

Engineering our way to a culture of continuous learning



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Introduction

Industries that rely heavily on engineering expertise are undergoing rapid transformation. As we progress through the digital age, engineers are seamlessly blending the digital realm with the physical world to enhance productivity, safety, sustainability, and, ultimately, our quality of life. In addition, increasingly complex engineering systems necessitate the integration of a wide range of other disciplines from both within and outside of the engineering domain. Engineers need to respond to these ongoing developments with continued learning throughout their careers.

Other spotlights in this report have highlighted challenges that require engineering skills, ranging from the mining industry to AI. This spotlight explores how we can tackle these and future challenges by promoting a culture of continuous learning.

A culture of continuous learning is defined as an organisational environment where ongoing opportunities for individuals to cultivate knowledge, skills and abilities are actively encouraged throughout their careers.¹ This culture is characterised by a commitment to learning, growth and adaptability, which fosters the agility and flexibility crucial for adapting to changing circumstances, including the introduction of new technologies and new challenges brought about by population growth, demographic changes, environmental changes, and more.²

While all stakeholders in the engineering capacity ecosystem need to adapt, respond to, and learn in the face of rapid technological and societal change, this spotlight focuses on continuous learning opportunities within the engineering profession. According to the Institution of Engineering and Technology, adaptability and continuous learning are some of the skills most needed by engineers today.³ Embedding this within engineering culture is therefore critical.



¹ How To Foster a Culture of Continuous Learning, Goel, A. Forbes, 4 May 2021 at <https://www.forbes.com/sites/forbesbusinessdevelopmentcouncil/2021/03/04/how-to-foster-a-culture-of-continuous-learning/?sh=36689c88296c> (retrieved 17 April 2024).

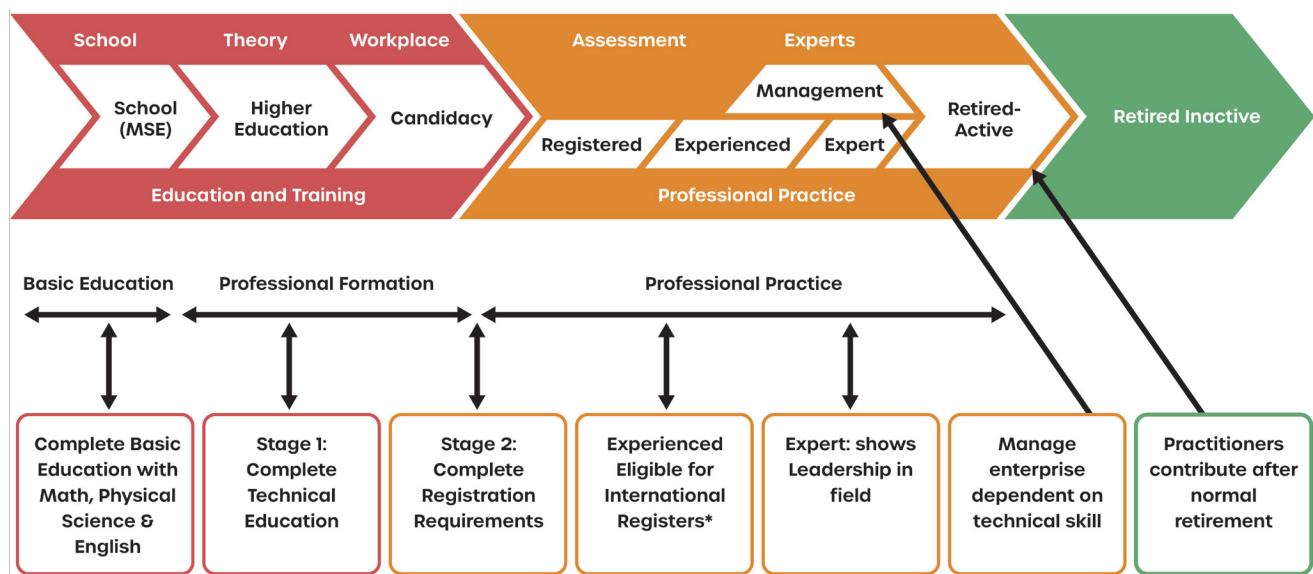
² Ibid.

