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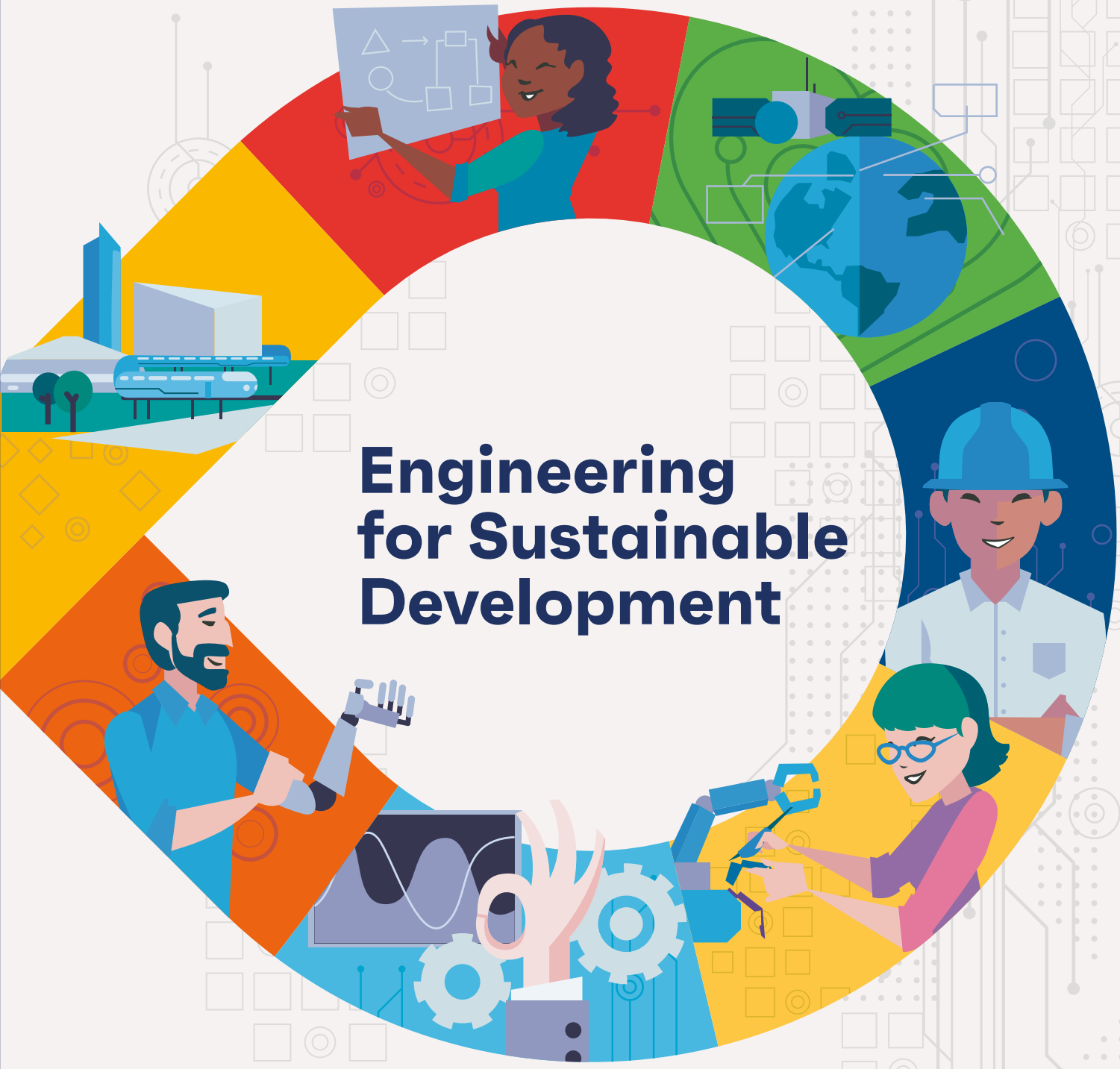

Engineering for Sustainable Development

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Engineering for Sustainable Development

Delivering on the Sustainable Development Goals

SHORT SUMMARY

Engineering the SDGs

The report highlights the crucial role of engineering in achieving each of the 17 SDGs. It shows how equal opportunities for all is key to ensuring an inclusive and gender balanced profession that can better respond to the shortage of engineers for implementing the SDGs. It provides a snapshot of the engineering innovations that are shaping our world, especially emerging technologies such as big data and AI, which are crucial for addressing the pressing challenges facing humankind and the planet. It analyses the transformation of engineering education and capacity-building at the dawn of the Fourth Industrial Revolution that will enable engineers to tackle the challenges ahead. It highlights the global effort needed to address the specific regional disparities, while summarizing the trends of engineering across the different regions of the world.

