

EMPOWERING LIFELONG LEARNING: BUILDING FLEXIBLE PATHWAYS IN ENGINEERING EDUCATION

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ABSTRACT

Lifelong learning is becoming increasingly essential as professionals seek continuous development and society urges higher education to define new models that support those in the workforce. At Dutch universities, including the University of Twente, there is growing recognition that the traditional 'one-time education' model no longer suffices. At the Faculty of Engineering Technology (ET), we are building a strategic approach to lifelong learning (LLL) that supports professionals in upskilling and reskilling throughout their careers, while ensuring our educational offerings remain relevant, flexible, and aligned with societal needs.

This is a practice paper that shares the steps we are taking to develop a faculty-wide LLL framework, based on internal reflection, stakeholder collaboration, and early implementation experiences aligning it with our university's ambitions.

Our LLL strategy builds on the faculty's strong research foundation and MSc programmes, and has been shaped through internal interviews and external collaborations. We have identified three key models for professional education:

- Participation in master's-level courses
- Masterclasses and tailor-made programmes
- Engineering Doctorate (EngD) pathways for professionals

We are currently focusing on opening up MSc-level courses to professionals, who can enrol in full or partial modules with master's courses that align with our research themes, such as water management, maintenance engineering, sustainable energy technology, and high-tech equipment design. We are also expanding our masterclass and customised programme offerings, which provide compact, targeted learning opportunities for professionals. These are often co-developed with external partners and can act as standalone training or as introductions to more advanced study. The Engineering Doctorate (EngD) programme offers another promising route for professional learners. Traditionally a full-time, post-master's track, we are extending it with part-time variants that better serve working professionals and deepen cooperation with industry on applied innovation.

Across these formats, our aim is to embed LLL into core faculty activities; not as a separate track, but as an integrated extension of education, research, and societal impact. This

includes improving internal processes at both faculty and university level, creating sustainable support structures, and aligning with funding opportunities through employer engagement and public programmes.

By expanding access and flexibility, our faculty seeks to build a robust LLL offering that supports professionals, strengthens partnerships, and amplifies the impact of our research and education.

DRIVERS OF CHANGE: SOCIETY, LABOUR MARKET, AND THE EVOLVING ROLE OF UNIVERSITIES

The demand for LLL becomes more urgent in the face of accelerating technological advancement, demographic shifts, and complex societal challenges. Labour markets are undergoing significant transformations for example, in automation, digitalisation, and the green transition. This is reshaping the skills required across many sectors. Workers must continuously update their knowledge and competencies to remain employable and productive. In parallel, societal expectations are evolving, and more and more individuals are seeking flexible, modular, and relevant learning opportunities throughout their lives.

Traditionally seen as centres of foundational knowledge and innovation, universities are increasingly being challenged to transform their structures, cultures, and educational offerings. The existing model of 'one-time education' no longer stands in a knowledge economy where learning is continuous. Institutions must develop new roles and systems to serve not only full-time students, but also adult professionals seeking to reskill or upskill; often while balancing work, family, and other responsibilities (Cronholm, 2021; Georgia Tech, 2018; OECD, 2017).

This transformation is already underway. Dutch universities, for instance, have called for a systemic repositioning of life-long development within higher education. They advocate for the legal recognition of shorter, flexible learning units (e.g., micro-credentials), modular master's programmes, and non-linear study trajectories (Universiteiten van Nederland, 2023a; 2023b). However, the success of such reform depends not just on policy change, but on institutional willingness to reorganise governance, funding, and educational design.

A key insight from higher education institutes in Europe is the importance of embracing university continuing education as a structural, strategic dimension of higher education (Davies, 2007). Rather than treating it as peripheral or project-based, universities are encouraged to recognise it as a "fourth pillar" alongside research, teaching, and societal impact (Weil, 2023). This shift calls for a reconfiguration of how education is governed: embedding flexibility, modularity, and stakeholder engagement into core processes.

