## THE COOPER UNION Reforming Engineering Education:

An Experiential Approach to Control Systems Design and Building Sustainability Tyler DiStefano (B.Eng. Mechanical Engineering) The Cooper Union for the Advancement of Science and Art, New York NY



- York City that features energy efficient and complex systems
- Use 41 Cooper Square's heating, ventilation, and air condition (HVAC) system as a platform for the Feedback Control Systems laboratory curriculum
- > Develop and provide a tangible laboratory experience that naturally supplements the theoretical coursework in the Feedback Control Systems course
- > Expose engineering students to practical applications of basic process control systems found in HVAC industry

## **Engineering Theory & Practice in** Laboratory Curricula



Basic Process Rig [BPR] (Fluid Level/Flow)

Temperature Process Rig [TPR] (Fluid Temperature)

## Feedback Control Systems Laboratory Development

**Guided** Direction

**Laboratory Practicals:** 

- System Time Constant [BPR]
- On/Off Control Hysteresis [BPR/TPR]
- PID Control Parameters [BPR/ TPR]
- Ziegler-Nichols Tuning [BPR]



Laboratory Outcomes:

- Conceptually supplement theoretical subject matter with laboratory exposure
- Tangible experience • controlling systems that mimic HVAC processes

## Measuring Student Outcomes

**Student Assessment of Learning Gains (SALG) Survey Results** How much did the PROCON laboratory exercises help your learning? 30% N = 2328% Average Rating = 3.525%

#### Student Benefits

"Very useful for learning how theoretical knowledge is applied in reality."

"Strong introduction to actual control systems and helped solidify class knowledge and make it applicable ." "Being able to fiddle with the numbers and seeing how the response changes is a lot easier to understand than the theoretical concepts discussed in class."



# Semi-Structured

- > Adapt a semi-structured<sup>1</sup> laboratory curriculum around Feedback Instruments<sup>©</sup> process control (PROCON) rigs
- > Role of the undergraduate teaching assistant is to integrate this pedagogical structure within the Feedback Control Systems course

Instructor / Teaching Assistant



How much did the PROCON Background Reading and Laboratory Questions help your learning?



Evidence

"Labs were a great first introduction to actually using controls and seeing how they impact a system."

### **Constructive Critiques**

"They felt very separate from the lectures..."

"They were cook book labs..."

"....Sometimes we felt pressured for time."

"Lots of messing around with things to get things to work."

### Conclusions

- $\triangleright$  According to student responses, a majority of the class considered the PRÓCÓN laboratory curriculum as a helpful experience for their learning
- ➢ Background reading and laboratory questions could be improved to further help students' learning
- ➢ Need to find the right balance between

experimentation and guided direction for laboratory exercises

### **Future Directions**

- Submit PROCON laboratory curriculum to mechanical engineering faculty at other institutions for
- Integrate experiential laboratory component across upper-level mechanical engineering coursework (e.g. Fluid Mechanics, Heat Transfer, Thermodynamics, Experimentation, etc.)
- Streamline laboratory exercises to address the students' concern about time pressure References

[1] Sheppard, Sheri, et al. Educating Engineers: Designing for the Future of the Field. San Francisco: Jossey-Bass, 2009. Print.

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