It is essential that more young people, especially girls, consider engineering as a career

By presenting case studies and approaches, as well as possible solutions, the report reveals why engineering is crucial for sustainable development and why the role of engineers is vital in addressing basic human needs such as alleviating poverty, supplying clean water and energy, responding to natural disasters, constructing resilient infrastructure, and bridging the development divide, among many other actions, leaving no one behind.

It is hoped that the report will serve as a reference for governments, engineering organizations, academia and educational institutions, and industry to forge global partnerships and catalyse collaboration in engineering so as to deliver on the SDGs.

UNESCO

'Since wars begin in the minds of men and women it is in the minds of men and women that the defences of peace must be constructed'

Table of Contents

José Vieira[15] and Eli Haugerud[16]

4.3 ENGINEERS' CONTINUING PROFESSIONAL DEVELOPMENT

15 President-elect, World Federation of Engineering Organizations (WFEO).
16 Chair of European Monitoring Committee (EMC), European Federation of National Engineering Associations (FEANI).

Abstract. The challenging environment of continuous technological evolution requires skilled and competent engineers who can contribute towards achieving the United Nations Sustainable Development Goals and who can strive for innovative and sustainable solutions. To be able to do so, engineers should continuously acquire new knowledge and skills, and update their existing skills to incorporate individual and team competencies. Continuing Professional Development (CPD) can play a fundamental role in adapting the engineer to technological innovations and new working methods to better fulfill his or her commitment to society. In this regard, engineering professional certification systems could be of paramount importance for the recognition of engineering qualifications and professional competencies worldwide by establishing minimum requirements of knowledge, skills and competencies for the engineering profession.

Trends and challenges affecting the engineer

Engineers are situated as potential problem solvers able to work towards achieving the 17 SDGs through the application of an innovative and solution-based approach (UN, 2020). To be able to contribute to a future-looking environment, engineers need to update their competencies in terms of skills, knowledge and experiences (IACEE[17]). A lot of the basics in engineering remain the same, but additional competencies and trends need to be met and addressed accordingly by engineers themselves, but also by the engineering profession as a whole. This, together with increased migration (EC, 2017; Trevelyan and Tilli, 2011), is relevant in order to assess the competencies needed for a sustainable future.

There are also megatrends that are relevant for the engineer and engineering's role. These trends are automation, Artificial Intelligence (AI) and digitalization (CEDEFOP, 2020*a*). The implications of digitalization might result in new forms of work and learning, such as platform or gig work, or remote ICT-based work (CEDEFOP, 2020*b*). Digitalization will transform engineering practice into a new paradigm, which is network-based, data driven and AI empowered.

The role of the engineers will thus change and end up higher or lower in the competency hierarchy, which may lead to a polarization of the labour market and a mismatch of skills.

In order to remain professionally competent in this world of constant change, engineers must continuously acquire new knowledge and skills, and update their existing skills to integrate individual and team competencies (WEF and BCG, 2018). CPD can be defined as the intentional maintenance and development of the knowledge and skills needed to perform in a professional context. This could mean honing current skills or developing them to a new level, or it could mean learning new ones that expand an employee's role, or that prepares them for potential promotion (CPD, 2020). CPD for engineers comprises both the acquisition of new capabilities to broaden competency and the enhancement of existing capabilities to keep abreast of evolving technology and its application. It is noteworthy that CPD is not just for updating and upgrading the technical knowledge and skills of engineers, it is also for deepening the understanding of sustainable development and its goals, and for promoting the awareness of ethical codes that evolve along with the social and technical development of engineers.

How to work with CPD

CPD is essential for the maintenance of high professional standards, and it enhances the employability and mobility of individual engineers. It assists career progression and strengthens professional satisfaction. It is the individual's responsibility to engage with CPD, but it requires the cooperation, encouragement and support of employers and professional and academic institutions. To be most effective, CPD has to be planned and related to specific objectives. It is essential to reflect on what has been learned to enable an individual's Competency Development Plan to be periodically updated.

To contribute towards enhanced use of CPD, national institutions and authorities must highlight the key role of qualified professional engineers for economic growth and the development of society. Companies, universities, professional organizations and other engineering entities must be encouraged to invest in CPD. Quality CPD must be encouraged alongside innovative practises in learning and good examples and best practices to help others find relevant ways to CPD (FEANI, 2020).

There is a continuing need for CPD for engineers to maintain and develop their professional competencies. In this regard, individual engineers are encouraged to:

- Recognize the importance of CPD for their career, employability and mobility, as well as their

17 International Association for Continuing Engineering Education official website: www.iacee.org

professional satisfaction and well-being at all ages and stages throughout their career.