³ The skills most in demand for engineers, The Institution of Engineering and Technology, 12 Oct 2023 at The skills most in demand for engineers (theiet.org) (16 April 2024). Other critical skills include problem solving, communication and ethical judgement.

Learning opportunities throughout the engineer's career

Throughout the engineer's career journey, there are many opportunities to learn, grow and adapt skills.

Figure 1: Example career progression of the professional engineer in South Africa



Internships, apprenticeships, on-the-job training, micro-credentialing, and continuing professional education are various forms of training aimed at upskilling emerging, new and experienced professionals. Internships and apprenticeships are primarily targeted at students and entrylevel professionals, while micro-credentialing and on-the-job training can cater to all experience levels. Continuing professional education and continuing professional development tend to be more focused on experienced professionals.

Internships and apprenticeships can complement formal education by providing valuable opportunities for engineering students

to apply their knowledge in their prospective fields.⁴ Internships are typically short-term and may be unpaid in some countries, whereas apprenticeships tend to last longer, ranging from 6 months to 3 years, and are usually paid roles with on-the-job training.

Micro-credentials are commonly offered by higher education institutions, national standards bodies and skills organisations, often in partnership with industry. They consist of certified short courses that can be taken by students, graduates and experienced engineers alike, and are a useful tool for increasing responsiveness

⁴ Good practices in Apprenticeships in South-Africa: Challenges and Opportunities, International Labour Organisation, 2022, pp. 34 at <https://www.ilo.org/publications/good-practices-apprenticeships-south-africa-challenges-and-opportunities> (retrieved 12 May 2025).

to evolving industry needs. They provide greater, more flexible access to learning opportunities and can reinforce ethics and safety standards.⁵ Some micro-credentials are 'stackable' and can contribute to a degree qualification, which helps students and those looking for a career change to build their skills without the financial and time commitment of a full-time degree programme.⁶

Continuing professional education is commonly in the form of structured courses, workshops

and conferences offered by private training providers, industry associations or professional bodies, and can be in partnership with academic institutions. In some countries, these allow engineers to fulfil the prerequisites for registration and licensing, as well as to keep up with changes in technology, policy and regulation. They serve as a valuable means for engineers to remain abreast of the latest advancements in their field and can include technical and social or professional skills.

What key roles do professional engineers, government and industry play to ensure a culture of continuous learning?

Professional engineers, government bodies, the engineering industry, and regulatory bodies need to adapt to rapid advances in technology and safety; therefore, all play a role in creating and adopting a culture of continuous learning. The next section will explore the roles and responsibilities of each stakeholder group in creating a culture of continuous learning within engineering. It is important to note that these groups and their capacities are interconnected and require coordination and partnership to work effectively.



The professional engineers' stakeholder group includes engineers in industry as well as in research and higher education institutions. Individual engineers are responsible for pursuing their own continuous learning journey and

finding opportunities to keep up with advances in their field.⁷

From the outset, aspiring engineers and technicians should aim to achieve qualifications that meet the International Engineering Alliance's (IEA's) international benchmarks, which ensure that engineers and technicians at various levels all over the world meet the same minimum competency requirements to contribute effectively to their field.⁸ The

⁵ Improving the Quality of Engineering Education and Training in Africa, World Bank, 2014, at <https://documents1.worldbank.org/curated/en/773831468007776683/pdf/860620BRIOWBOH00Box382147B00PUBLIC0.pdf> (retrieved 12 May 2025).

⁶ Small But Mighty: Why Micro-Credentials Are Huge for The Future of Work, Perna, M, Forbes, 5 October 2021 at <https://www.forbes.com/sites/markcperna/2021/10/05/small-but-mighty-why-micro-credentials-are-huge-for-the-future-of-work/?sh=745adcd0302b> (retrieved 19 April 2024).

⁷ Understanding the Educational and Career Pathways of Engineers, National Academy of Engineering, Washington, DC: The National Academies Press, 2018, at <https://nap.nationalacademies.org/read/25284/chapter/5#64> (retrieved 17 April 2024).

