

Engage Students in Engineering – using Everyday Engineering Examples



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Abstract

Fifty percent of students entering engineering programs do not earn an engineering degree. Many students leave engineering because unsatisfactory experiences in introductory engineering courses in their first and second years. Improving student engagement through the use of everyday examples is one key ENGAGE strategy because research indicates that this strategy has a powerful impact upon students' satisfaction with and perseverance in engineering. This project implemented Everyday Engineering Examples (E³s) in four engineering classes to teach technical concepts through a ENGAGE E³s mini-grant. This paper introduces ENGAGE project and E³s and shares the benefits of our E³s mini-grant experience and strategies of using the E³s examples in engineering classes.

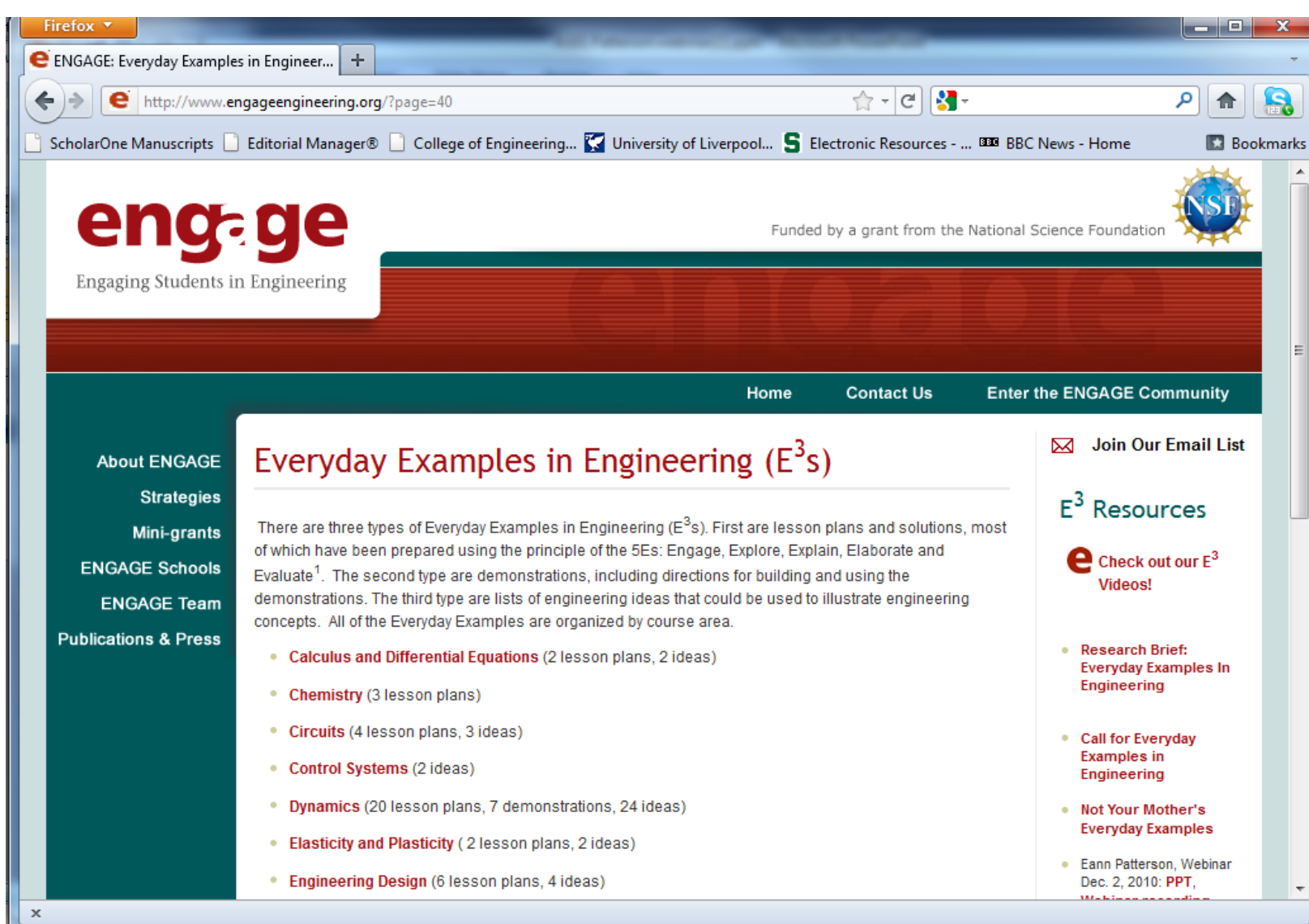
ENGAGE

ENGAGE is an extension services project, funded by NSF GSE (Research on Gender in Science & Engineering). The goal of ENGAGE is to increase the capacity of engineering schools to retain undergraduate students (1st and 2nd year) by facilitating the implementation of three research-based strategies to improve the educational experience. ENGAGE is working with faculty and administrators from over 70 engineering schools to implement ENGAGE strategies including:

1. Improve and increase interaction between faculty and students.
2. Use everyday examples in engineering to teach technical concepts.
3. Improve spatial visualization skills of students with weak skills.

Everyday Examples in Engineering (E³s)

E³s are examples that demonstrate a concept, based on objects and ideas with which students are familiar. E³s, like exploding coke cans, musical instruments, salt-water taffy, bicycles, or avalanches are more engaging to students than are the more typical examples such as I beams and boiler pipes. ENGAGE has developed numerous E³s for first and second year engineering courses as well as E³s video demonstrations, which can be found in the <http://www.engageengineering.org>.