- Take active ownership of their professional and personal development and invest in CPD. At a personal level, they should establish a Competency Development Plan and a broad idea of a career goal.
- With the employer, negotiate a CPD plan that is realistic and builds competencies in a systematic way, ensuring good execution of tasks and enabling career development.
- Actively work towards realizing the CPD plan. Systematically record CPD activities and achievements so that maintaining and/or developing professional competency can be demonstrated, and if needed, the competency acquired may be assessed and acknowledged.
- Strive for quality in personal CPD, as well as in the use of a variety of methods, e.g. formal courses/programmes, academic studies, professional visits, on-the job-learning.

In countries where access to professional engineering activities is subject to mandatory registration, it is already common practice to recognize and value engineers' CPD achievements in maintaining their professional status. In general, the evaluation is done through the attribution of CPD credits acquired through different types of activities: developmental, work-based and individual (ASCE[18]; EA[19]; ECSA[20]; ECI[21]; ENGC[22]).

Engineering professional certification systems

National qualifications frameworks (NQFs) have been adopted worldwide as instruments to classify a country's qualifications at different levels. Significant efforts have also been made to establish regional qualifications frameworks in order to compare skills and qualifications internationally (CEDEFOP/ETF/UNESCO/UIL, 2020). However, there is still a long way to go to establish international mechanisms for the recognition of professional skills and competencies in engineering.

The quality of engineering education is usually ensured at the national level through accreditation granted by governmental institutions or professional associations. However, for educational, social and political reasons, the recognition of engineering degrees at the international level is a complex and highly sensitive issue that hinders the mobility of professionals. Even in areas of high political integration, such as the European Union, there are still great difficulties in the mutual recognition of diplomas. Some initiatives to facilitate mutual recognition have been successfully developed by professional associations through multilateral agreements, such as the European Network for Accreditation of Engineering Education[23], and the International Education Alliance[24].

Efforts to establish continuing engineering education programmes have been developed the world over. A wide variety of teaching methods, including face-to-face or online courses, have been adopted in lifelong learning activities across different geographies: Europe and the United States (Dutta, Patil and Porter, 2012), Africa (Kirkland, Vitanov and Schaefer, 2007), China and India (Li, 2012; Singh, Sarkar and Bahl, 2018). However, there is no standard worldwide accreditation process that allows for easy mutual recognition of CPD quality and integration for engineers.

Globalization of labour markets, mobility of students and workers, increased migration, automation, digitalization, polarization of the labour market and skills mismatch are some of the challenges that engineering faces globally in making significant progress achieving the SDGs. In this context, the development and implementation of Engineering Professional Certification Systems (EPCS) could be of paramount importance for the recognition of engineering qualifications and professional competencies worldwide by establishing minimum requirements of knowledge, skills and competencies for the engineering profession.

To be an accepted, effective and useful mechanism, EPCS must respect both nationally and internationally established systems and provide confidence in quality assurance for three essential pillars: engineering education, professional competencies, and CPD and lifelong learning. Details of EPCS are given in Box 1.

Recommendations

- Work towards the development and implementation of Engineering Professional Certification Systems that could be of paramount importance for the promotion of CPD and for the recognition of engineering qualifications and professional competencies worldwide.
- Encourage employers to invest in their engineer's CPD in terms of innovation and sustainable solutions so as to ensure that their employees remain relevant and that their company's competencies are up to date.
- Encourage engineers to take an active role in their CPD to ensure their employability and mobility.

18 American Society of Civil Engineers official website: https://www.asce.org/continuing-education/
19 Engineers Australia official website: www.engineersaustralia.org.au/
20 Engineering Council of South Africa official website: www.ecsa.co.za
21 Engineering Council of India official website: www.ecindia.org
22 Engineering Council official website: www.engc.org.uk/professional-development/continuing-professional-development-cpd
23 European Network for Accreditation of Engineering Education official website: www.enaee.eu
24 International Engineering Alliance official website: www.ieagreements.org

Box 1. Engineering Professional Certification Systems (EPCS)

Characteristics of an EPCS:

- Engineering education and professional experience combine to meet a required level of engineering capacity.
- The EPCS must be based on quality assurance and values.
- The initial formal education of engineers typically takes place in universities, universities of applied sciences and technical colleges. This may take the form of first-cycle, second cycle or integrated programmes, which have either an applications-oriented or conceptual/theoretical-oriented profile.
- Professional competency does not describe the learning process of the individual but it instead assumes that learning has taken place. This may be the result of several individual pathways of non-formal or informal learning processes. For the sake of measurement/assessment, it is necessary to demonstrate the learning outcome.
- Learning outcomes and competencies integrate CPD and must be assessed and verified.

Importance of an EPCS:

- It establishes minimum requirements of knowledge, skills and competencies for the engineering profession.
- It contributes towards mutual recognition of engineering education and engineering professional capacity at a global scale.
- It facilitates mobility for professionals under a shared and accepted system in an ever-increasing scenario of economic globalization and continuous advances in technology.
- It respects established systems both nationally and internationally.

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