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Transferable Competencies and Skills as Fundamental to Engineering Curricula: Introduction and Lessons from Ten Institutional Case Studies

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There is an outmoded notion that technical knowledge is the substance of engineering and the basis for engineering education, while transferable skills and competencies are peripheral. Serving as the introduction to Part 4, this chapter sets the stage for ten institutional case studies that illustrate how such skills can be meaningfully embedded within curricula. We highlight their distinguishing contributions with a focus on leadership development, collaboration, communication, sustainability, and entrepreneurship. These cases showcase distinctive emphases on the contemporary skills and competencies currently embedded into engineering curricula within Europe and beyond. They reveal recurring patterns, including the use of problem-based learning and other active, enquiry-based and reflection-supported learning pedagogies, the cultivation of professional identity, and the necessity of alignment across multiple levels. Together, they provide engineering educators with a rich set of adaptable practices and issue a clear call to action: to champion and advance the deep integration of transferable competencies and skills within engineering education.

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1 Introduction

In this part of the handbook, we present ten case studies from universities spread across three continents that are strategically implementing transferable competencies and skills into their engineering curriculum. These institutions are leading the way in taking on the myth long beholden by engineering education: technical knowledge and disciplinary skills are its 'hard' substances, while transferable skills such as communication, collaboration, teamwork, creativity, and ethical awareness are 'soft' extras to be taught in standalone modules. Like many myths, it speaks to a truth: technical knowledge is fundamental to practice because it distinguishes engineers from other professions. However, traditional educational approaches that have aligned with this thinking have left previous generations of graduates technically proficient yet underprepared for the complex, uncertain, interdisciplinary, ethically charged realities of practice (Habbal et al., 2024).

The historically prolific idea that transferable competencies and skills are important yet can be siphoned off and taught separately by experts outside of the discipline — such as by centralised educational specialists present in many large universities, or by consultants from the corporate world — is outdated, as evidenced by the case studies presented as chapters in this handbook part. Indeed, each study goes further in demonstrating that teaching transferable competencies and skills is not just equally important to teaching technical skills, but that these competencies are constitutive: part of the context required to learn engineering in pursuit of practice within the profession and woven into its very fabric. Although each institution tells a unique story, they all answer the same questions: how to best embed transferable competencies and skills into their engineering curriculum? To aid in comparing approaches, we asked authors to structure their chapters with guidelines: as well as describing the programmes themselves, they were asked to comment on how their work aligns to the competencies and skills presented and explored in the preceding parts of the handbook. Thus, they refer back to the relevant chapters and foundational concepts that consult on the wider and growing relevant literature, as well as giving space to explain their unique institutional context. All chapters conclude with a set of practical takeaways, including clear recommendations on what to do and what to avoid, as well as recommended further reading.

Each chapter demonstrates deep integration and embedding of transferable competencies and skills into curricula. However, they also reveal that there is no universal approach to transferable skill teaching. Their educational leadership stories differ in terms of both presentation and content, as well as differentiating histories, stakeholders, environments, culture, policies, personalities, and myriads of other factors which can influence the design of embedded skills curricula. Anticipating this, we asked chapter authors to describe not only their initiatives, but aspects of their context they thought important and which influenced how they designed and developed their own curricula, revealing fascinating insights into their universities and associated educational culture. This should help you appropriately interpret them in light of your own context and draw on them selectively to embed transferable competencies and skills now, or in the future when the opportunity arises. This chapter introduces each case study, identifies recurring themes, and finishes with a call to treat transferable competencies and skills as constitutive, rather than ancillary elements of engineering curricula.

2 The chapters: institutional case studies

To help you to prioritise your reading, we provide a summary of each chapter together with what we've identified as its distinguishing contribution.

Denmark's *Aalborg University* (Chapter 4.2) has championed problem-based learning (PBL) for over fifty years, helping to establish it as the signature pedagogy for teaching transferable competencies and skills not just in Europe but globally. It was therefore appropriate to open this Part by inviting this university to share its extensive experience and research. Guerra et al. detail their groundbreaking PBL model, mapping its 48 competencies to those outlined in this handbook. The learning activities are centred on complex problem solving, project management and leadership development, collaboration and co-creation, interdisciplinary engagement, and professional identity and agency. Drawing on decades of lessons learned, they offer a comprehensive set of recommendations for the reader to adopt or adapt, many of which are echoed in subsequent chapters.

