Building Sustainability into Control Systems Courses

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Goal
The project aims to improve student learning of control systems by:
1) Creating new learning experiences leveraging a new energy efficient, LEED-certified academic building; and
2) Developing hands-on process control laboratory scenarios connecting traditional classroom theory to a building systems theme.

Expected Outcomes
As a result of these new teaching strategies and learning materials students should be able to:
1) Describe the basic operational principles of central HVAC systems;
2) Identify the control goals, process variables, controller inputs/outputs, sensors and actuators; and
3) Consider the energy consumption and environmental impact during system, component, or process design.

Methods & Strategies
The project exposes mechanical engineering students to real-world control systems applications while weaving in sustainable design principles by:
1) Creating a website with system descriptions, photos, and diagrams to accompany mechanical room and building Management System tours; and
2) Designing new experimental scenarios using bench top process control rigs and configurable software interface from Feedback, Inc.

Evaluation Methods
The assessment plan consists of both direct and indirect measures. Students describe the systems in a short writing assignment; the assignment is evaluated using a cognitive skills rubric based on Bloom’s Taxonomy (both shown below). Customized pre- and post- Student Assessment of Learning Gains (SALG) surveys assess perceived learning gains and affective outcomes.

Preliminary Findings
Preliminary faculty observations and student survey results suggest exposing students to real-world applications of classroom theory positively impacts learning and engages students in the learning process. Providing students with background learning material about the systems on a website before the tour increases their conceptual understanding.

Survey results generally reveal students view building systems tours as an opportunity to appreciate the real-world applicability of control systems theory.

Future Work
• Integrate building energy usage and automation data on website
• Design new experimental scenarios using upgraded controller and configurable software interface for liquid-level and temperature process control rigs
• Create problem solving assignments that mirror building systems (e.g., rain water harvesting system, radiant panel heat exchangers)
• Further assess impact on student learning and motivation (e.g., focus groups or interviews, observations of student behavior, and/or concept inventories)
• Continue to encourage and advise advanced building modeling, energy analysis, and building controls undergraduate and Master’s research projects
• Disseminate results via publications, a symposium hosted by Cooper Union, and the Engineering Pathway CSE electronic library

Acknowledgements
Special thanks to Gerardo del Cerro, George Sidebotham, and the Cooper Union Facilities staff, especially Julio Santillana and Jody Grapes.