level, current predictions emphasise ICTs, nanotech, new materials, possible geo-engineering and greener, sustainable technology for climate change mitigation and adaptation. The latter is most important for humanity and the planet, if we are to move toward a more sustainable, carbon freer future, together with the development of humanitarian technology for poverty reduction in low income countries and regions. At the specific level, new technologies will include the renewable energy and distributed system technologies, electric vehicles, increased use of ICTs (eg for sustainable and humanitarian technology in such areas as technology transfer – see Appropedia) and such technologies as voice recognition (no keyboards), increased materials recycling and sustainable design. Macro- and mega-level technologies could include carbon capture and storage and geo-engineering.

Changing modes of knowledge production, dissemination and application relate to increasing interdisciplinarity, teamwork, the increasing use of ICTs, peer-group and self-learning (already lecturers face the prospects of students Googling while they speak). Engineers will be required with graduate attributes and professional competencies to reflect such changes, including not only engineering knowledge, problem analysis and investigation, solution design and development and the use of tools, but also engineering and society, ethics, communications, project management and life-long learning (Washington Accord). Innovation in and the transformation of engineering education will be required to provide environments and curricula to facilitate learning and the development of such engineers, and relates particularly to the need to move toward student-centred, project- and problem-based learning.

Engineering needs to engineer and innovate its educational future. SEFI has a particular responsibility to drive and support innovation in learning approach, environment and curricula development, for the development of engineers with attributes and competencies in greener/cleaner and humanitarian engineering, and the transformation of engineering education. SEFI needs to facilitate this not only in Europe, but also to assist developing countries and institutions in this process. As noted above, innovative learning and teaching methods, with an emphasis that engineering can be fun and highly relevant to the global challenges we face in sustainability, climate change and poverty reduction appeals to and attracts the young people we need to be the engineers of the future. This is reflected in the popularity of PBL courses and the growth of Engineers Without Borders groups in many countries. If we could look back in 40 years' time, we would hopefully see the effects of innovation and transformation in engineering education in promoting the enrolment and graduation of engineers needed to address global challenges. Failure to change will result in continued shortages of engineers, brain drain from low income countries and the prospect of continued increase in climate change, environmental

and human degradation around the world. This grim outlook can be avoided with good policy and planning in engineering and engineering education right now. In the celebration of the fortieth anniversary, SEFI need to address this as the highest priority, together with other engineering and international organisations such as UNESCO.

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Washington Accord - an international agreement established in 1989 recognising equivalencies in accreditation for professional engineering academic degrees between national bodies responsible for accreditation in its signatory countries. Signatories in 2010 included Australia, Canada, Chinese Taipei, Hong Kong China, Ireland, Japan, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, the UK and USA.

MESSAGES

From Europe

From the Board of European Students of Technology - BEST

By Mario Nzualo, President of BEST 2012-2013, Mihai Tociu, President of BEST 2013-2014

In 1996, our journey in engineering education started with an invitation from SEFI to join a thematic network called "H3E" and dealing with the European Dimension in Engineering Education matters. This initiative came from the fact that SEFI and BEST believed that students play a natural role in shaping engineering education along with their academic and industry peers.

Today, we provide a structured way for engineering students to give input on their education. Our approach is based on two pillars: First, we organise events all over Europe and create surveys that aim to gather students' opinions; second, we disseminate this input to the relevant stakeholders.

17 years have passed and we are very pleased to see SEFI's continuous role in supporting the involvement of students in educational matters through initiatives such as the SEFI Student Year, the SEFI Student Contest and the participation of students to the SEFI annual conferences and the Permanent Committee on Student Cooperation.

It is always a huge pleasure for us to work with SEFI and we are very proud of SEFI's achievements during the past 40 years. We are looking forward to closely witness SEFI's innovative initiatives during the coming years.

From the German Council of University Faculties in Engineering and Informatics - 4ING

By Professor Manfred J. Hampe, President 4ING

On behalf of the Board and the members of 4ING (German Council of University Faculties in Engineering and Informatics), I convey my warm congratulations to the members and to the leadership of SEFI (European Society for Engineering Education) as they celebrate the organisation's fortieth anniversary.