⁸ The benchmarks are laid out for the three professional tracks: engineer, engineering technologist, and engineering technician.

attributes and competencies required by the benchmarks include problem solving, application of engineering theory and practice, use of technologies, sustainable development, diversity and inclusion, ethics, and continuing professional development and lifelong learning. The IEA encourages institutions offering engineering to seek accreditation from recognised bodies to ensure that programmes meet rigorous standards, promoting quality education and lifelong learning.⁹

The IEA also advocates for a lifelong learning mindset by encouraging engineers to become members of professional bodies and register with their relevant professional regulators, which in turn sets an expectation of continuing learning. Through participation in and membership of professional engineering organisations, engineers gain access to continuous learning opportunities. This allows them to stay updated on industry trends and advancements through workshops, conferences, seminars, and mentorship programmes.¹⁰ Mentorship in particular can be an effective way to foster a culture of continuous learning as experienced professionals pass on their knowledge while students and early-career engineers bring new questions and perspectives that can help mentors further refine their skills.¹¹

Hands-on practical training is a critical part of continuous learning. However, this may be more challenging in resource-constrained environments. Simulations can offer a useful and potentially less resource-intensive approach to maintaining practical, relevant skills, such as safety skills. The COVID-19 pandemic accelerated the adoption of simulations and showed that hands-on training does not necessarily require physical presence. Increased use has provided greater evidence of its effectiveness, but has also highlighted potential limitations, such as the inability to effectively build the social skills and human interaction that are integral to engineering.¹² Upfront costs for developing simulation tools may also be prohibitively expensive. Nevertheless, simulations remain a valuable tool for both practical continuous learning and the testing of designs, offering the advantages of enhanced safety and, in the long-term, cost-effectiveness.¹³

While the professional engineers are the ones doing the continuous learning, the other stakeholders in the engineering capacity ecosystem have important contributions to make to foster this culture.

⁹ Graduate Attributes and Professional Competences. Version 4, International Engineering Alliance, 21 June 2021, at <https://www.ieagrements.org/assets/Uploads/Documents/IEA-Graduate-Attributes-and-Professional-Competencies-2021.1-Sept-2021.pdf> (retrieved 12 May 2025). Note, accreditation helps ensure that programs maintain high standards, including well-equipped labs.

¹⁰ Engineers can earn professional development units (PDUs) by participating in these relevant activities, which also contribute to maintaining professional competence.

¹¹ The Benefits of Mentorship for Engineers. PDH Classroom, at <https://pdhclassroom.com/articles/benefits-of-mentorship-for-engineers> (retrieved 18 April 2024).

¹² Efficacy of Clinical Simulation-Based Training in Biomedical Engineering Education, Singh, A., Ferry, D. and Balasubramanian, S., J Biomech Eng, 27 Nov 2019, at <https://pmc.ncbi.nlm.nih.gov/articles/PMC7104742> / (retrieved 14 April 2025).

¹³ Simulation In the Engineering Field: Benefits and Challenges, Gopal, A., Forbes, 8 October 2020, at <https://www.forbes.com/councils/forbestechcouncil/2020/10/08/simulation-in-the-engineering-field-benefits-and-challenges> / (retrieved 20 November 2023).

Government

Having a workforce of engineers that are incorporating the latest technologies and safety standards into their design, testing, implementation, and inspection processes is in the national interest. The government can encourage, enable, regulate, fund, and in some cases implement educational and training programmes.

Government regulations on quality, ethics and safety standards can steer educational institutions and training providers at all levels to develop their curricula towards awareness of and compliance with these regulations. Government can also require appropriate engineering credentials and licensing that help ensure the highest standards are met when awarding public contracts. For example, in the US, government contracts often require engineers to be licensed Professional Engineers (PE). To obtain a PE licence, engineers must typically complete a four-year engineering degree, gain relevant work experience, pass the Professional Engineering exam, and then continue to upgrade their skills through lifelong learning.¹⁴

Indonesia requires engineers who wish to work on government contracts to be registered with

the Indonesian Engineers Association (Persatuan Insinyur Indonesia, or PII), the professional organisation responsible for regulating the engineering profession in the country. This registration demonstrates that the engineer has met the necessary educational, experience and ethical requirements to perform engineering work at a professional level.¹⁵

In the UK, a fire in the high-rise Grenfell Tower block resulted in numerous deaths and casualties, and exposed poor practices in building design, maintenance and regulation.¹⁶ In response, the government has created the Building Safety Regulator, a new body that will regulate higher-risk buildings, raise safety standards and help build professional skills in design, construction and building control.¹⁷ The new regulations will encourage a culture of continuous learning through industry-led competence frameworks and requiring adherence to more stringent guidelines from stakeholders including contractors, developers and building managers.