Chapter 4.3 by Craps et al. from *KU Leuven* in Belgium is the first of the many chapters in this Part which outlines a competency-based framework to help students with collaboration in teams and to progress their attainment of transferable competencies and skills. They present six clusters of competencies: team dynamics, project management, communication, innovation, entrepreneurship, and ethics. They embed these skills across a multi-campus curriculum. Their distinguishing characteristic is engineering identity development, supported by e-portfolios and authentic projects.

In Scotland, at the *University of Strathclyde* (Chapter 4.4), the Vertically Integrated Projects for Sustainable Development programme (VIP4SD) integrates transferable competencies along with entrepreneurial and sustainability skills. Strachan et al. describe their methodology, which includes structured workshops and assessments. Significantly, VIP4SD is an adaptation of the established Vertically Integrated Projects (VIP) model, which originated at Georgia Institute of Technology (USA), and has since been adopted internationally by numerous universities who have come together to form the VIP Consortium. This highlights the increasing viability of sharing and unifying around global best practice models for embedding transferable competencies and skills.

Gómez-Puente et al. from *Eindhoven University of Technology (TU/e)* in the Netherlands (Chapter 4.5) position self-directed learning (SDL) as the backbone of a longitudinal professional and personal development (P&PD) learning trajectory within their Industrial Design bachelor curriculum. They integrate the SDL subskills of goal setting, planning, self-regulation, reflection, and professional identity into a competency-centred and problem-based learning environment. Their distinguishing characteristic is a whole-curriculum, change-managed redesign that embeds SDL across projects, coaching, mentoring, and assessment, enabling students to take ownership of their learning pathways and evolve as adaptable, reflective designers prepared for lifelong learning.

The Integrated Engineering Programme (IEP) at *University College London (UCL)* in the UK (Chapter 4.6) has gained attention in engineering education literature and communities globally for its exemplary model of skills integration across all engineering disciplines using various forms of project-based learning, including challenge-based learning. Nweke et al. share the implementation of this approach through a typical engineering degree: their undergraduate degree programme in Biomedical Engineering. Notably, the IEP illustrates the necessity of developing transferable skills incrementally through a progression model that is associated with dedicated teaching and assessment of such skills within and alongside student engagement with disciplinary and interdisciplinary scenario-, project-, and challenge-based learning opportunities.

Cooke et al. from *University of Birmingham* in the UK (Chapter 4.7) present a multi-level framework aligning institutional graduate attributes, faculty-level professional identity formation, and curriculum-level competencies development through integrated design projects (IDPs). Skills are conceptualised distinctly at each level — as qualities, identity, and competencies — creating coherence across the student experience. Their distinguishing characteristic is the positioning of professional identity and student belonging as developmental and transferable competencies, embedded through psychologically safe teamwork, inclusive practices, and challenge-based learning across interdisciplinary engineering cohorts.

At the *University of Melbourne* in Australia (Chapter 4.8), Rios et al. showcase the development of teamwork skills through three distinct case studies. They developed the Teaching, Practicing and Assessing Teamwork (TPAT) framework, which conceptualises the demonstrable individual behaviours of effective team practice. The case studies across their programmes collectively demonstrate the utility of TPAT as a tool for reflecting upon and enhancing existing teamwork teaching, as well as driving the creation of new modules and assessment methods. The chapter highlights the important and powerful role of developing and applying evidenced-based conceptual frameworks which draw on contemporary engineering education research.

Between them, the *University of Technology Sydney* and *University of Sydney* in Australia (Chapter 4.9) have two decades of experience in embedding transferable competencies and skills at scale. Machet et al. describe a dedicated five-unit sequence integrating skills across project units and co-curricular requirements. Both show that structure matters less than the principles of embedding, scaffolding, authenticity, and evidence-based assessment.