SEFI, being the largest and most important European network for higher education of engineering, and 4ING, associated to SEFI and representing 135 engineering and informatics faculties at university level at 52 universities in Germany, have both a common objective: it is our responsibility to enable the next generation of engineers to contribute to innovation, economic stability, process safety, world-wide security, and a better quality of life for us all, or in short, to contribute to the advancement of the European and the global society.

Therefore, it is a great honour for 4ING to co-organise a workshop jointly with SEFI and the European Engineering Deans Conference (EEDC) during the annual conference of SEFI 2013, and to mark SEFI's 40th anniversary.

4ING wishes SEFI all the best on its 40th birthday and looks forward to continuing to improve engineering higher education in Europe.

From the European University Association - EUA

Lesley Wilson, EUA Secretary General

EUA congratulates SEFI on its 40 years of continuous support to the developments and improvement of engineering education across Europe. Created in 1973 by a forward looking nucleus of 21 European universities, thus long before the development of the ERASMUS programme and the growth in inter-university cooperation in Europe in the late 1980s, SEFI is an example to us all in paving the way for European cooperation. By bringing its growing membership together to discuss and learn from each other on the particularly important topic of engineering education, it enriches the perspective of individual universities while also making a major contribution to building the European dimension in higher education. It is my personal pleasure to have been associated with SEFI in different functions since the late 1980's and to have observed and admired its constant growth and consolidation, its increasing global outreach and the diversification of the services provided to members. Thus SEFI demonstrates its special place in the world of European higher education as the first, and in the meantime also the largest and most important network of institutions of its kind. EUA values its cooperation with SEFI and recognises our complementarity as associations whose common mission is to serve European universities. We wish SEFI all the best on its 40th birthday and look forward to continuing to continuing our cooperation in future.

From the Internationale Gesellschaft für Ingenieurpädagogik - IGIP

By Michael Auer, IGIP President

The 40th anniversary of the foundation of SEFI should first and foremost be celebrated as a special moment to look back on SEFI's marvellous achievements in Engineering Education over the years, but also as a new beginning to look forward to the next successful 40 years.

The International Society of Engineering Education (IGIP) celebrated its 40th anniversary last year and is proud to mention that in all these decades there has been a very good cooperation between our associations. Especially in the last few years we have started a new kind of relationship.

As a befriended organisation, IGIP would therefore like to congratulate SEFI on its valuable contributions to the development and improvement of engineering education across the globe. SEFI' s efforts in fostering higher engineering education in Europe and worldwide, in placing engineering education as a key topic in European politics, in promoting Europe-wide and global collaboration of professional engineering education societies and in successfully handling large-scale European and international initiatives, are being well acknowledged by the international engineering education community.

On behalf of all IGIP members, we wish SEFI and its members all the best for a bright future in promoting our common objective: the increase of quality in engineering education and the strengthening of the ties between the members of the world-wide engineering education community.

From the Fédération Européenne des Associations Nationales d'Ingénieurs - FEANI

By Dirk BOCHAR, FEANI Secretary General

As Secretary General of FEANI, the most comprehensive European Engineers Federation, I am particularly honoured that SEFI has asked me to deliver a written address to its distinguished members, at the occasion of its 40th anniversary.

Celebrating a 40th anniversary is a remarkable achievement and a success which goes probably beyond the dreams of the men and women - who at the time - set it in motion. Whereas it is well worth celebrating, it is also good to remember that there was probably nothing easy about building it. As FEANI, the Organisation I am privileged to lead, we celebrated our 60th Anniversary last year, so I know that significant anniversaries provide an opportunity to reflect upon achievements and the impact our services have on the world of engineers. A significant anniversary is also a day where we recognise where we have been and a day where we take the next step in fulfilling our vision and delivering on our growth strategy. As professional organisations we all face similar challenges today: regulation and deregulation of the profession, facilitating the professional mobility of young engineers, influencing the review of educational and academic curricula, creating value for members. Part of the historic greatness of SEFI has been its internationalism, its working across national borders. It is rewarding to see that in Europe, many educational institutions have become gradually aware of the basic and reassuring truth that working together pays off, that acting collectively helps in achieving the goal of professionalism. In addition, in a relation between member and Society, strength can only come from combination and unity.

