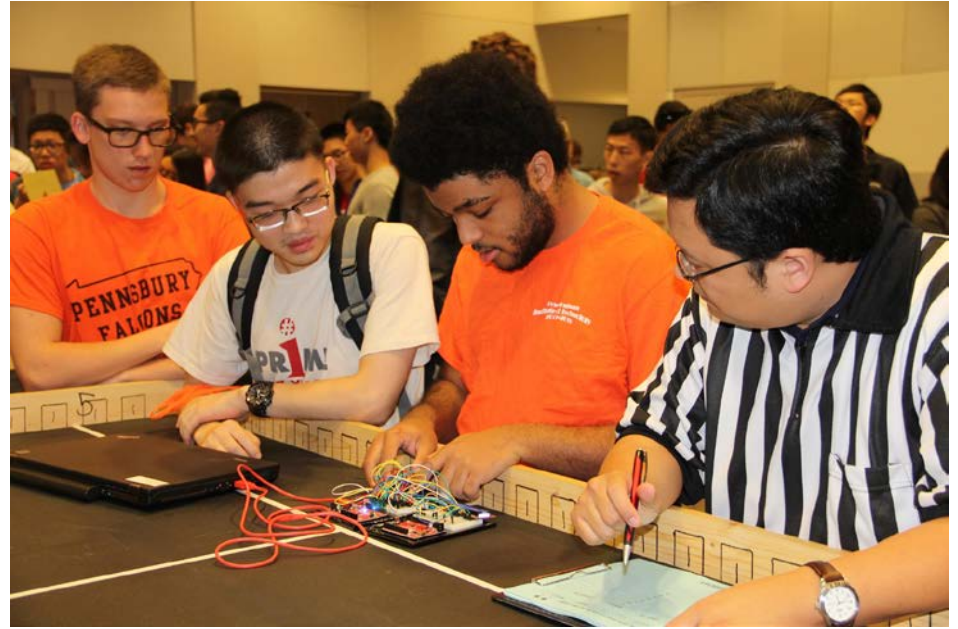


**From LEGO^(R) to Arduino:
Enhancement of ECE freshman design with practical
applications**

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Lego MindStorms \Rightarrow Arduino Microcontrollers



Motivation

- Create a stronger emphasis on electrical and computer engineering concepts as early as the first quarter
 - Show what electrical and computer engineers can do
 - Help with retention within the ECE major
- Improve programming and circuit building skills
- Increase the technical rigor
- Encourage a maker spirit

Objectives

- Learn about concepts in electrical and computer engineering, such as electronics, systems, and basic programming
- Learn about teamwork and the design process
- Learn presentation and documentation skills
- **Have Fun!**

SparkFun Inventor Kit

- Sample programs
- Sample circuit diagrams
- Arduino Uno Microcontroller
- Resistors
- LEDs
- Pushbuttons/Keypad
- Buzzer
- Breadboard
- LCD
- Wireless Transceiver
- Sensors (infrared, temperature)



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Schedule

2 credit hours

Meets twice a week for 2-hour periods

- Weeks 1 - 4 Mini-Projects (8 total)
- Week 5 Midterm Project
- Weeks 6 - 8 Final Project
- Week 9 Competition
- Week 10 Final Report/Presentation

Grading Scheme

Individual (60%)

- Mini-Projects (40%)
 - Demonstration
 - Journal
 - Code
- Midterm Project (10%)
- Participation (5%)
- Quizzes (5%)

Team (40%)

- Final Project (20%)
 - Demonstration
 - Memos
 - Code
- Final Presentation (10%)
- Final Report (10%)

Mini-Projects

- Learn to build simple circuits
- Learn to write simple programs in Sketch (similar to C)
- Keep an online journal about what they learned, observed, new skills, challenges, questions

Mini-Projects

1. LEDES (Digital Outputs)
2. Pushbuttons and Potentiometers (Inputs)
3. RGB LED & Buzzer (Outputs) [[Video](#)]
4. Temperature Sensor & LCD [[Video](#)]
5. Object Avoidance & Motors [[Video](#)]
6. Servos & Joystick [[Video](#)]
7. Keypad & Relay [[Video](#)]
8. Wireless Communication [[Video](#)]

Journal

Reflective learning journal

- States learning objectives
- High level procedure overview
- Observations
- New skills learned
- Challenges
- Questions

Demonstration and Code

- Show and explain a working mini-project in class
- Submit properly commented code with a header description
- Show efficiency and modularity by using variables, constants, functions, for loops, and conditionals

Midterm Project

- Multifunction Transistor Tester Kit
- Learn how to solder
- Learn how to recognize and test resistors, capacitors, inductors, diodes, transistors
- Keep for Rose-Hulman career



Quizzes

Weekly quizzes

- Hardware Components:
 - Electrical Components
- Software Components:
 - Functions
 - Syntax
 - Conditionals

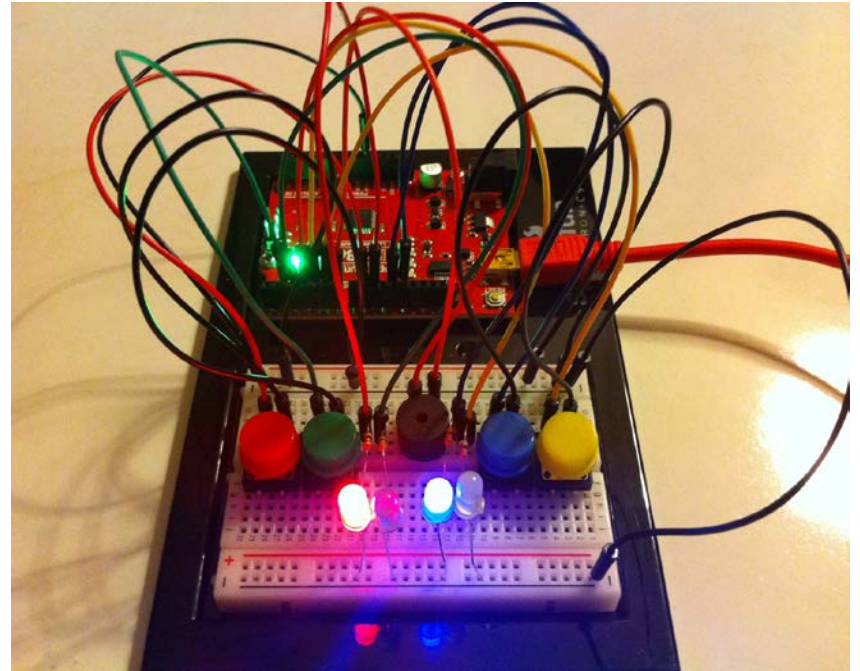
Final Project

- Build on prior projects (integrate concepts)
- Working in teams of three
 - Alternating roles: Hardware, Software, and Documentation
- Less explicit instruction
- Several milestones and demonstration checkpoints
- Document progress in weekly memos
- Final Project Report and Presentation

Final Project

Simon Says

- 70s Electronic Memory Game
- Add statistics on LCD
- Add rewind mode
- Original Game
- Project Game
- Enhanced Game



Course Evaluations



Positives:

1. Appreciated integration of microcontrollers
2. Enjoyed creativity and soldering project
3. Less complaining about paperwork

Criticisms:

1. Less explicit instruction on mini-projects
2. More explicit programming and circuit instruction
3. Asked for robots for final project
4. More clear competition rules
5. Schedule too rigorous

Connections to other ECE Courses

Freshmen:

- ECE 203 – DC Circuits
- CSSE 120 – Introduction to Software Development

Sophomore:

- ECE 230 – Embedded Systems
- ECE 233 – Introduction to Digital Systems

Conclusions

- More instruction on hardware and software concepts in the beginning
- Bring back the robots, but with a focus on sensors and peripherals versus building
- Get more non-ECE majors to register for the course

Conclusions

- Presentations, Reports, and Memos were acceptable although greatly reduced from prior years
- As usual students need more explicit instruction on quality submissions, grammar, spelling, punctuation
- Although some students really struggled in the beginning, most were successful by the end
- No significant change in course grades or evaluations

Future Work

- Create a basic intro to programming and breadboard assignment
- Create more challenging/rigorous mini-projects, final projects, and competitions (remote, sensors, motors, wheels, robot, wireless communication)
- Stagger the soldering tutorials and increase midterm project work time due to space constraints

Questions

www.rose-hulman.edu

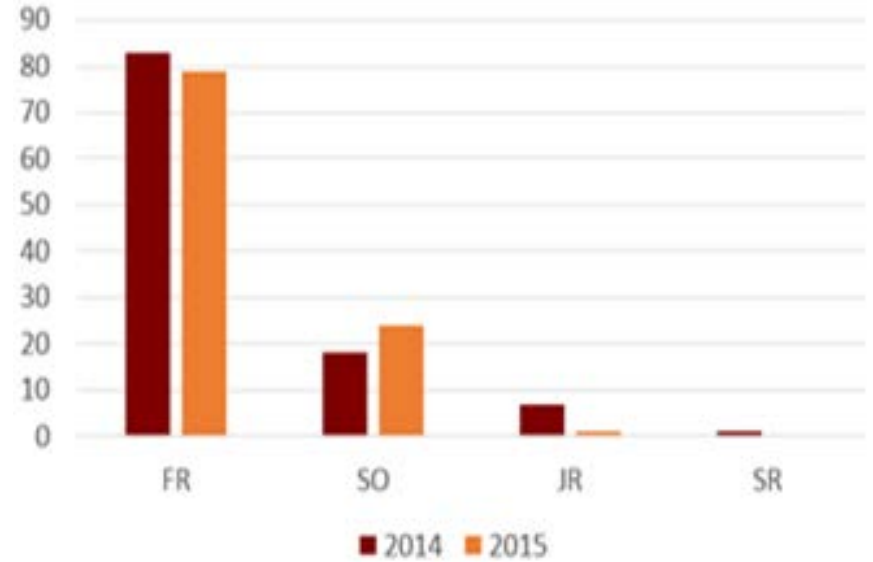
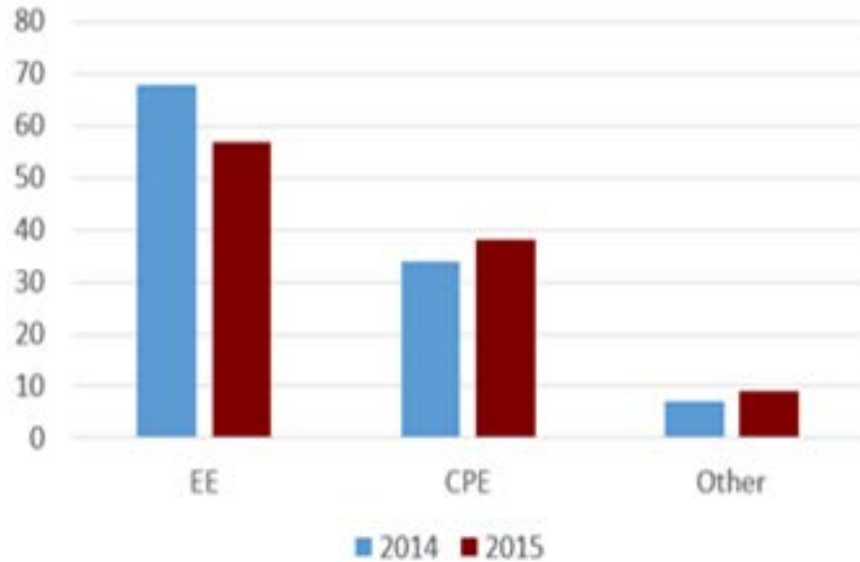


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Course Demographics



Future Work

- Put ethics professional development memo back in the course
- Create competition rules quizzes in addition to hardware and software quizzes
- Consider increasing the number of credit hours to 3 to match the workload