In addition to setting policies around safety standards, licensing and registration,¹⁸ governments can also directly encourage and fund training programmes, such as apprenticeships for engineers. Ireland's Apprenticeship Action Plan 2021–25 aimed to expand the type and number of apprenticeships to 10,000 per year by 2025. Through the Irish government's Department of Further and Higher Education, Research, Innovation and Science, extra financial support and other mechanisms help learners and employees take up these

¹⁴ What is a PE?, National Society of Professional Engineers, at <https://www.nspe.org/about/about-professional-engineering/what-pe> (retrieved 14 April 2025).

¹⁵ Requirements for Provision of Professional Services – Engineering Services, ACPECC Secretariat, Republic of Indonesia, 2012 at 03-licensing-_-registration-rules--engineering--indonesia--ccs-65-7ncjpHL.pdf (retrieved 25 April 2025).

¹⁶ New Building Safety Regulations in the UK Construction Industry: The Post-Grenfell Era, KE Fibretec, 14 August 2024 at <https://www.ke-fibretec.com/uk/news/new-building-safety-regulations-the-post-grenfell-era/> (retrieved 12 May 2025).

¹⁷ Fire safety rules for blocks of flats since the Grenfell Tower fire (England), House of Commons Library, 14 May 2024, at <https://commonslibrary.parliament.uk/fire-safety-rules-for-blocks-of-flats-since-the-grenfell-tower-fire-england/> (retrieved 12 May 2025).

¹⁸ It should be noted that industry associations create standards and typically are the licensing body, while governments can require licensure.

apprenticeships.¹⁹ In November 2023, two new apprenticeship programmes in Civil Engineering were announced under the scheme. These programmes currently include a two-year 'Higher Certificate' and a three-year Bachelor of Engineering. Future phases will introduce more advanced programmes, completing the progression from higher certificate to master's level. The delivery model combines online lectures, campus labs and workplace learning.²⁰

Other examples of support that government ministries can provide include registered apprenticeship systems or platforms, such as the UK government's 'Find an Apprenticeship in England' website²¹ or the US' apprenticeship²² gov website. The Nafis programme in the United Arab Emirates encourages companies to take on apprentices by providing help to cover their salary costs.²³

Many governments recognise that engineers play a vital role in economic growth, from building and maintaining the infrastructure that economic activity relies on to developing the innovations that improve quality of life and propel society to new levels of productivity. Therefore, it is in the national interest to seek ways to collaborate with industry, educational institutions and training providers that offer opportunities for continuous learning and development, to ensure the engineering workforce has the skills to meet the current and future engineering challenges that countries face.



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¹⁹ Action Plan for Apprenticeship, 2021 to 2025, Department of Further and Higher Education, Research, Innovation and Science, 17 Feb 2022, at <https://www.gov.ie/en/department-of-further-and-higher-education-research-innovation-and-science/publications/action-plan-for-apprenticeship-2021-to-2025/> (retrieved 23 April 2024).

²⁰ Press release: Minister Harris announces two new construction apprenticeship programmes in Civil Engineering, Department of Further and Higher Education, Research, Innovation and Science, 13 November 2023, at <https://www.gov.ie/en/press-release/11328-minister-harris-announces-two-new-construction-apprenticeship-programmes-in-civil-engineering/> (retrieved 18 April 2024).

²¹ Find an Apprenticeship, GOV.UK, at <https://www.gov.uk/apply-apprenticeship> (retrieved 12 May 2025).

²² ApprenticeshipUSA, US Government, at <https://www.apprenticeship.gov/> (retrieved 12 May 2025).