Engineers help to develop and produce the machines that help feed the world, they move the goods that improve the quality of our lives and they create electricity when and where it is needed most. It is humbling to consider the efforts so many people have put into the development and manufacture of technology over the past decades: technologies which serve a variety of so many industries. SEFI would not have contributed in achieving these successes without the collective efforts, the risks and the breakthroughs generations of engineers developed and accomplished. SEFI, more than any other non-governmental institution in Europe, has put its imprint upon the character and the quality of these engineers. More than any other body you have the right to defend that character and that quality. I am confident that you will and I am proud to join you in honouring those who have gone before you by asserting the fundamental mission at the heart and soul of this organisation, which is to defend and serve the education of the engineering profession. A special thanks must therefore go to those who went above and beyond the call of duty to give of themselves, either in research or in support. As FEANI, we are particularly pleased to be associated with SEFI and we wish the Society a successful and prosperous future.

From the Conference of Engineering Schools for Advanced Engineering Education and Research - CESAER

Marco Gilli, Rector Politecnico di Torino, CESAER President

The foundation of SEFI in 1973 was undoubtedly a milestone in the development of Engineering Education in Europe. SEFI is the widest network and provides the largest platform of higher engineering education institutions and educators in Europe. Already from the beginning SEFI contributes substantially to the formation of a European community of engineering institutions and to the development of engineering education in Europe. SEFI is a highly appreciated meeting place of actors in engineering education committed towards continuous improvement by addressing the challenges of the newest developments in technology and society. Through its well-structured activities of annual conferences, standing working groups and ad hoc task forces SEFI makes important contributions to European developments and ensures at the same time the visibility as well as the status of engineering in society. SEFI is also one of the strategic partners of CESAER. In the past we joined forces in thematic networks and joint communications on the Bologna process in order to have the engineering voice heard. Today both associations play a major representative role and appreciate the regular exchange of views and experiences at the level of the associations' presidents and the collaboration in specific initiatives on a case-by-case basis. In that respect, the annual Deans' Convention is an example of targeted partnership and good practice.

On the occasion of its 40th anniversary, it is my pleasure to extend best wishes to SEFI and to congratulate the president and the officers of the association on behalf of all CESAER members. We look forward to continue the debate and cooperation between our associations and we wish SEFI all the best for a bright, challenging and successful future.

From the World

From the American Society for Engineering Education - ASEE

Professor Kenneth F. Galloway, President, American Society for Engineering Education (ASEE)
Dr. Norman L. Fortenberry, Executive Director, American Society for Engineering Education (ASEE)

On behalf of the Board of Directors and the membership of the ASEE (American Society for Engineering Education), we extend warm congratulations to the members and to the leadership of SEFI (European Society for Engineering Education) as they celebrate the organization's fortieth anniversary.

SEFI can be most proud of its role in enhancing communication and supporting collaboration and cooperation between the all of the stake-holders in higher engineering education in Europe and SEFI can be most proud of its role in understanding problems and identifying solutions relating to engineering education.

As engineers and engineering educators, it is our responsibility to educate the next generation of engineers. These engineers will contribute to innovation, economic stability, world-wide security, and a better quality of life for us all. The ASEE is proud to join SEFI in this endeavour.

We value our partnership with SEFI and look forward to continue to work with you to support and to improve higher engineering education.

Once again, congratulations to SEFI on forty-years of significant contributions to engineering education.

From the International Society for Engineering Education - IFEES

By Jose Carlos Quadrado, IFEES President 2011-2013

On behalf of the members of the International Federation of Engineering Education Societies (IFEES), I would like to congratulate SEFI on forty years of achievements in higher engineering education in Europe. SEFI has contributed greatly to the advancement of engineering education in Europe, and will continue to have an impact on the region and the world in years to come. As a younger institution, IFEES has benefited from SEFI's experience, particularly in the earlier years of its development, when IFEES leadership was identifying its own mission and strategic objectives, and when society members elected their first president, Claudio Borri, a former SEFI president. Values of the European region have always been represented in IFEES thanks to dedicated members like SEFI. SEFI also contributes to IFEES' effort to broaden its global reach with its extensive European network of students, research, staff and corporations.

We are proud to have had several opportunities to collaborate with SEFI on a global scale, the prime example being in 2011 the joint initiative resulting in the creation of the International Institute for Developing Engineering Academics (IIDEA). Together, the presidents of our respective institutions, one from Puerto Rico and the other from Denmark, turned into reality the idea of providing a world class offering of seminars and workshops, and held their first event in Beijing, China. This one initiative truly exemplifies what IFEES members are able to accomplish in collaboration.

