Integrating Smart Technologies into Campus Facilities: A Senior Design Project

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Course Name & Description: ECE Senior Design Project I and II (ECE 492/493)
This is a required one-year course sequence for Electrical and Computer Engineering (ECE) majors in the College of Engineering and Computer Science (CECS).   In this culminating experience, students design complex engineering projects, one as individuals and one as part of a team. Projects are subject to realistic constraints and require the integrated application and extension of science, engineering, economic and social concepts. Ethics, written and oral communications, and methods of technical problem solving will be included.

Project Abstract: This course re-design focuses on the team project component of the ECE 492/493 sequence. During the 2016/2017 academic year, a team of students enrolled in this course sequence designed, built, and tested a prototype Smart Restroom with the goals of reduced energy and water usage and waste production. The goal was to expose students to the modern engineering process in the context of a real world problem with a focus on sustainable solutions.

GE Credit (if applicable): No
Instructional Delivery: Laboratory

Pedagogical Approaches: Team-based learning, increased use of technology
Class Size: 80 students divided into teams of six students each

Stage 1: About the Course and the Students
Course History/Background
- ECE 492/493 is a one-year course sequence required for all ECE students. It is designed to be a culminating experience taken in the final year.
- Team projects should be designed to have realistic constraints and require the integrated application and extension of science, engineering, economic and social concepts. Ethics, written, oral communication and methods of technical problem solving should be also included.
- Currently there is no sustainability themed curriculum in the department. This will be the first design project introduced with elements of sustainability.
- Students in the course are typically assigned a project and then expected to work independently in their team with very little faculty supervision.

High Demand / Low Success Issues
- Many ECE students do not complete their senior design project according to schedule.
- This results in delayed graduation.

Motivation for Course Redesign
- Students are assigned a group project by the course instructor. There is a standard list of projects that has been used for years.
- Students find that the projects currently used are not very motivating.
- Most projects do not include real world problems, particularly those related to sustainability issues.
- With the course re-design students were assigned to solve a real world engineering problem that exists on campus. The assignment of this real world problem gave the students an end to end engineering experience and the opportunity to consider environmental factors in their design

Stage 2: About the Student and Instructors
Student Characteristics
- All electrical and computer engineering undergraduates must complete this course sequence
- Students in this course sequence are typically in their last year

Course SLOs Aligned with Course Redesign
c. An ability to design systems which include hardware and/or software components within realistic constraints such as cost, manufacturability, safety and environmental concerns.
d. An ability to function in multidisciplinary teams.
f. An understanding of ethical and professional responsibility.
g. An ability to communicate effectively through written reports and oral presentations.
h. An understanding of the impact of engineering in a social context.
k. An ability to use modern engineering techniques for analysis and design.

Assessment Plan: Regular evaluations by faculty determined how well the students were progressing. At several times during the year students presented their progress to the CALL champion and other physical plant personnel.

About the Instructors
Sharlene Katz, Ph.D., P.E. and James Flynn are faculty members in the ECE Department. They have collaborated on a number of senior and graduate projects over the past 10 years.

About the Faculty Staff Partner
Austin Eriksson is the Director of Energy and Sustainability at California State University, Northridge.

Stage 3. Course Redesign Planning
Course Redesign Plan
- Supervise a group of senior design students on a project to develop a proof-of-concept system using sensor and communications technology to yield a smarter, green cleaning program for campus restrooms.
- Most custodial plans are largely "open loop"; spaces are cleaned based on a time schedule rather than use of need. This may result in wasted water, cleaning products, etc.
- Students will design a system that informs the custodial staff when a restroom needs to be serviced based on a variety of sensor inputs.
- Throughout the project, the focus would be on using technology that uses little or no additional power, does not produce additional pollution, and does not require extensive adjustment or maintenance.

Influence of CALL on Course Redesign
- CALL provided students with an opportunity to design a real world system on their own campus
- CALL provided students with funding for parts and supplies.
- Director of Energy and Sustainability (and CALL Champion) on campus met with the team several times during the project to receive progress reports and provide feedback.