²³ NAFIS Platform, at <https://nafis.gov.ae/> (retrieved 12 May 2025).

Engineering industry

Finally, the engineering industry, professional bodies and industries that rely on engineering, play a critical role in fostering the culture of continuous learning. This can include company-level training programmes as well as a range of partnership models between industry, academia, regulatory bodies, and professional engineering institutions, which help ensure access to continuous learning opportunities.

An example of an effective partnership that is encouraging continuous learning is between Bosch Ulwazi, a South African consulting engineering and project management company and a subsidiary of the Bosch Holdings group, and the Engineering Council of South Africa (ECSA). ECSA has endorsed the Bosch Ulwazi Engineer-in-Training (EIT) programme as its first certified training academy where candidates learn how to apply their theoretical knowledge in the workplace on a daily basis. The programme runs over a three-year period after candidates have completed a university qualification. It provides “graduates with relevant and applicable work experience, together with mentorship, to enable them to meet the requirements for registration and achieve professional status with ECSA.”²⁴ Microcredentials are an effective way to encourage a culture of continuous learning. They are often delivered through partnerships, harnessing the knowledge, real-world examples, and latest technology from industry, and the resources, research advancements and pedagogical knowledge from aca-

demia. Advisers from industry help ensure the courses are regularly updated, focused on job roles and quicker to respond to the changing needs of the market, while partnerships with professional and accreditation bodies can offer support with certification requirements.

For example, Engineers Australia is the national accreditation body for Australian tertiary education programmes and is responsible for ensuring they meet international standards.²⁵ In addition, Engineers Australia offers microcredentials developed in collaboration with industry and designed to measure and assess results in the workplace. Each microcredential is aligned to industry standards of practice or to a recognised framework. These include micro-credentials on Implementing Safety in Design, Contract Management for Engineers and sector-specific courses such as Develop Rail Track Alignment Design.²⁶ Similarly, the College of Engineering, Design and Computing at Colorado University Denver in the US offers interdisciplinary micro-credentials to provide students and working professionals an opportunity to upskill and gain new qualifications with in-demand emerging skills such as reliability engineering, electric vehicle technology and quantum computing.²⁷

Other mechanisms for upskilling via industry-academia partnerships include providing access to laboratory equipment or laboratory donations, research partnerships and industry-sponsored capstone projects, where students tackle a real challenge faced by industry. In some instances, industry invests significantly

²⁴ Company endorsed as first certified training academy, Mavuso, Z, Engineering News, 8 April 2022, at <https://www.engineeringnews.co.za/article/company-endorsed-as-first-certified-training-academy-2022-04-08> (retrieved 21 April 2024).

²⁵ Australia is a full signatory to all three accords of the International Engineering Alliance: Washington Accord for professional engineers, Sydney Accord for engineering technologists and Dublin Accord for engineering associates.

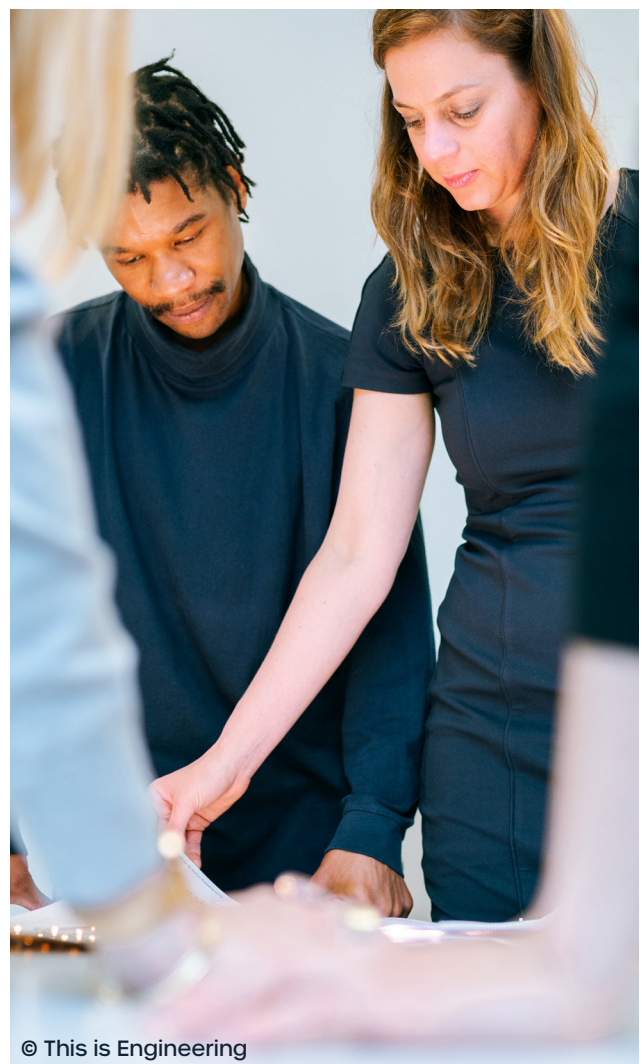
²⁶ Micro-credentials, Engineers Australia, at <https://www.engineersaustralia.org.au/learning-and-events/micro-credentials> (retrieved 25 May 2025).

