Building Sustainability into Control Systems Courses

Objectives

- Improve student learning of control systems by:
  1. Creating new learning experiences leveraging a new Leadership in Energy & Environmental Design (LEED) Platinum-certified academic building,
  2. Developing hands-on process control laboratories connecting classroom theory to a building systems theme.

Methodology

-Expose mechanical engineering students to real-world control systems applications while weaving in sustainable design principles by:
  1. Integrating new experiments that mirror actual building systems using bench top process control rigs and configurable software interface,
  2. Facilitating synthesis of control systems theory using building content management website, real-time data, and mechanical room tours.

Evaluation

Assessment plan measured student learning outcomes, the project’s impact on student motivation, as well as the efficacy of the project beyond its initial implementation and consisted of:

1. Pre- and post- Student Assessment of Learning Gains (SALG) surveys

As a result of your work in this course, what gains did you make in:

- Integrating how studying control systems helps engineers address real-world issues
  - Interest in taking additional classes or working on projects related to control systems

2. Writing assignment grading rubric

3. Pre- and post- concept inventories

4. External evaluator/instructor observations and student interviews

- To evaluate the efficacy, in Fall 2014, an instructor unaffiliated with the project implemented the new course interventions.

41 Cooper Square

41 Cooper Square is a 175,000 square feet, LEED Platinum-certified academic and laboratory building. The building has two 500-ton chillers, natural gas fired boilers, heat exchangers for radiant ceiling panels, water- and air-side economizers, and a 250 kW cogeneration plant. A state-of-the-art Building Management System (BMS) operates the building’s heating, ventilation, and air conditioning (HVAC) systems.

Outcomes

New course components help students appreciate the real-world applicability of control systems.

- Measurable gains in three new learning outcomes:
  1. Identifying control systems
  2. Describing basic HVAC operational principles, and
  3. Considering the environment and energy consumption during design.
- Affective outcomes include:
  1. Increased interest in projects related to building systems (Students are working with faculty and facilities staff to improve building operations)
  2. Students pursuing building systems & sustainability advanced degrees
  3. Acquired vocabulary and knowledge help students get industry jobs

Broader Impacts

- Students learn industry relevant skills so graduates are better prepared.
  - Professional organizations have asked to use content for training manuals & webinars
  - Graduates refer back to the job
- Learning content is scalable and adaptable.
  - Content and professional training adaptable as undergraduate course modules or boot camps
  - Community college interested in adapting process control labs into Energy Services & Technology program

Future Work

Build on established academic, industry, and government partnerships to disseminate, evaluate, adapt, and scale-up project.

1. Incorporate feedback from Center for Sustainable Engineering (CSEE) Electronic Library peer-review and other colleges
2. Continue to develop adaptable and scalable curricular modules
3. Continue work with CUNY Building Performance Lab to apply Building Re-Tuning
4. Share energy savings strategies with NYC Carbon Challenge University partners
5. Continue engaging students in building projects & implementing energy savings

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*The HVAC mechanical rooms/BMS tours helped provoking a common real-world application of the course materials. It also strengthened my interest in controls, maybe even leading to interest in a controls engineering professor in the future.* ~ Fall 2012 Student

*I tend to be a 'big picture' type of person. If I knew exactly why I’m learning something, it is easier for me to learn... After seeing the building’s systems and sensors, I was able to make the connection between theory and reality, so learning in class became easier.* ~ Fall 2012 Student

*Hands-on approach proved valuable in emphasizing non-obvious characteristics of systems. For example, it is easier to control the level of the tank than the flow rate into it because the capacitance of the tank causes slow response times.* ~ Fall 2014 Student

*I think having labs really helps in learning the material. The things we do in class are theoretical and sometimes it’s hard to see what actually happens in reality. Labs help visualize what really occurs as we change the different variables.* ~ Fall 2013 Student

*The valuable thing learned from the project is sustainability. You can learn about all sorts of systems and models in the classroom, but to get an idea of industry standards and terminology is very valuable.* ~ Fall 2014 Student

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