Reforming Engineering Education: An Experiential Approach to Control Systems Design and Building Sustainability

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ABSTRACT

Feedback control systems are an important part of a mechanical, electrical, and chemical engineers' undergraduate curriculum and are found in a myriad of industrial applications. All too often undergraduate coursework is presented by chalkboard or PowerPoint lectures, which has established a passive standard of learning. This teaching strategy has led to poor learning outcomes and forms an intangible basis of one's knowledge when designing feedback control systems in practice. The National Science Foundation has awarded Dr. Melody Baglione a Transforming Undergraduate Education in STEM (TUES) grant to reform this learning process under the project, "Building Sustainability into Control Systems Courses". The main goal of this project is to enhance the student's experiences in the feedback control systems course by incorporating an experiential laboratory component. Specifically, the laboratory curriculum addresses topics of heating, ventilation, and air conditioning (HVAC) process control, as well as energetics and environmental sustainability. This supplementary laboratory experience reinforces theoretical concepts presented in lecture while simultaneously exposing students to a practical application of feedback control systems.

Cooper Union's academic building at 41 Cooper Square is a recently built development designed for high energy efficiency and reduced environmental impact. Its features have earned it a Leadership in Energy and Environmental Design (LEED) platinum rating by the U.S. Green Building Council. The minimized costs and demands of operation can be partly attributed to the control system design for the building's novel HVAC system. Therefore, 41 Cooper Square harbors considerable characteristics that are worth studying by Feedback Control Systems students at Cooper Union. Elements of the HVAC control system within the building have been integrated into the laboratory component of the course. In particular, a curriculum has been developed around water level, flow, and temperature process control (PROCON) rigs by Feedback Instruments© featuring similar parameters found within the HVAC system.

This poster will specifically highlight the development of the experiential PROCON curriculum, preliminary outcomes, and role of the undergraduate teaching assistant. An HVAC tour of 41 Cooper Square and hands-on laboratory exercises work in tandem with the theoretical material presented in lectures to form a comprehensive introductory foundation for feedback control systems. Student learning outcomes were measured using specially crafted pre- and post-concept inventory surveys and writing assignments accordingly. Student feedback from Student Assessment of their Learning Gains (SALG) survey instruments and interviews by an external assessor suggests the experiential approach helps students appreciate the real-world applicability of control systems theory. The positive learning outcomes from this curriculum development have motivated a revamped hands-on approach across the mechanical engineering undergraduate curriculum for Cooper Union students in the future.