²⁷ Engineering micro-credentials, University of Colorado Denver, at <https://engineering.ucdenver.edu/academics/micro-credentials> (retrieved 25 May 2025).

in collaborative research centres in partnership with higher education institutions. All these engagements with universities provide industrial engineers with access to the latest developments in research and higher education, informal learning opportunities through engaging with academics and students, and opportunities for academics and future engineers to experience real-life industry challenges. The Royal Academy of Engineering's Transforming Systems through Partnership (TSP) programme facilitates partnerships between universities, large companies, SMEs, and startups to address sustainable development goals.²⁸ Among other outcomes, these partnerships provide opportunities for engineers from industry and academia in different countries to collaborate, share knowledge, build their skills, and learn from each other while also helping to update university courses with industry inputs to equip the next generation with skills for the future.

Finally, bootcamps are short intense programmes (often up to 20 weeks) offered by a range of companies and higher education institutions. They provide an opportunity for upskilling or reskilling for people at all levels of experience and may come with support to access jobs for successful participants. Bootcamps may be government backed, as in the UK, which is using these to help boost in-demand skills including software development, data engineering, heat pump technology, and construction, with a guaranteed job interview offered after completion.²⁹ In South Africa, the University of Cape Town has partnered with Umuzi, a digital training provider, and various South African

corporates to offer a Digital Bootcamp to provide new job opportunities in a high demand sector for students whose studies have been interrupted, or for graduates who have not found a job after three or more years.³⁰ Digital skills bootcamps, particularly for coding, have become a multimillion-dollar industry, with in-person and online courses offered by numerous training providers and companies requiring few to no previous skills and often providing a more accessible and cost-effective learning route than a degree.



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²⁸ Engineering X Transforming Systems through Partnership: Transforming Systems through partnership.

²⁹ Skills Bootcamps, Department for Education, at <https://www.skillsforcareers.education.gov.uk/pages/training-choice/skills-bootcamp> (retrieved 12 May 2025).

³⁰ UCT Digital Bootcamp – Umuzi (retrieved 26 June 2025).

Conclusion

Twenty-first century global challenges and rapid advances in technology are placing increasing demands on engineers and technicians to update their skills. Strategic partnerships between industry companies, professional bodies and educational institutions are needed to foster a culture of continuous learning throughout professional careers. When actors across the engineering ecosystem partner together to support engineers and technicians on their learning journey, a culture of continuous learning can take hold. Reciprocal relationships can develop, with professional engineers providing mentoring and guidance for the next generation while younger engineers bring new technologies and the latest thinking from education into industrial environments. Through collaborations and partnerships, the engineering industry offers practical experiences and insights into current challenges and needs. Expert communities, through professional bodies and academic institutions, can set advisory guidelines and shape practical training programmes to meet current and future industry demands.

The partnerships highlighted in this spotlight demonstrate the interdependence of the three stakeholder groups in creating a culture of continuous learning throughout the engineer's career. This engineering ecosystem is vital to continuously build overall engineering capacity to provide safe, sustainable and efficient solutions to meet the ever-changing demands and challenges of our world.



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