**An effective approach to embedded learning of professional skills contextualized in engineering practice.**

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**1. Introduction**

Professional skills are an essential element of the modern engineering curriculum, and are required to provide graduates with the ability to competently approach the challenges of tomorrow. Even though professional skills are incorporated into engineering programs, employers still struggle to recruit graduates with sufficiently developed abilities. With industrial positions evolving in scope, do traditionally based educations adequately prepare students for the professional practice of engineering post-graduation? Unfortunately, even when professional skills are incorporated into engineering programs, this question persists as professional skills are often not embedded as integrated curricular themes facilitating continual, incremental development. While professional skills focused modules are essential for introducing new concepts, these modules are often non-technical in nature, and time-limited to a specific term. This approach routinely leads to a disjointed student experience, where professional skills are not applied within a real-world context and are disconnected from the broader curriculum, while constraining student development to a single term. On the other hand, directly embedding professional skills within core modules also leads to challenges, such as inconsistency of assessment format and evaluation criteria, tacit discouragement of incremental development, and application of professional skills in a manner not directly relevant to engineering in-practice. In particular, both approaches encourage the development of professional skills outside of a practical engineering or industrial context, and limit incremental development, as professional skills are practiced in unrelated contexts lacking a unified theme woven throughout the program. As a result, it is difficult to develop practical professional skills beyond a superficial level following these approaches.

In notable contrast to the above approaches, capstone design courses often foster significant development of practical professional skills. This often stems from the practical, integrated nature of engineering design. The quintessential design project incorporates and links core engineering theory, experimental results, process modelling, safety analyses, further impacts, and consideration of the broader context. The integration and delivery of such projects actively develops professional skills in a practical, professional context. Unfortunately, by this point of their studies, many students have already adopted poor habits, and must unlearn, acquire, and build professional skill competency within the duration of a single project. While capstone projects enable effective development, due to their time-bound nature, they are not singularly adequate for preparing students to enter the engineering community.

**2. Methods and discussion**

Aside from industrial placements, design projects are often the closest to real-world practice students experience throughout their education. Acknowledgment of this reality provides the opportunity to develop an effective approach to embedding professional skills into an engineering curriculum from the onset of study. By embedding a coherent through-line of practical design, unified by a common theme and structure, the disadvantages of the classical approaches can be mitigated, and synergistic advantages arise. The elements to this approach include both professional skills focused modules and design projects embedded in core modules. Although, unlike the classical approach, the professional skill modules and embedded design projects serve only as part of a unified professional skills thread that builds rigor through the course of the program. In this manner, profession skills are holistically co-developed as essential elements of applied engineering in-practice.

**3. Results and conclusions**

An implementation of the discussed approach has become the favored method for professional skills development within the Department of Chemical Engineering at University College London (UCL). This approach has been enabled by the integration of a core through-line of practical design incorporate during each academic term. Multiple design projects are embedded in core modules each term and are facilitated as independent design sprints, with sequentially increasing rigor. The design projects are directly complimented by corresponding Design and Professional Skills modules, providing the requisite continuity for incremental development. The direct link between design projects and professional skills modules provides immediate context for taught professional skills, including engineering specific skills (e.g. safety evaluation, sustainability assessment, applied ethics). The success of this implementation is resultant of not only program structure, but also the structure of the design project sprints. Design projects are framed as a program nexus, with links throughout the program, and are perceived by students as independent milestones of the university experience. Herein, program structure and design project case studies will be critically discussed, focusing on both the successes and limitations of this approach.