LLL should thus not be seen as an add-on; it is essential for building a resilient, inclusive, and future-proof society. As stated by the Dutch government commission for the regulation of work (Commissie Regulering van Werk, 2020), a structural learning infrastructure must be in place to enable people to adapt and thrive across life stages. Universities, in turn, must transform to fulfil their public mission not only for young students, but for learners at every stage of life. In order to effectively respond to societal transformation, labour market demands, and individual learning needs, universities should fully embed LLL as a core, strategic mission, equal to teaching, research, and service. Certain features of the Dutch higher education system, however, make it particularly challenging to implement innovation in university continuing education. The rigid legal framework of the Higher Education and Research Act is one example: current legislation primarily regulates full bachelor's and master's degree programmes, while short, flexible learning units such as micro-credentials

and modular pathways still lack a clear legal status. This makes it difficult for universities to structurally embed short-format university continuing education. In addition, funding mechanisms are not aligned with LLL. Government funding models incentivise traditional, full-time degree-seeking students, whereas professionals and part-time learners often fall outside these schemes (Universiteiten van Nederland, 2023a; 2023b). As a result, LLL initiatives are financially precarious and typically dependent on temporary projects or employer contributions. A further barrier is the limited collaboration between institutions and regional partners, which constrains the development of seamless LLL pathways (Thunnissen, 2021). De Grip et al. (2018) concluded in their policy report on LLL and competence development that a cultural shift is necessary to realise LLL in the Netherlands. This requires a learning culture in which employers and employees recognise its urgency, given rapid changes in required competences, longer working lives due to postponed retirement, and the increasing flexibilisation of the labour market.

Countries look for ways to accelerate and facilitate a more structural learning infrastructure for LLL. For example, within the Netherlands, a €392 million national LLL programme funded by the government (LLO-Katalysator, 2021; Cedefop & ReferNet, 2025) aims to accelerate LLL through demand-driven solutions, educator professionalisation, and regional learning ecosystems. Led by the Ministry of Education, it unites universities, vocational institutions, employers, and government partners to build a future-proof, skills-oriented learning infrastructure.

A structural change in governance, funding, curriculum design, recognition systems and partnerships with external stakeholders is needed, leading to flexible, inclusive learning pathways that serve diverse learners throughout their lives (Davies, 2007). Designing impactful continuing education offerings requires close alignment with external partners. Co-creation with employers, professionals, and regional stakeholders ensures that educational offerings are grounded in real-world needs and remain responsive to sectoral developments (Thunnissen, 2023; Lam et al., 2023). Moreover, increasing learner diversity in terms of age, background, and goals challenges universities to adopt flexible didactic models that support personalised, work-integrated learning paths (De Boer & Collis, 2005; Väätäjä et al., 2024; Smith et al., 2024).

Universities are exploring ways to respond to societal needs. Even within individual institutions, different approaches emerge, depending on the specific demands of various domains. Learning with and from each other, facilitated by networks such as EUCEN, supports universities on this journey. The following section presents the case of the Faculty of Engineering Technology (ET) at the University of Twente.

STRATEGIC LLL APPROACH AT THE FACULTY OF ENGINEERING TECHNOLOGY (ET)

The Faculty of Engineering Technology (ET) at the University of Twente is building a comprehensive strategy for LLL that integrates initial education, research, and societal impact. Our approach builds upon the faculty's domain expertise and the same cutting-edge research that informs our MSc programmes which focus on the fields of mechanical engineering, civil engineering and industrial design engineering. Central to this strategy is ensuring that LLL offerings remain relevant to societal and industrial needs, manageable for academic staff, and financially sustainable.

To develop this strategy and build on the university's ambitions, we began in 2024 by conducting a structured series of interviews with ET colleagues involved in various LLL activities. These interviews and discussions with the faculty board and departments formed

the foundation of our methodology and provided crucial insights into both opportunities and challenges. The findings shaped our understanding of existing offerings, organisational models, and requirements for quality assurance and programme development.

The identified models that came from the interviews and other activities that were undertaken to get insight into our experiences and ideas were the following.

MASTER-LEVEL COURSE PARTICIPATION

We learned that professionals already join existing MSc courses, either fully or partially, for example, within courses about design principles for precision mechanisms and machine learning in engineering. The number remains limited since we are not explicitly catering to this group.

Challenges for professionals joining master's courses include the absence of formal registration and invoicing procedures and courses primarily designed for young full-time students, limiting flexibility. Also, combining different groups of learners could lead to challenges for teachers, because the students differ in their needs and approaches. However, ET has experience accommodating professional learners, and faculty are open to adapting offerings. This approach requires relatively low investment. It is also a way to gain more experience with more diverse groups of learners, and approaches of accommodating them.

