

Project-Based Methods to Teach NGSS Engineering Practices in Physics Classroom

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Goals of the Class

- Impart to students a flavor of what engineering entails: teamwork, design, innovation, imagination, ...
- Teach students the science behind the engineering of the projects they complete.
- Students design and build devices that accomplish tasks and measure how well they perform.
- Students conceive, propose, design and build novel projects with the goal of advancing the human condition.

Assessment

<u>Category</u>	<u>Weight</u>
Short Projects/Journal Entries	40%
Final Project	40%
Unit Test	10%
Class Participation	10%

Short Projects

- Small groups (2-3 students)
- 4-6 hours classroom time
- Design constraints specified
- Performance objectives are also defined
- ½ of grade is based on performance
- ½ of grade is based on journal entry
 - Student demonstrate understanding of concepts that were applied to this project
 - Students reflect on strengths and weaknesses of their design
- Midterm test (early in 2nd quarter) on concepts learned

Boat

- Students build a boat given 1 roll of duct tape and 1 4x8 sheet of foam insulation
- Must paddle in pool
- Speed contest: time for one lap
- Endurance: most laps in 5 minutes
- Concepts: Forces, buoyancy, stability, drag



Wind Turbine

- ❑ Students build gearbox from basic kit
- ❑ They optimize blade design; choose vertical or horizontal shaft
- ❑ Contest: maximize average power over 5 minute period
- ❑ Concepts: Energy transfer and efficiency; drag; lift; electrical power



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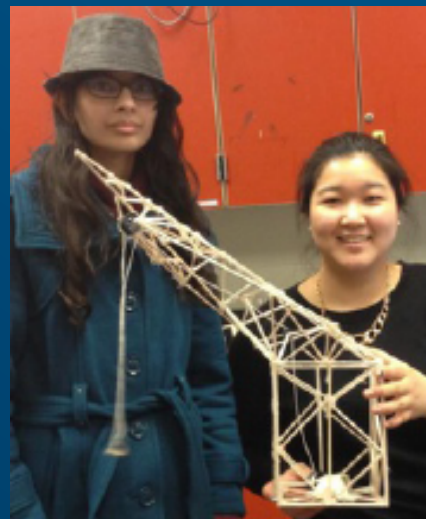
Hydraulic Arm

- Students arm basic kit
- They modify swivel-base and fingers to grasp plastic golf balls and deliver them to a pipe.
- Contest: move 5 balls in a minimum amount of time
- Concepts: Hydraulics; levers; mechanical advantage



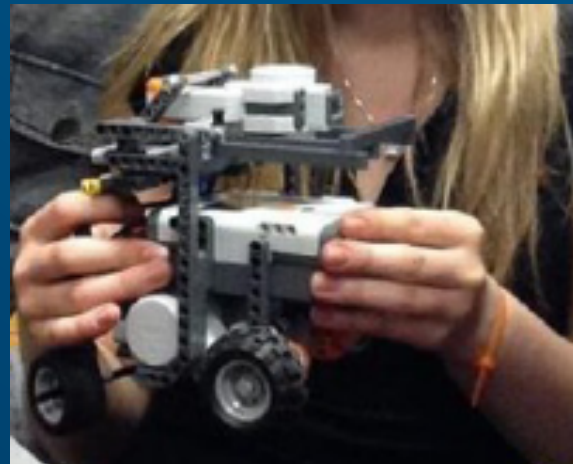
Crane

- Students are given a motor, counterweights, pulleys, string, and a fixed amount of balsa wood
- They design a crane to lift a specified mass to a specified height.
- Bonus points if they exceed specifications of either mass or height
- Concepts: Structural strength, torque, mechanical advantage of levers and pulley systems



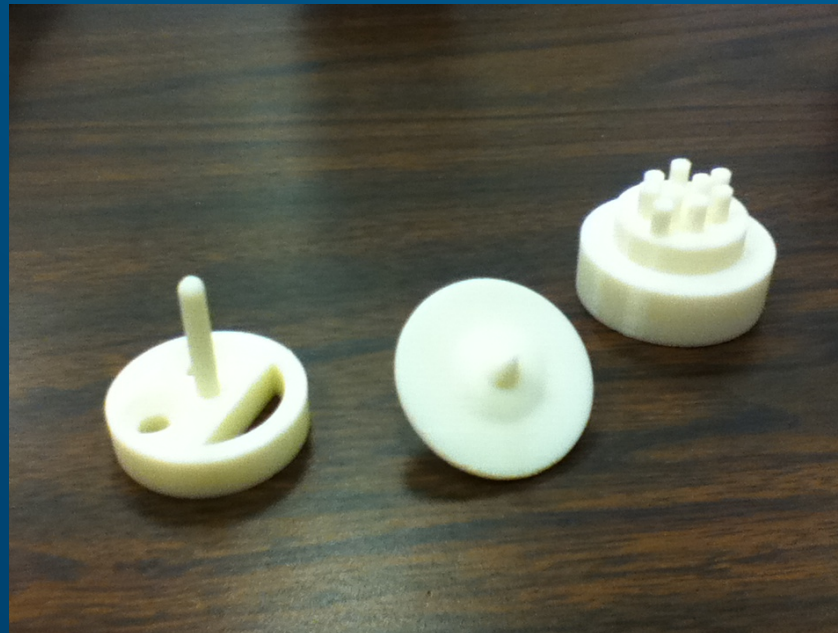
Lego Mindstorm Robots

- Students build and program a Mindstorm robot to navigate an obstacle course.
- Students are required to use at least 2 different sensors and incorporate input response in program
- Contest: Time to complete the course or degree of completion of the course.
- Concepts: logic programming; feedback and feedforward control.



CAD/3D Printer

- Students complete a tutorial on SolidWorks and design a small part to be constructed on a 3D printer



Final Project

- Goal: Build working prototype; advance the human condition
- Each student proposes/presents an idea
- 5-6 project ideas are selected
- Students work in groups (3-4) to design and build a working prototype
- Presentations and reports are at end of the semester

Final Project



Final Project

