Invited Workshop

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SIG ENGINEERING SKILLS - COMPLEMENTING THE CONVENTIONAL: ENGINEERING COMPETENCIES AND SKILLS FOR AN UNCERTAIN FUTURE

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ABSTRACT

This workshop, inspired by the SEFI SIG Engineering Skills' Position Paper on Skills (SEFI, 2025), focusesd on defining skills in curricula to meet the challenge of a volatile, uncertain, complex, and ambiguous (VUCA) world. The position paper advocates for a comprehensive framework that equips future engineers with cognitive, social, and ethical competencies, alongside technical skills. Workshop participants, including engineering educators, policymakers, and industry professionals, engaged in reflection and peer-to-peer dialogue to map current skills and identify areas for improvement. The workshop facilitated the co-design of strategies to integrate technical, transferable, and transdisciplinary skills ("3T skills") - into practice, fostering engineers capable of addressing global and societal challenges with creativity, collaboration, and social responsibility. The workshop began with an overview of the key concepts from the position paper, followed by a self-reflective mapping activity. Small-group discussions allowed participants to compare experiences and identify gaps in skills development. The collaborative phase focused on practical strategies for embedding these skills, informed by the position paper's recommendations. The workshop concluded with a plenary discussion, where participants shared insights.

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1 BACKGROUND AND RATIONALE

This workshop was guided by the SEFI 2025 Position Paper *"Complementing the conventional: Engineering competencies and skills for an uncertain future"* of the Special Interest Group (SIG) on Engineering Skills (SEFI, 2025). This paper advocates for an integral and adaptive framework of engineering education - one that goes beyond traditional disciplinary boundaries to equip future engineers with the competencies required to address changing global and societal problems.

The paper's main concepts can be neatly summarised by the accompanying "5-4-3-2-1" infographic concept (Figure 1). With the world becoming more volatile, uncertain, complex, and ambiguous (VUCA), engineers must build not just strong technical foundations but also versatile and multidisciplinary skills. Such skills encompass cognitive, social, and ethical competencies; the capability to work across disciplines and sectors; and the resilience to pivot with evolving technologies and societal demands. The Position Paper highlights the necessity to educate engineers with collaborative skills, creativity, and commitment to social responsibility - engineers who can contribute to sustainable solutions in the context of a fifth industrial revolution incorporating artificial intelligence, personalisation, and ethical innovation.

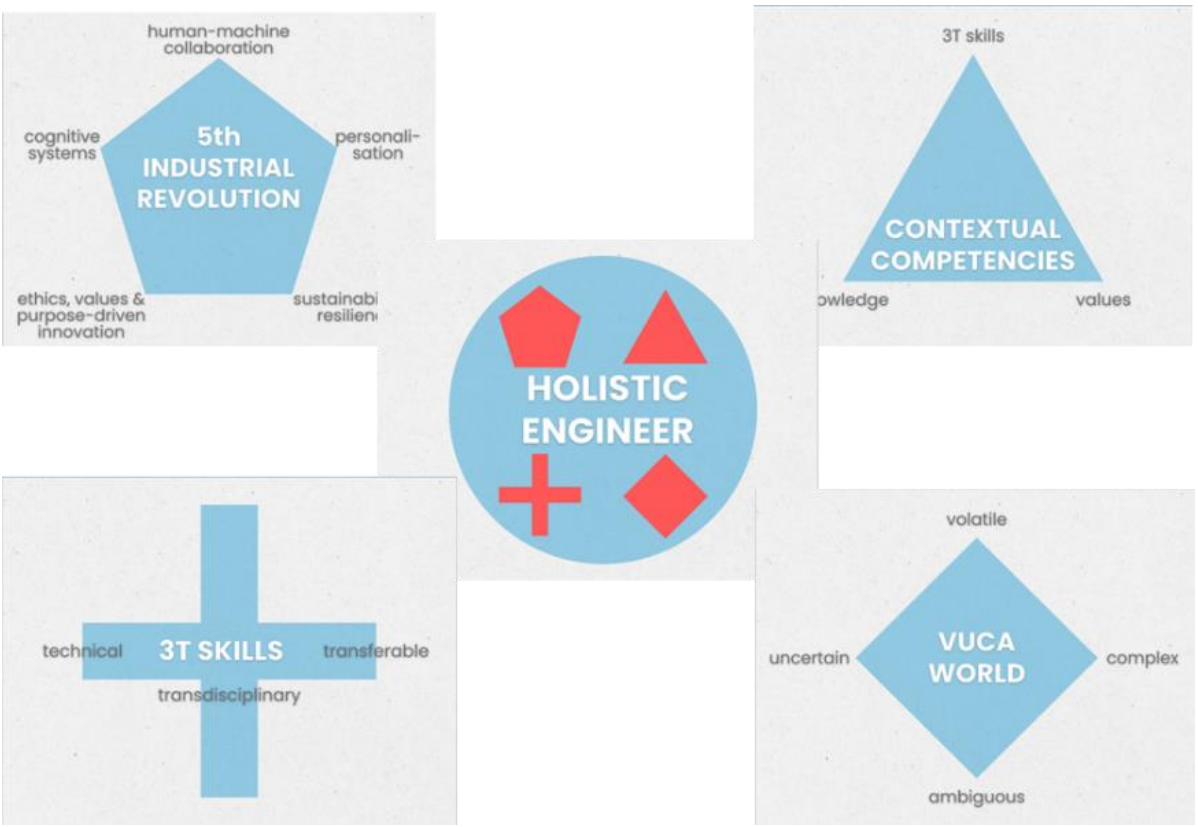

Figure 1. Key concepts from the position paper

This workshop invited participants to consider how such a skill set can be supported and embedded within their own educational or work settings. Through guided reflection and peer-to-peer dialogue, participants interacted with the 3T's – technical, transferable, and transdisciplinary skills (figure 1, bottom left) – as they considered actionable steps for fostering engineering competencies that are intrinsically linked to practical applications in the real world, societal values, and ongoing personal growth.

Figure 2. Introduction into key concepts from the position paper

2 WORKSHOP OBJECTIVES

2.1 Target audience

- engineering educators; engineering policymakers; professionals in engineering industry

2.2 Expected learning outcomes

1. Insight in the key concepts from the "Skills Position Paper 2025".
2. Identify and mapped out current skills and areas for improvement.
3. Co-design strategies to integrate technical, transferable, and transdisciplinary skills into educational or professional practices.

3 WORKSHOP DESIGN

This workshop was designed to engage participants in critically reflecting on the role of engineering skills and competencies in preparing engineers for an uncertain and rapidly evolving future, with a particular focus on the three T's—technical, transferable, and transdisciplinary skills. The session began with a brief overview of the key messages from the Skills Position Paper 2025 (SEFI, 2025), providing the conceptual foundation for the workshop. Participants then engaged in a self-reflective mapping activity, identifying how the three T's feature in their own teaching, learning, or work experiences. This set the stage for small-group discussions, where participants compared experiences, identifed common patterns or gaps, and began to consider how these skills are supported - or overlooked - within their broader institutional or professional contexts. In the next phase, participants worked collaboratively to co-design practical strategies for embedding or enhancing skill development. These ideas were informed by the position paper's recommendations and shaped through the use of guided prompts and peer dialogue. The workshop concluded with a plenary discussion, during which groups shared key insights and committed to one or more actions they can take forward in their own settings.

Figure 3. Workshop during brainstorming phase

3.1 Time plan

Table 1. Engineering Skills SIG workshop

Time	Activity	Notes
10 min	Introductions and position paper overview	Overview of the workshop and key concepts from the position paper: The "5-4-3-2-1 Infographic concept"
15 min	Skill maps: What are the 3T Skills?	Skills Mapping Exercise: Have participants map out their current skills on the three T's and identify areas for improvement. Arrange participants into tables.
25 min	Brainstorm: How do we integrate 3T skills as Contextual Competencies?	Divide participants into small groups to discuss how these skills can be integrated into their own programs as contextual competencies i.e. a mix of skill, knowledge, and values in a specific context Groups brainstorm ideas for implementing the recommendations from the position paper.
10 min	Discussion and conclusions	Each group briefly shares 2-3 key "how to" ideas that emerged from their reflection. Short discussion to identify common themes, potential challenges, and opportunities for collaboration. Provide assistance on how participants can share and disseminate in their networks and

		institutions. Point towards resources like the SEFI Handbook on Teaching Transferable Competencies and Skills in Engineering

3.2 Interactivity

The think-pair-share method was used. It is a collaborative learning strategy designed to foster interactivity and engagement. It involves three steps: individuals first think about a topic or question, then pair up to discuss their thoughts, and finally share their ideas with a larger group.

4 WORKSHOP RESULTS

4.1 Skill maps: What are the 3T Skills?

Participants identified and categorised individual skills into either technical, transferable or transdisciplinary. This revealed a snapshot of what educators' current comprehension of these categories:

- **Technical skills included**: Systems thinking, software proficiency, AI capabilities, cybersecurity, modelling, data analysis, coding, applied experimental skills.

- **Transferable skills included**: Creativity, critical thinking, project & time management, communication, leadership, resilience, empathy, humility, collaboration, feedback literacy, intercultural communication, decision-making, professionalism, reflection.

- **Transdisciplinary skills included**: Perspective-taking, entrepreneurship, adaptability, sustainability, languages, holistic thinking, process solving, dealing with uncertainty, life cycle awareness.

4.2 Brainstorm: How do we integrate 3T skills as Contextual Competencies?

Participants shared actionable ideas to foster 3T skills and define contextual competencies which combine 3T skills with knowledge and values. The following is a synthesis of the ideas shared across groups during the session.

Transdisciplinary skill development is a dynamic process, especially important in projects facing regional challenges, such as those in rural Africa. Technical and transferable skills—like leadership, empathy, and collaboration—form the basis for transdisciplinary competencies, which are essential for addressing complex, real-world problems. While integrating these skills into disciplinary curricula through case studies is promising, concerns remain about maintaining technical depth. Transdisciplinary skills are context-dependent and not clearly defined, making their implementation challenging but necessary. The conversation also touched on the need for empirical evidence of a transdisciplinary skills gap and how teaching can bridge conceptual and practical learning.

Real-world challenges & wicked problems (VUCA): One example suggested in the workshop and developed further afterwards by the authors was to set the students the

problem of designing a product to help the homeless community, and frame it as a VUCA problem. One example solution might be a robust, portable powered shelter to replace the typical tents currently used and unsuitable for persistent urban use. This was considered volatile due to a person's changing needs, transient lifestyle, and frequent loss of possessions. Uncertainty might arise from limited access to resources such as electricity, the person's health, and regulations or use of shelters in public spaces. The complexity could be due to the diversity of the homeless population, while ambiguity arises from ethical considerations about products that on the one hand ease the discomfort of a homeless person, yet also prolong more systemic solutions. PBL (Problem-Based Learning) was the pedagogy of choice for such problems.

Skill progression (3Ts): Developing the concept of a shelter for the homeless further requires identifying the 3T skills (technical, transferable, transdisciplinary) needed to produce a solution. A consensus arose that the technical skills must come first. These included industrial and product design, manufacturing, mechanical and structural engineering as well as materials science. Transferable skills included stakeholder needs analysis along with teamwork and communication skills. Identification of the technical and transferable helped to identify the transdisciplinary skills. These are less well understood by engineering educators and were consequently more difficult to define. However, these included teachers from non-technical disciplines such as from public health and social work, formulating research questions, public engagement, and even art appreciation to broaden engineers' viewpoints.

Values in Competence: Identifying the 3T skills helped to partially define the contextual competence to solve the problem. One group considered that the values engineers used to collaborate also define their design decisions. This included ensuring that the final product was sustainable and met the needs of the person. Artificial Intelligence (AI) was also identified as a potential additional team member in future engineering teams, whose synthetic values might influence decisions, and consequently need to be identified and scrutinised.

5 SUMMARY

This workshop successfully translated the core principles of the 2025 SEFI Engineering Skills' Position Paper into a collaborative and practical forum. A key insight is that giving educators the tools to conceptualise multiple skills as contextual competencies is a significant yet worthwhile activity.

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