I have been honoured to have served as a both a SEFI vice president and IFEES president, and look forward to the great things to come from these two institutions.

By Hans J Hoyer, Ph.D, Secretary General of IFEES

The Secretariat of IFEES sincerely congratulates SEFI on its fortieth anniversary. Our office has had the pleasure and privilege of working closely with the SEFI Secretariat and individual members of the SEFI community for the last eight years, and hope to continue working together well into the future.

The office of the Secretariat is fortunate to have had support from SEFI during the early years of our organization, with SEFI members helping to guide the strategic direction and objectives of IFEES including contributing to the formation of the Global Engineering Deans Council (GEDC) and IIDEA. During periods of transition, SEFI had also offered much needed help in maintaining the IFEES website and collaborating in the development and maintenance of a global engineering education calendar. It is small, but important gestures such as these that give us confidence that IFEES and SEFI have a strong, trusting partnership and friendship, which is the foundation of any good collaborative work that identifies win-wins.

IFEES' global community of engineering education societies continues to grow, thanks to members like SEFI who are commonly dedicated to the mission of creating well-rounded engineers all across the world.

From the World Federation of Engineering Organisations - WFEO

By Marwan Abdelhamid, President-Elect WFEO, Tahani Youssef, Executive Director WFEO

WFEO and SEFI have had a successful and long–standing relationship, which has benefited the members of both organisations.

WFEO looks to Europe for many reasons in undertaking its prime roles of helping its national members and representing them to world organisations like the United Nations, UNESCO, the World Bank, World Trade Organisation and so on. As far as education is concerned SEFI has been a valuable partner and source of information and contacts in that work.

Europe has provided some of the recent hosts of WFEO's Committee on Education in Engineering (CEIE). For example Hungary and then Poland and even with the current host, Lebanon, there is considerable cooperation between WFEO, SEFI and other European agencies. Speakers at the World Congress on Engineering Education in Beirut, October 2013 exemplify this.

It was particularly pleasing to have the help of SEFI in establishing working relations between WFEO and ENAEE, EUR-ACE, FEANI and the International Engineering Alliance on the Mobility of Engineering Professionals. CEIE has a working group under the same title. SEFI's help has also been very useful in WFEO's facilitating role to encourage cooperation and publicise the work on accreditation and certification of these key international agencies.

WFEO looks forward to a long and fruitful working relationship with SEFI as it works to bring its national members from Africa and South America into contact with European and other agencies. The work of institutional capacity building, improving the education and experience of engineers around the world. The achievement of the Millennium Goals and UNESCO's Engineering Initiatives means much work lies ahead of us.

Cooperation with SEFI will be invaluable in that work.

SEFI is the largest network of higher engineering education institutions (HEIs) and educators in Europe.

It is an international non- profit organisation created in 1973 in Leuven by 21 Engineering faculties to contribute to the development and improvement of Higher Engineering Education (HEE) in Europe, to reinforce the position of the engineering professionals in society, to promote information about HEE and improve communication between teachers, researchers and students, to reinforce the university-business cooperation and to encourage the European dimension in higher engineering education.

Through its membership composed of higher engineering education institutions, academics, students, related associations and companies, SEFI connects over 1 million students and 158000 academic staff members in 48 countries.

To reach its mission and objectives, SEFI implements diverse activities such as Annual Conferences, Ad hoc seminars/workshops organised by its thematic working groups and committees, organises European Engineering Deans Conventions, publishes a series of Scientific publications (European Journal of Engineering Education) and Position Papers, is involved in European projects, cooperates with other major European and international associations and international bodies (European Commission, UNESCO, Council of Europe, OECD). SEFI also participated in the creation of international organisations such as ENAEE, IFEES, Euro-Pace, IACEE, IIDEA and of the European Engineering Deans Council, EEDC.

This book is published in the context of the 40th anniversary of our Society.

For further information

SEFI aisbl, 119 rue de Stassart
B-1050 Brussels
Tel : + 32 2 5023609
info@sefi.be
www.sefi.be

The list of our members is available on www.sefi.be.

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