MASTERCLASSES AND CUSTOMISED TRAINING PROGRAMMES

Our faculty has experience in offering focused and tailor-made offerings for industry and other parties, i.e., in the area of rubber technology, water management, maintenance engineering, biomechanical engineering and systems engineering for and with employers such as ASML, Philips, governments, and small and medium-sized enterprises. These shorter, intensive offerings meet specific industry/government skill demands and contribute to a stronger collaboration with external partners.

Challenges in masterclasses and tailor-made programmes include no or limited support for teachers in designing and delivering education tailored to this specific group. There is limited administrative support, causing professors to handle many tasks themselves. Also, the returns on investment are uncertain. Despite relying mainly on individual experts, opportunities exist to adapt master's courses for industry, strengthen research and industry ties, and collaborate with other higher education institutions to increase impact and reduce costs. Additionally, aligning these topics with existing master's courses can reduce the investment needed to develop entirely new offerings, making it more feasible for faculty staff to participate within their busy schedules.

ENGINEERING DOCTORATE (ENGD) PROGRAMMES

The EngD is a doctoral-level programme focused on applied research and innovation within an industrial or professional context. Most students are employed at the university and take the 2-year full-time programme. But we learned that it is also possible to provide EngD programmes for professionals and give them more time, for example, with a participant from the Dutch Ministry of Infrastructure and Water Management – Rijkswaterstaat. It effectively combines advanced research with practical innovation for working professionals.

Challenges include limited awareness of the EngD outside the university, and even within the institution, its possibilities are not fully known. Enrolment is rather low and should be increased. Promoting and flexibilising the programme could attract more participants. The

EngD offers valuable opportunities for the university to collaborate intensively with industry and societal partners on real-world challenges.

THE FACULTY APPROACH FOR LLL

Our LLL approach builds on the strong foundation of our master education and research activities, aligned with key thematic areas reflecting industry and societal needs and the university's ambitions to make a societal impact as a fourth-generation university.

We have developed a structured LLL framework comprising three main types of propositions, aimed at serving the continuing education needs of engineering professionals:

- **Contract students for master's courses:** Professionals can enrol in full or partial master's courses, as well as thematic course clusters, to enhance their skills. We aim to expand the number of courses available to professionals, clearly communicating relevant details such as required prior knowledge, types of projects involved, and available participation options. These offerings are accessible through both business-to-business and business-to-consumer channels, with flexible options such as stackable (micro)credentials.
- **Masterclasses and tailor-made programmes:** Customised learning tracks are designed specifically for companies, organisations, or individuals seeking upskilling in emerging areas. We aim to develop a series of short masterclasses and more comprehensive programmes, based on our research activities and MSc courses, in collaboration with external partners from whom participants will join.
- **Engineering Doctorate (EngD) as LLL:** A post-master's programme focused on design-driven industrial innovation, optimised for part-time participation by working professionals.

Strategically, we aim to invest more and expand on experiences from current programmes by embedding LLL as an integral tool for valorisation and dissemination. This enables us to enhance the impact of research and innovation within larger cooperation programmes involving industry and governments. By integrating LLL into these collaborations, we create structured pathways to translate knowledge and project results into practice, increasing societal and industrial benefits. At the same time, costs for the development of masterclasses and tailored programmes, can be supported by the income provided through these funded (research and innovation) programmes.

Another strategy is to better guide participants once they are enrolled in a course or masterclass by familiarising them with our full range of offerings and what might interest them. This could encourage them to take additional courses or masterclasses, or eventually pursue a full master's programme or an EngD. Dedicated support for professionals, providing personalised guidance on these possibilities, is essential for this approach.

Over time, we expect to grow the availability and uptake of LLL options through increased course accessibility, thematic course clusters, and expanded tailored programmes and doctoral offerings, all designed to meet evolving industry and societal demands. We will invest in adapting selected master's courses which are most relevant to our societal partners, and gain more experience in optimising them for the mixed classroom where professionals and traditional students learn together (Brinkhuisen, De Vries, Bartelse, Oonk, & Gulikers, 2021), i.e., building upon the rich work experience of those professionals (Smith et al, 2024).