Stage 4. Course Redesign Impact on Teaching and Learning
Students designed, built and tested a prototype Smart Restroom that includes:
- Sensors to detect low and/or empty paper towel and toilet paper dispensers
- Sensors to count the number of people entering a restroom in a given time period
- Sensors to measure the utilization of a restroom based on motion
- Sensors to detect flooding in a restroom
- An RFID reader to update website after a restroom is serviced
- A website that displays the status of each sensor in the restroom
- A flexible network topology that allows restrooms and sensors to be added to the system

Effect of Redesign on Teaching and Learning
- Instructors were provided with a real world problem for the course
- Students were given the opportunity to work within real constraints to solve a problem
- Instructors were given an opportunity to closely study the challenges of team work

Student Impact
- Working on a real world problem in the campus environment was motivational to students
- All six students on the team completed their project work on time resulting in no graduation delays

Mastering of SLOs
The redesign had a positive impact on SLOs c, d, f, g, h, and k above

Incorporation of Technology:
- Document sharing with Google Apps
- Use of Chat rooms for collaboration outside of regular meetings
- Creation of a dynamic web site
- Use of project management software.

Elements of Sustainability. The final project:
- Focuses on using technology that uses little or no additional power, does not produce additional pollution, and does not require extensive adjustment or maintenance.
- Will result in reduced water, paper product, and cleaning product use
- Reduces unnecessary trips and associated transportation costs

CSUN

PROJECT NAME: Integrating Smart Technology into Campus Facilities

CALL CHAMPION: Austin Eriksson

LEAD FACULTY PARTNER: Sharlene Katz / Jay Flynn

Learning Outcomes

- **Describe proposed course in one sentence; including campus sustainability element**
- This is a capstone course for electrical and computer engineering students that will use sustainable engineering approaches to solve real world sustainability problems or issues on the CSUN campus.
- **What specific skills will students learn? What knowledge will they gain?**
- Students will learn to collaborate on a team, design a system to meet requirements, and incorporate sustainability as a requirement in any project. Additionally, they will develop their professional and communications skills.
- **What Sustainability Outcomes does your team want the students to achieve?**
- The sustainability outcomes are to reduce energy use, water use, and waste.

Connecting to CALL

- **How does this proposed course align with CALL program objectives?**
- Facilities and the College of Engineering and Computer Science are teaming up to develop innovative approaches to campus operations, maintenance, cleaning, etc. using smart technology.
- **Which activities can CALL program support?**
- CALL will support the development of a Smart Restroom system
- **What is the team's vision for the next year as part of the CALL redesign program?**
- During the coming year, the CSUN team will design, build and test a prototype Smart Restroom with reduced energy and water usage and reduced waste.

Overcoming Obstacles

- **Are there mismatches between desired learning outcomes and sustainability outcomes?**
- **Do you need to modify existing outcomes?**
- There are no obstacles anticipated at this time. The team has already connected with campus IT and facilities staff to insure a good working relationship.

Tracking Success

- **How will you know if students achieved Sustainability Outcomes?**
- Pre and post measurements of waste, water, and other resources will be made and compared.
- **How will you know if this redesigned course is an improvement over the current version? How will you measure?**
- An end of the year survey with students will determine their satisfaction with the course. Regular evaluations by faculty will determine how well the students are progressing on the learning outcomes.

Taking Action

- **What tasks/activities will the students perform?**
- The team will design, build and test a prototype Smart Restroom.
- **What role will facilities/sustainability officer have in redesign process and course delivery?**
- The facilities/sustainability officer is an important part of our team. He will attend regular meetings with the team, contribute to the development of system requirements, evaluate the team's progress, and work with the team as a liaison with physical plant management.

Future Tasks

Designing the assignments
- **Structure of assignments (group/solo)**
- **Sequencing of assignments**
- **What kind of formative assessment/feedback along the way?**
- **Background info needed to achieve goals of this course?**

Defining Criteria for Success
- **Characteristics of the finished product**
- **How will you assess whether product demonstrates student learning?**
- **How will you assess whether students have addressed Sustainability Outcomes?**
- **How will you describe assignment to students?**
- TBD

CALL OBJECTIVE

The 'Campus as a Living Lab' Grant Program is a unique opportunity to partner faculty and facilities management staff in using the campus as a forum for the exploration of sustainability concepts and theories.