Ramirez et al.'s E-Lead programme at *University of Texas El Paso (UTEP)* in the USA (Chapter 4.10) integrates skills by broadly framing them as leadership and entrepreneurial competencies. The programme centres student development on personal attributes adapted from the US military. This American context, involving students from disadvantaged Hispanic backgrounds, offers a unique example of embedding transferable competencies and skills with a strong entrepreneurial focus to facilitate upward social mobility.

At *Cornell University* in the USA (Chapter 4.11), Hutchison et al. position communication as inseparable from engineering practice. Their Engineering Communications Program (ECP) embeds core communicative competencies: context, design, social action, and identity, into engineering curricula through both tailored teaching and flexible partnerships with disciplinary subjects. Distinctive to their model is its emphasis on authentic, situated communication tasks and discipline-specific genres, reinforced by longitudinal self-efficacy studies showing measurable gains in students' communicative confidence and capability.

Additionally, while all chapters address targeted redesigns of a specific degree programme or module, some also consider integration across all engineering disciplines or an entire institution, including non-engineering subjects (Fig. 4.1.1).

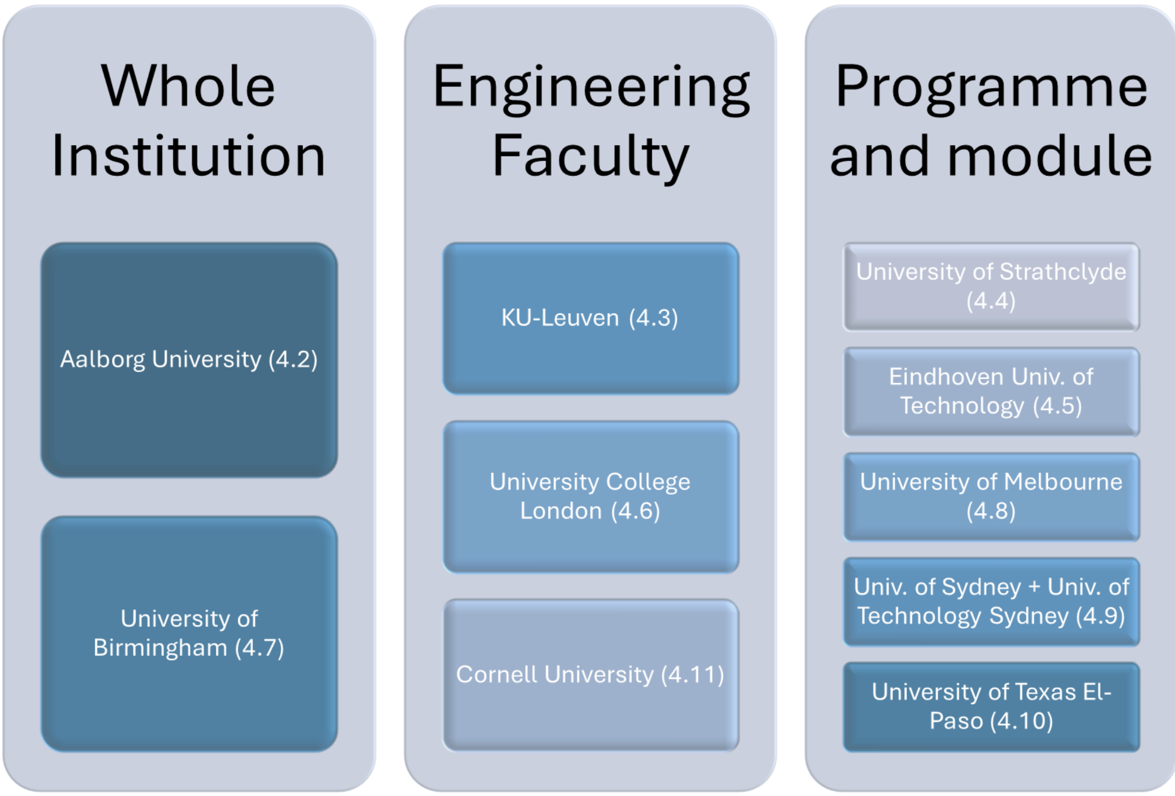

Figure 4.1.1: The ten case studies in this part with their chapter numbers, categorised according to the highest level of integration detailed (Own Work by Cooke and Tilley, 2026)

3 Recurring themes

When editing this Part of the handbook, we identified some common threads, which are important to set out in advance as a collective reflection of the integrative approaches to competencies and skills teaching and assessments within engineering curricula.