UB ENGAGE E³s Mini-Grant

School of Engineering at the University of Bridgeport was among ten engineering schools selected in February 2013 to receive a E³s mini-grant to implement Everyday Examples in Engineering in their classrooms. The purpose of the ENGAGE mini-grant (\$2000) is to offset expenses associated with initial implementation of an Everyday Examples in Engineering (E³s) program in four engineering courses:

1. ENGR 111 Introduction to Engineering in Fall 2013 by Dr. Navarun Gupta,
2. MEEG223 Material Science for Engineers in Spring 2013 and Spring 2014 by Dr. Junling Hu,
3. CPEG 210 Digital Systems I in Spring 2013, Fall 2013, and Spring 2014 by Dr. Miad Faezipour, and
4. CPEG 315 Digital Systems II in Fall 2013 by Dr. Miad Faezipour.

E³s Examples in ENGR 111 Introduction to Engineering

Cellular Telephone System Design

- Teach engineering design process in a hands on manner to ENGR 111 (Introduction to Engineering) students
- Apply computer tools such as WWW, Excel and Word to create the design
- Steps involved in the process:
 - Problem definition
 - Problem Evaluation
 - Problem Solution
 - Communication



Problem and Solution

- Cellphone area of coverage: 329 square miles
- Structures over 30 ft now allowed in the city
- Non overlapping hexagonal cells used
- Radius of typical cell ~ 5 Km
- To do:
 - discuss of how to place antennas to address the political difficulties
 - discussion how many cells you will be needed
 - a map of cell locations with antenna locations indicated

E³s Examples in MEEG 223 Materials Science for Engineers

Structure-Properties-Processing

- Bobby pin experiments
 - Experiment 1 - bend and not break
 - Experiment 2 - heat it in propane flame, then quench in water, bend and break
 - Experiment 3 – Reheat bobby pin in candle flame, cooled in air to room temperature, bend and not break



Polymer Structures and Properties

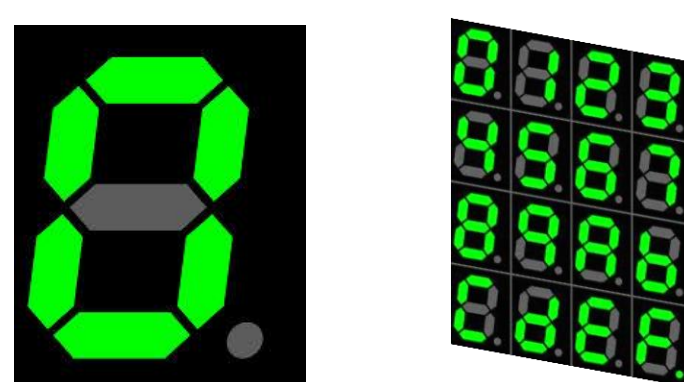
- Regular-size spaghetti vs chopped-up spaghetti
 - Molecular weight and properties
- Copper wires vs licorice sticks
 - Structure and properties



E³s Examples in CPEG 210/315 Digital Systems I/II

Seven Segment Decoders

- For Freshman/Sophomore Computer Science and Engineering
- Topics:
 - Digital Design of Combinational Logic
- Activity:
 - Explore the seven segments of the LCD display
 - Design and simplify the Logic of each segment
 - Connect the derived logic to turn on/off LEDs in a 7-segment display



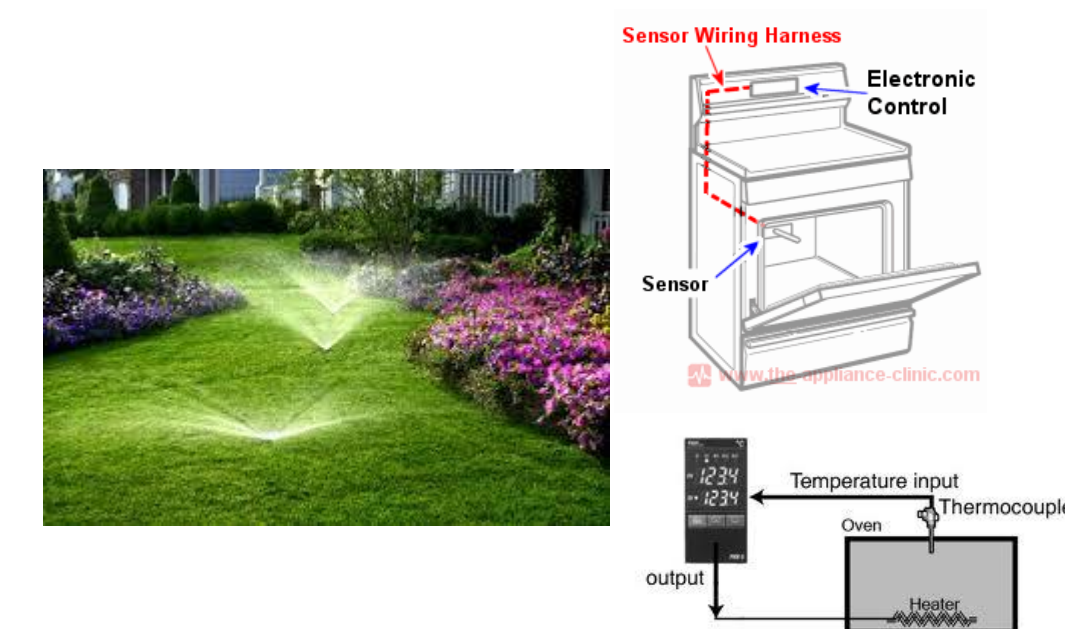
Alarm Clock Design

- For Sophomore and early Junior in Computer Engineering
- Topics:
 - Digital Design of Combinational and Sequential Logic
- Activity:
 - Identify inputs and outputs (alarm time, alarm enable, alarm buzz, snooze)
 - Find the sequence of logic leading to the design and implement using discrete logic gates
 - Implementation can be programmed on an FPGA



Many E³s for Computer Engineering Digital Systems I and II courses developed:

- Lawn Sprinkler Controller,
- Oven Temp Controller,
- Password Detector,
- Frequency Divider
- Design and implementation concepts of combinational and sequential logic introduced
- Opportunity to implement/test designs using development board



Outcomes of using E³s Examples in the Four Classes

- Students have been found to be more engaged in class. They ask for more questions and actively participated in discussions.
- Students have been more enthusiastic to learn when we relate the engineering concept to real everyday engineering examples.
- Students have been found to be more apt to continue a course of study if the work involves subjects and activities that interest them and they are confident of.
- Everyday examples are designed to be things students already are familiar with so they have a comfort level and some basic intuitive understanding they can apply to the engineering concept.
- Familiar examples that students can easily visualize, like cellphones, digital decoders, alarm clocks, sprinklers, bobby pins, and pastas, are more interesting and familiar to students than more traditional examples like I beams and boiler pipes.
- Everyday examples enhance the likelihood that students will be interested in and will better retain the information they learn.
- Students are also encouraged to use of critical thinking in the everyday engineering examples.