This is not easy, as faculty are already very busy and universities in the Netherlands are facing budget cuts. On the other hand, we have already noticed that staff at the University of Twente are more open to catering to a more diverse group of students compared with some years ago. At that time, the idea of opening up master's education for professionals was also

discussed, but teachers were not supportive. This has changed, seemingly due to a stronger societal focus on the possibilities of LLL, as well as government-supported programmes to review legislation and formal structures. These initiatives are backed by large innovation funds specifically focused on LLL (e.g., LLO Katalysator, 2021), and by the attention that LLL receives in other major thematic programmes in which industry, governments, and educational partners cooperate, such as the *Steel Sector in Transition* programme (see: groeienmetgroenstaal.nl/en). Our faculty's support is grounded in a faculty-wide exercise to develop a future-proof educational portfolio (Faculty of Engineering Technology, 2024), in which we defined our ambitions and strategy for the next 10–15 years. A large representation of faculty staff contributed in shaping this strategy. The faculty board and department boards are now implementing innovations aimed at a more diverse student population, and investments in resources and staff to build expertise and gain experience are being made available to support this.

As a faculty, we will continue to learn from programmes within our university and beyond, particularly how to organise our education so that it becomes more accessible for professionals. These steps strengthen the role of LLL in our evolving ecosystem and maximising the impact of our research and education efforts. At the same time, progress remains modest. Lifelong learning is not yet structurally embedded in national funding or fully recognised institutionally. Current practices therefore represent early steps that require continued refinement, stronger organisational support, and clearer positioning within national and European LLL systems.

DISCUSSION AND CONCLUSION

Universities in the Netherlands are gaining experience in setting up models for LLL. Challenges remain, as LLL is still not part of the funded assignment from the Dutch government, while technological change, demographic shifts, and complex societal challenges increase the need for it. The national programme to accelerate and catalyse ideas and experiences (LLO-Katalysator, 2021) contributes to the ambition of defining new ecosystems in which LLL becomes an integral part of what universities do (Davies, 2007; Weil, 2023). It aims to move beyond traditional 'one-time education' models, serve more diverse learners, including working professionals balancing multiple responsibilities, and support labour markets demanding continuous upskilling and reskilling.

There is now clearly more momentum within universities in the Netherlands to take significant steps: developing strategies, gaining experience, and creating new offerings for professionals. The government is supporting experiments and the development of new ecosystems, and university policies (such as those at the University of Twente) are increasingly focused on LLL. Regional networks between educational institutions and employers are also being strengthened, supported by funded programmes. In addition, the LLL learning networks of universities in the Netherlands are very active and dedicated to supporting inter-university learning on all aspects of LLL, including educational models, staff professionalisation, business models, communication, and cooperation with societal partners.

The ET at the University of Twente aligns its LLL strategy with these broader trends, building on the future-proof portfolio exercise carried out in recent years. Building on its strong research and master's education foundation, ET integrates LLL into its thematic priorities and external collaborations. We foresee LLL as a key mechanism for valorisation and dissemination, amplifying the impact of research and innovation within industry and government partnerships.

We recognise that we are at the start of our journey. While we are already busy, LLL needs to be incorporated into our ways of working, aligned with our mission and vision. We need to gain experience adapting existing course structures, improving administrative support, and raising awareness of programmes like the Engineering Doctorate among professionals. Our strategy focuses on embedding our LLL portfolio in funded projects and alliances, thereby expanding our offerings.

As part of the broader university ambitions, our faculty seeks to expand access to LLL through increased course flexibility, thematic clustering, and tailored programmes that directly respond to the needs of industry, government, and societal needs. While participation of professionals in existing courses, masterclasses, and EngD pathways is growing, current impact remains modest, and the effectiveness of these offerings requires ongoing evaluation. The development of LLL within our faculty and across Dutch universities depends not only on local initiatives but also on systemic conditions. Limited structural funding, partial recognition of micro-credentials, and administrative models insufficiently tailored to professional learners constrain scalability and integration. Similar challenges are observed across European higher education systems. Our efforts contribute within this broader context, illustrating both the potential and the substantial work still needed to embed LLL as a fully integrated and sustainable component of higher education practice.

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