Submitted by: Kellie Schneider
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Freshman Engineering Program
University of Arkansas
Fall Semester 2012

Biomechanical Project 1
Water Filter
Topic Summary

Outcomes

At the end of the Engineering Design Project 1: Water Filter, each student should possess:
1. experience working on a team;
2. an understanding of the engineering design process;
3. a fundamental understanding of the use natural materials in a water filtration system;
4. an ability to construct a technical report.

Project Tasks

Task 1- Form a team

In class on Monday, September 10 or Tuesday, September 11, students will be assigned to teams of three or four. Locate your team, introduce yourselves, exchange contact information and record the information in the table provided.

Team #	Team Name:	
Member Name	Email	Phone

Task 2- Build a Filter

Use the time allotted during class to build your filter.
Hint: Take measurements as you build your filter so that you can replicate/improve your results later.

Materials and Tools:

- 500mL water bottle
- Cotton Ball
- Drainage rock
- Pea gravel
- Sand
- Scissors
- 9 oz Collection cup (clear plastic)
- 8 oz Styrofoam cup

Filter Construction

- Remove the label from the bottle and write your team name/number on it
- Empty the contents of the water bottle into the clean water collection tank.
- Cut the bottom off of the bottle (less than 1”)
- Poke four or five pin size holes in the cap. (place the cap back on the bottle)
- Invert the bottle(cap down)
- Add a cotton ball to the bottom (cap end)
- Add a 1”-2” layer of drainage rock (10-15 rocks)
- Add a 1”-2” layer of pea gravel (level it)
- Add a 2”-3” layer of sand (level it)

Filter Holder Construction

- Cut a hole in the bottom of the Styrofoam cup large enough for the bottle cap
- Cut the top edge of the Styrofoam cup until the edge will fit inverted inside the plastic one
- Place the inverted Styrofoam cup into the plastic collection cup
- Place the filter bottle (cap down) onto the Styrofoam cup

<u>Task 3- Check Flow Rate</u>

Once your filter is built, examine whether your filter will flow under ideal conditions. Pour 100mL of clean water through your system. Measure the time it takes to collect your water from your filter and the amount you collected. Record the data and calculate the flow rate. Repeat the process multiple times to check accuracy. Compare the clarity of your water to the pure water.

<u>Task 4- Filtration</u>

Once your filter has shown that it can pass clean water, you must determine whether it can actually filter particles. Set up your filter as you have done previously. Add 100mL of “dirty water” to the filter. Again, you should measure the flow rate. You should also keep a sample of the water for comparison. Repeat the process three more times. Compare your results for flow rate and water clarity.

Safety Note: Although your filter should produce clear water, there may still be bacteria in it. You would then have to boil the water to kill the microorganisms before drinking it.

Task 5- Design Improvement

Using only the materials and tools provided for your original filter, create a second design which you think may improve the filtering process. Explain the changes you made to the design. Why you think it will improve the filtration? Experiment with your design and record your results.

Task 6 – Obtaining a quality resource

Find a magazine article, journal article, government document, or book that shows a practical application of water filtration. Provide a complete reference for the item. Include information from your reference in the Background portion of your technical report.

Project Assessment (300 project points)

Intermediate Deliverable 1 (50 points)

Prior to the end of class on Wednesday, September 12 (sections 004 and 005) or Thursday, September 13 (sections 012 and 013) each team should demonstrate a working water filter for their instructor or Primary TA.

Intermediate Deliverable 2 (100 points)

In class on Wednesday, September 19 (sections 004 and 005) or Thursday, September 20 (sections 012 and 013), teams will submit their final filter design. Each filter will have three cycles of 100mL of dirty water added to it. Samples will be collected from the third cycle on each filter. The samples will be compared against the other teams for yield, clarity, and color.

Honors Students: In class on Wednesday, September 19 (sections 004 and 005) or Thursday, September 20 (sections 012 and 013), honors teams will be asked to reconstruct their filter from scratch during the class period. Each filter will have three cycles of 100mL of dirty water added to it. Samples will be collected from the third cycle on each filter. The samples will be compared against the other teams for yield, clarity, and color.

Final Deliverable (150 points)

Each student will complete an individual technical report in the form of a 1 – 2 page memo. The memo should include background information including real-world applications associated with inexpensive water filtration, a summary of the tasks accomplished during the Biomechanical Project 1, a summary of your filter and how it compared to other teams, and a peer evaluation.

In class during the week of September 24, students will have an opportunity to work on their memo, and the Engineering Librarian will discuss appropriate citation styles and library resources for inclusion in technical reports. The memo should follow the FEP Assignment Policy with regards to Formatting of Word-Processed Work Submitted as Part of an Assignment. The completed memo should be uploaded to the individual section BlackBoard page (not the master course) by 4:20pm on Monday, October 1 (sections 004 and 005) or Tuesday, October 2 (sections 012 and 013).

Peer Evaluation
Include the Peer Evaluation in your memo. There are 100 total points to be allocated.

Your Name: Points Assigned:
Tasks you completed:

Team Member 1 Name: Points
Assigned:
Tasks Member 1 completed:

Team Member 2 Name: Points
Assigned:
Tasks Member 2 completed:

Team Member 3 Name: Points
Assigned:
Tasks Member 3 Completed:

Submitted by: Kellie Schneider
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Freshman Engineering Program
University of Arkansas
Fall Semester 2012

Computing Project 1

Arduino Basics

Topic Summary

Outcomes

At the end of the Engineering Design Project: Arduino Basics, each student should possess:

1. experience building and testing a programmable circuit;
2. experience programming for the Arduino Uno R3 Microcontroller;
3. experience with LEDs and resistors;
4. experience working on a team;
5. an ability to construct a technical report.

Project Tasks

Task 1 – Forming a team and obtaining an Ardunio kit

In class on Monday, September 10 or Tuesday, September 11, students will be assigned to teams of two or three. Locate your team, introduce yourselves, exchange contact information and record the information in the table provided.

Team #	Team Name:	
Member Name	Email	Phone

Task 2 – Constructing your initial circuit

With the help of the instructor, build a simple circuit using the Arduino Uno, breadboard, two wires (one connected to GND and one connected to port 13), one LED, and one resistor. Connect the Arduino to the computer with the provided USB cable and open the Arduino Uno program. If you would like to obtain a copy of the software for your computer, a download is available at http://arduino.cc/en/Main/Software. You may need to change the serial port setting by clicking on “Tools” and then “Serial Port”. A green light next to the word “ON” should be lit up on the Arduino Uno. Next, click on “File”, “Examples”, “Basics”, and “Blink”. Click the arrow button to upload the “Blink” program. Watch your light blink.

Task 3 – