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Establishing A Timber-Focused Competency Framework To Up- And Re-Skill Built Environment Professionals To Meet Sustainability Goals

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ESTABLISHING A TIMBER-FOCUSED COMPETENCY FRAMEWORK TO UP- AND RE-SKILL BUILT ENVIRONMENT PROFESSIONALS TO MEET SUSTAINABILITY GOALS (PRACTICE)

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ABSTRACT

Engineers equipped with skills for a sustainable built environment have never been more critical, as government and industry sustainability goals such as the 2050 net zero target have significant implications for the construction sector. Concurrently, the UK's Construction Industry Training Board (CITB) has estimated that over 250,000 new workers will be needed by 2027 to meet demand. Besides this need for green skills, the sector is also looking towards more sustainable building materials, methods, and technologies, such as homegrown biogenic offsite manufactured (bio-OSM) timber: an innovative technology requiring additional engineering and manufacturing expertise.

To address this critical skills gap, the Timber Technology, Engineering, and Design (TED) Competency Framework was established by a coalition of academic and industry partners. This framework then informed the development of a hybrid training course that can prepare the next generation of timber engineers with the knowledge, transferable skills, and industry experience that can drive change towards sustainability in the built environment and inform a transformational approach in engineering education.

This practice paper describes the development of the Timber TED framework and the launch of the corresponding training programme in September 2022. It also reflects on the initial implementation across two cohorts, delivered at the Centre for Advanced Timber Technology at the New Model Institute for Technology and Engineering in Hereford, England, in partnership with Edinburgh Napier University and Timber Development UK. This educational initiative showcases an innovative and replicable approach to upskilling and reskilling for green skills in engineering education.

1 INTRODUCTION

80 to 90% of our time is spent in the built environment, with buildings and construction together accounting for 36% of global final energy use and 39% of energy-related carbon dioxide (CO_2) emissions (Timber Development UK 2023). With 300,000 housing starts called for by the UK government per year (UK Parliament 2022), building materials and technologies that promote sustainable and regenerative practices are essential to achieving net zero. The utilisation of modern engineered timber products like cross-laminated timber (CLT) from sustainably managed forests capture carbon and store it in the built environment resulting in an additional 1,556 to 2,567 t CO_{2e} stored in the structure of a hybrid CLT building compared to a traditional reinforced concrete building (Pierobon et al. 2019). Indeed, the embodied carbon of a house constructed using offsite panellised timber frame is approximately half that using traditional masonry forms (Monahan and Powell 2011). Timber buildings are also capable of meeting performance targets including Passivhaus Standards with high levels of airtightness and thermal and energy performance, and they can be produced efficiently using modern methods of construction that minimise waste.

However, the UK is one of the largest global net importers of timber products, creating emissions from shipping and limiting local economic growth potential from local forest resources. Of these imports, 42,500 m3 / year is of CLT. At present there is no UK commercial producer of CLT, although it has been demonstrated to be feasible (Crawford, Hairstans and Smith 2013). Scaling up the production of homegrown CLT would represent a viable way of increasing the 30% utilisation of UK produced sawn softwood in construction, estimated to be 3.6 million m3 per annum (Construction Management 2015). Besides homegrown mass timber, other advanced timber technologies can also positively impact sustainability goals by responding to the need for restoration and retrofit. Digitisation is unlocking the potential of these materials and systems, and it is also considered a game changer in the construction sector with the implementation of Building Information Modelling (BIM), the integration of Enterprise Resource Planning (ERP), the utilisation of Virtual Reality (VR) and Augmented Reality (AR), and Digital Twinning. The opportunity is a digitally connected ecosystem of built assets with a digital thread from these back to the forest floor implementing a virtual factory environment capable of improving overall productivity, maximising resource utilisation, unlocking investment and creating sustainable growth.

Yet to take advantage of these advances, the construction sector must address its skills crisis. Engineers from multiple disciplines – materials, manufacturing, civil, and structural – are needed who possess the knowledge and skills that can catalyze efforts around these opportunities for positive impact. Besides requiring more workers with new skills, the industry must change culture towards more collaborative and interdisciplinary approaches (Fort and Cerný 2022). This means new and different ways of working, requiring but also enabling flexible, hybrid learning with opportunities to engage with real world challenges, clients, and companies.

2 METHODOLOGY

The method adopted to address these needs was multistaged constructive alignment focused around three strategic actions. A constructive alignment approach was chosen because it enables a holistic educational strategy that provides a throughline between policy, learning outcomes, and pedagogy (Loughlin, Lygo-Baker and Lindberg-Sand 2020). First, a Competency Framework was developed through an iterative process of stakeholder engagement as part of a Timber Industry-approved Skills Action Plan (Timber Development UK 2023). This framework then informed learning outcome development for an educational programme mapped to those competencies. Finally, two short hybrid courses based on this programme of learning were developed for postgraduates and working professionals.

2.1 Timber TED Competency Framework

Competency frameworks are common across many industries, and they have become increasingly pertinent to sustainability education efforts; for example, EU GreenComp sets forth 12 competencies to foster a sustainability mindset through knowledge, skills, and attitudes, and the Institute of Environmental Management and Assessment articulates the sustainability skills and knowledge required at different career stages. Competency-based approaches to education have been employed since the 1960s (Nodine 2016) but have gained wider attention in engineering education in the last two decades (Henri, Johnson and Nepal 2017). Scholars have shown that these frameworks are essential for developing programmes of learning that can support future leaders and positive change within sustainability education (Lozano et al. 2017).

Professional competencies are also viewed as crucial within the UK construction sector, and the Chartered Institute of Building (CIOB) has made clear that significant up- and re-skilling in these areas is required for the 3.1 million people employed in the UK construction sector (CIOB N.d.). Indeed, in 2020, the British Standards Institution also announced the development of an overarching framework for competence in the built environment sector.

Technical competencies are essential for built environment practitioners; however the education of future engineers also requires the instillation of collaborative practices, leadership development, improved holistic understanding of the net-zero challenge, and meaningful and valuable work experience with an emphasis on SME engagement.

Against this backdrop, experts at Edinburgh Napier University, with funding from the HCI Skills Gateway, established a stakeholder group of all the main UK timber industry bodies, including the Structural Timber Association, the Confederation of Forest Industries, Swedish Wood, Truss Rafter Association, Timber Trades Federation, and Timber Research and Development Agency (the latter two now having merged to form Timber Development UK, or TDUK). These networks gave access across the interface of UK and European construction and timber sectors to

consult and inform on establishing a framework with core competencies in timber relative to industry occupations and level of necessary attainment.

The development of the framework was an 18-month process which began with desk research using a range of sources, from job descriptions to existing relevant competency frameworks and chartered member requirements. Following desk research, interviews with key sector stakeholders enabled the drawing up of a first draft of the framework that was presented to working group members for discussion and feedback. Further revisions were made and additional content was developed and refined. Feedback was then obtained at two events: the Timber Engineering and Design Steering Group meeting and the Offsite/Mass Timber Construction Virtual Conference. After a subsequent review by the working group, wider views on the structure and content of the framework was sought through an industry survey.

The resulting Timber Technology Engineering and Design (TED) Framework consists of three competency areas: 1) core technical competencies; 2) cross-disciplinary competencies; and 3) core behaviours and meta skills. The competences are designed to be at English, Welsh, and Northern Irish Levels 5-7 and Scottish Levels 8-11 (equivalent to HNC/D – degree level). They assume foundation knowledge in maths, English, physics, and/or chemistry, according to job role. A depiction of the framework can be seen in Figure 1.

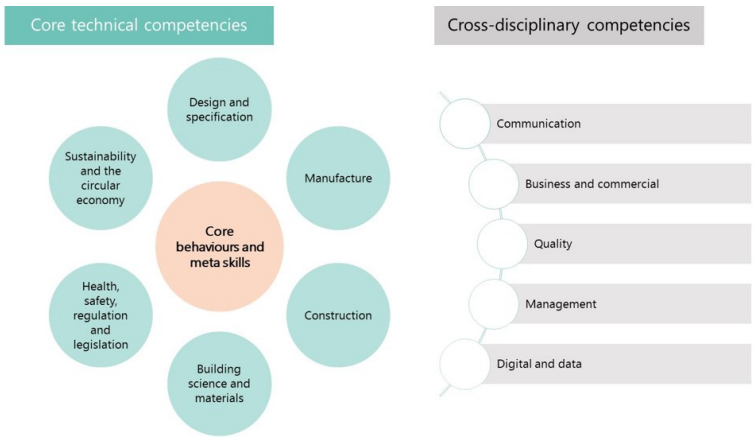

Fig. 1. Competencies Identified in the Timber TED Framework

The framework outlines specific content in each technical competency area, referring to technologies, processes, materials, systems, and standards that enable practitioners to maximise a globally responsible approach to timber construction. Six core behaviours and meta skills are identified that sit at the centre of all competency development and must be fostered alongside the technical knowledge, without which its implementation would be impeded. These are: Critical thinking and problem solving, Innovation, Collaboration and teamwork, Organisation, Professionalism and career development, and Ethics.These competencies speak to the durable, transferable skills essential to interdisciplinary and inclusive work. They spur the ability for judgement, creativity, initiative, reflection, and lifelong learning which is applicable to professional, academic, and civic life. Finally, cross-disciplinary

competencies are articulated which reflect the knowledge and skills that then enable the technical competencies and core behaviours to combine for optimum capability development as well as for delivery of the sustainable built environment.

Taken together, the competencies outlined in the Timber TED Framework are designed to help learners put technical principles into practice in an effective and responsible way. Crucially, they move beyond a focus on solving technical problems and explicitly call for the development of knowledge, skills, and behaviours that reflect the broader environmental, social, and economic impacts that built environment professionals must acknowledge and grapple with. They are written so that they could easily be adapted into learning outcomes or performance standards within many engineering disciplines, meaning that they have relevance to students, educators, professionals, accreditors, and employers.

2.2 Course Development and Framework Implementation

The Centre for Advanced Timber Technology (CATT) at the New Model Institute for Technology and Engineering (NMITE) in Hereford, UK, was established in 2021 in partnership with Edinburgh Napier University (ENU) and TDUK to be a centre for timber engineering excellence and to drive the change towards new ways of building, learning, and working. In response to the development of the Timber TED Competency Framework, CATT educators developed a comprehensive and flexible training programme in partnership with TDUK. The programme is comprised of 2 hybrid short courses, TED 1 and TED 2. TED 1 focuses on learning outcomes necessary to understand timber as a structural material, the array of product options, and how they can be used to respond to a design brief sustainably. TED 2 builds on this by creating a broader understanding of timber in construction and design for manufacture and assembly approaches including available technologies. Learners gain specialist knowledge and skills for ‘better, faster and greener’ built environment delivery. Grounded in immersive ‘learning by doing’ activities, Timber TED stimulates critical thinking and instils new knowledge and skills to achieve net zero carbon. Both courses are delivered over 12 weeks and consist of three modules: a design module featuring a real-world challenge running for 12 weeks, and two complementary modules running for 6 weeks each in sequence. While the majority of learning takes place online, learners are brought together for three 3-day residential blocks where they engage with local partners, work in teams, and present their projects. To illustrate this structure, Figure 2 shows the delivery and content of the TED courses.

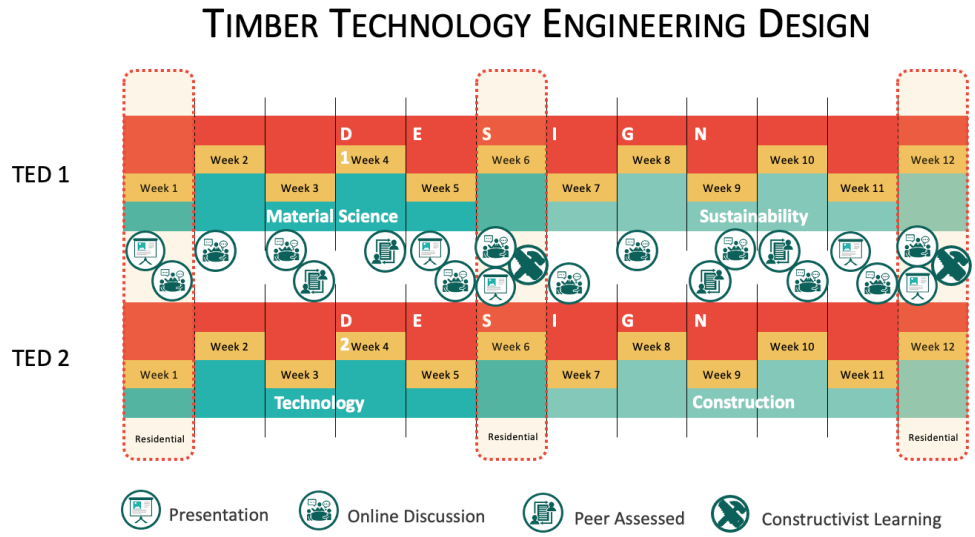

Fig 2. A visual depiction of the TED course structure

3 FINDINGS

Each strategic action has resulted in a key outcome. First, the Timber TED Competency Framework was endorsed by industry and formally released as part of a Timber in Construction Skills Action Plan in December 2022 which called for training and development in timber technical knowledge and core skills to help achieve net zero carbon. Second, the TED educational programme was approved by Chartered Institute of Architectural Technologists as a continuing professional development course, and approval is in process with the Construction Industry Training Board. Finally, the Timber TED short courses were launched at CATT in Sept 2022 in partnership with local employers Oakwrights, Taylor Lane and Border Oak as well IBI Group, Fast House and Stirling Prize Winning architectural practice dRMM and Wood Award Winner Stage One. So far, 24 learners (42% female) have undertaken TED 1 over two cohorts (September 2022 and January 2023), and the first iteration of TED 2 began in June 2023 with 11 learners participating. The learners represent many different roles and industries, including architecture, design, engineering, and sales. This allows for a multidisciplinary learning environment, enabling a more holistic approach to problem solving.

Stakeholder feedback has been collected via surveys of learners and industry partners, and it has been overwhelmingly positive. Learners particularly appreciated the experiential opportunities such as a productive forestry walk and sawmill visit, and the introduction to new skills and technologies such as timber grading and 3D scanning. Comments from the surveys include:

Quote from learner: " I believe that courses such as TED 1 offered at NMITE are required by the industry if we hope to diversify our knowledge of more sustainable construction materials and methods to reach our Net Zero 2050 ambitions."

Quote from Industry: “we need to attract into our industry the next generation, educate and train them well so that they can grow quickly into the driving force for

the use of wood and all the advantages to global warming the greater use of timber brings."

These testimonials demonstrate how student demands and industry needs can collectively inform an approach to sustainable engineering for the built environment.

However, a more robust assessment approach is required to ensure alignment with the Timber TED Framework, provide guidance on continuous improvement, and inform other initiatives such as accreditation and industry recognition of professional development. Additionally, further work must be done to connect these efforts with other areas of the built environment sector. As emphasised by the report *Modernise or Die* (Farmer 2016), construction culture is broken and there is a need for improved levels of collaboration with disciplines working together to create sustainable solutions.

4 NEXT STEPS AND SUMMARY

While initial efforts have been focused on the competency framework development and the corresponding educational delivery, the next crucial component is to enact an assessment approach. This will be achieved through tools created by the Housing Construction Innovation Scotland – funded organisation Daydream Believers. In July 2023 the usefulness and transferability of their STAMP iT and STELLAR assessment tools will be employed to provide quality evaluation of the Timber TED courses and learning. A corresponding assessment activity will correlate Timber TED efforts to the CIOB Corporate Plan 2023-28 which aims to bring about cultural change that ensures quality and building safety are never sacrificed for profit and equips modern professionals with the knowledge and skills necessary to delivery construction processes in environmentally sustainable ways that also champion diversity, inclusion, and worker welfare. Further, a multi-stakeholder leadership group for timber industry skills will be established, and an open access knowledge library of timber information is being created that can be used across sectors including within engineering education. Finally, a delivery model via regional hubs across the UK is being trialed as a means for upscaling and reaching more learners.

Indeed, the innovative educational approaches adopted within the Timber TED courses (hybrid delivery, challenge-based, real-world scenarios, working in diverse teams) for the purpose of achieving the Timber Skills Action Plan could easily translate to other areas of engineering education beyond timber and beyond the built environment and serve as a model for other industries and disciplines.

Ultimately, the hope is that sustainable skills development within the built environment can in turn inform the development of more sustainable policies. When engineers are competent in the knowledge, skills, and mindsets required for responsible and regenerative design and delivery, they can develop the confidence to advocate for a better future for people and the environment.

The development of the TED1 and TED2 courses, with learning outcomes aligned to the Timber TED Competency Framework's professional skills and capabilities,

demonstrate a method that could be replicated to encourage innovative engineering education that meets the need for sustainable engineering practice.

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