Authentic integration. All institutions are treating transferable competencies and skills as constitutive of engineering practice, not as auxiliary skills.

Authentic pedagogy. Problem-based learning (PBL) and its derivatives are frequently observed pedagogies used to simulate authentic engineering practice. All chapters demonstrate that transferable competencies and skills should be learned in real or simulated professional contexts.

Identity development. The curriculum is an intentional part of the student's professional identity formation. Many case studies focus on who students are and who they will be, framing transferable competencies and skills as a core component of becoming an engineer.

Skill progression. Mastery of skills requires a deliberate progression model. Many initiatives demonstrate how skill learning is intentionally scaffolded across years and levels of study, ensuring they are revisited and deepened.

Shared resilience. Different institutions with widely different contexts can achieve similar outcomes due a shared vision to embed transferable competencies and skills into the curriculum. These institutions have persisted and flourished because their work is underpinned by a resilient conceptual framework which supports their contribution to this shared vision.

Multi-level alignment. While each institution utilises different conceptual frameworks, they share the principle of multi-level alignment, which purposely connects the high-level institutional vision to the practical design and delivery of the curriculum.

Change management. All these case studies are continuous works in progress, as changing priorities and new understandings require a commitment to a constant cycle of innovation, scaffolding, measurement of impact, and revision. This highlights the need for strong overarching change management leadership with a mandate to remain flexible, reflexive, and future-focused when introducing and maintaining the embedding of transferable competencies and skills in curricula.

4 Final advice on institutional implementation of transferable competencies and skills

When universities or their degree programmes frame transferable competencies and skills as supplementary, they compromise their students' future. These competencies enable sound judgement, collaborative problem solving, and responsible action in contexts defined by uncertainty and trade-offs. Therefore, they are not supplementary; they are constitutive. Every Chapter within this Part of the handbook is evidence that deep curriculum embedding is possible, scalable, and transformative.

They offer not just inspiration but concrete strategies and resilient structures for the reimagining and restructuring of taught engineering degree programmes. This is not about teaching workshops at the margins; it is about integrating authentic tasks with real audiences, mapping outcomes across modules and programmes, and making competencies visible within the learning outcomes and developmental through credible assessment.

It must be mentioned that there are future challenges and significant opportunities for impact involving helping students to uncover, recognise, and articulate these embedded competencies and skills. Aimed at capturing the intrigue of keen practitioners and responding to the need for more accessible evidence-based guidance within higher education institutions, the chapters each tell a unique, well-informed, and experiential story. By comprehending and reflecting on each contribution, you will gain a fresh understanding of what could and what might not work in your own context.

The constraints are familiar: packed curricula, staff who lack confidence to lead pedagogical innovation, students who initially question the relevance of explicit skills teaching, and accreditation frameworks that can feel constraining. Yet change consistently takes root through focussed pilots, careful evidence gathering, and coalitions that bridge faculty, students, industry partners, and accrediting bodies. As durable structures, such as shared rubrics, cross-module themes, programme level assessment, and recognition for educational leadership, replace reliance on individual champions, momentum becomes self-sustaining. Movements precede mandates: practice, proof, and shared language generate the legitimacy that leadership then codifies.

The case is clear. Transferable competencies and skills must be treated as core competencies inseparable from technical learning and professional identity formation. Institutions that act on this imperative will graduate engineers equipped not only to solve complex problems, but to lead, adapt, and act ethically in service of society. Change often starts with grass-root effort and commitment, articulating the real need, and then planting ideas about how to address it, all the while working hard together to overcome obstacles. The concluding message is unapologetically direct: do not wait for permission. Commit to integration, build evidence, and institutionalise the gains. That is how engineering education moves beyond proficiency towards purpose. Movements create mandates, movements do not wait for mandates.

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AI statement

During the preparation of this work the author(s) did not make use of any AI tools.

Contributor statement

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