

Developing Graduate Engineering Skills

SEFI Position Paper

April 2016



SEFI Position Paper

on Developing Graduate Engineering Skills

Introduction



Scientists discover the World that exists; engineers create the World that never was.



Theodore von Karman

The past few years have witnessed a vibrant discussion about the competences, skills and knowledge that engineering graduates should possess to succeed in their future roles as engineers of the 21st century. This discussion takes place globally, and it varies from country to country depending on tradition, education system, make up of industry, etc. It is a complex dialogue between and among engineering education stakeholders, including legislators and governments, accreditation bodies, industry, universities, academics, and students. This SEFI Position Paper is a continuation of the dialogue that SEFI has consistently supported in Europe on engineering education in the context of a continuous world-wide benchmarking.

Engineering is about creating products, processes and systems in response to obstacles and demands, or in pursuit of new ideas and opportunities. Engineering is not something that takes place behind "closed curtains" since the work of the engineer is visible in almost every aspect of society and industry. Engineering is a collaborative, complex activity that demands socio-technical, societal and systems perspective.

Engineering graduates will have to professionally cope with social changes, with new technologies as well as more and more complex problems that need to be solved – all within a global and commercial context. Hence, there is a need for a more complete description of the abilities that graduating engineers should have, and these must include methodological, personal and social competence areas as well as professional skills of conceiving, designing, implementing and operating engineering solutions.

SEFI believes that this Position Paper can link the stakeholders of engineering education in order to create both an opportunity and a space for debate and joint contributions to examine what should be the learning outcomes from an engineering education, and how they are best achieved. SEFI believes that working together with all stakeholders, and across borders, presents the best conditions to examine the European engineering education that prepares engineering graduates for their future roles.

This is in line with the 2015 European Higher Education Area ministerial statement "[we] will therefore build on what we have in common while also enabling individual education systems to draw on their particular strengths and traditions. Diversity and the various aspects of the policy dialogue imply involvement of all levels: regional, national and institutional" (Fourth Bologna Policy Forum, Yerevan, May 2015).



*Each year Europe graduates approximately half a million new engineers.
Let us make them the best they can be.*



SEFI-European Society for Engineering Education

Our Position

Engineers are transforming the world. This is a profound realization. Thus engineers, those who employ them, students and those who educate them, should deliberate seriously on their responsibility in this transformation. Engineering education is about creating the future. Thus engineering education must embrace more than technical skills in order to better enable engineering students to understand the magnitude and context of their future role. Recognising that there are regional variations in definitions, needs and priorities for engineering graduates, there are a number of **key common issues within the formation and education of the engineer** that SEFI supports. These are:

- The world changes fast. The engineering graduates should have the skills to function and thrive, and be comfortable in their **ability to adapt** as their working world continually changes on a local and international scale. Consequently, engineering curricula should support this by developing innovative, entrepreneurial and social skills within the engineering graduate.
- Humankind continues to try to balance technological development and growth with the consequential environmental and social challenges these generate. The role of the engineer in helping to address this balance is central to all of our futures. Therefore, engineering education must **broaden the engineer** in addition to providing a deep technological knowledge. Critical thinking, creative thinking, reflective thinking, systems thinking, and synthesis capabilities of novel solutions are necessary attributes that every engineer should possess, and engineering graduates should develop a deep understanding of ethics and sustainable development.
- Higher engineering education institutions should embrace **diversity** both in the students they attract and the staff they employ. Diversity is one very important factor for delivering innovative, sustainable and well-designed solutions for industrial and societal needs.
- Engineering **graduate mobility and engineering programme comparability** are important elements of the quality of engineering education, albeit they are not the only indicators of programme quality. Mobility and comparability are facilitated through various instruments such as the Bologna Declaration, European Qualifications Framework (EQF), and EUR-ACE Label. Across Europe there is no consensus in structuring engineering education, but rather a constructive diversity in programme design, which can make comparisons difficult and be an obstacle to student mobility. This reflects the need for both EQF level 6 and level 7 engineering degrees (first/second cycle, bachelor/master level).
- Greater attention must be paid to academic staff development and support. Just as the practice of engineering is changing rapidly, the attitude of new generations of students is also changing, and digital learning methods offer a multitude of possibilities. The complex challenge of educating the engineering students of the 21st century continues to evolve. Consequently, due consideration must be given to **how our academic staff are equally evolving and supported as educators**, and how to enhance their ability to teach, coach, supervise and inspire student learning, and the development of an engineering identity within our graduate engineers.
- The education of the engineer should not stop after completion of the first or second cycle. Within their first cycle degree, the engineering student must learn how to learn, and that **learning is for life**. The state-of-the-art today is yesterday's news tomorrow.
- Industrial practices are continuously evolving. Therefore it is critical to cultivate and strengthen the **relationship and exchange of know-how between industry and academia** – between professionals and educators. Programme learning outcomes must be validated by industry stakeholders in order to ensure the understanding of engineering principles and practices in graduate engineers. This is a crucial factor for competitiveness.

SEFI now wishes to initiate a European wide discussion about engineering skills and how the various stakeholders can contribute to their development. To that end, European institutions and national authorities must be able to articulate policies across different constituents. SEFI is willing to contribute to such orientation and take a lead in ensuring the best possible set of qualifications for the European engineer of the 21st century.

A continuing discussion

SEFI invites comments and feedback on this Position Paper. A longer discussion paper will be developed by the SEFI Working Group on Engineering Skills, chaired by Professor Kamel Hawwash. Members of SEFI interested in joining the working group are invited to contact info@sefi.be.

SEFI is the largest network of higher engineering education institutions (HEIs) and engineering stakeholders in Europe. As an international NGO created in 1973, SEFI contributes to the development and improvement of HEE in Europe, reinforces the position of the engineering professionals in society, promotes information about HEE and improves communication between teachers, researchers and students, reinforces the university-business cooperation and encourages the European dimension in higher engineering education. SEFI is an international Forum composed of HEIs, academic staff and teachers, students, related associations and companies in 48 countries.

Our activities: Annual Conferences, *ad hoc* seminars/workshops organised by our working groups, councils and *ad hoc* committees, organisation of the European Engineering Deans Conventions, Scientific publications (including the European Journal of Engineering Education), European cooperation projects, position papers, cooperation with other major European associations and international bodies such as the European Commission, the UNESCO, the Council of Europe or the OECD. SEFI also participated in the creation of several organisations such as ENAEE, IFEEES, EuroPace, IACEE, IIDEA, and of the European Engineering Deans Council that was integrated within SEFI in 2015.

This Position Paper was finalised under the lead of:

Dr. Mike Murphy, SEFI, Chair EEDC, Dublin Institute of Technology

Prof. Kamel Hawwash, President of SEFI (2013-2015), University of Birmingham

Prof. Martin Vigild, President of SEFI (2015-2017), Technical University of Denmark

Mr. Xavier Fouger, Member of SEFI Board of Directors, Dassault Systèmes

SEFI would like to offer its thanks to all those from our community who actively contributed in the creation of this Position Paper which could not exist without their assistance.

SEFI is based in Brussels. For further information please contact:



39, rue des Deux Eglises
1000 Brussels – Belgium
Tel : + 32 2 502 36 09

info@sefi.be
www.sefi.be

SEFI receives the financial support of its corporate partners

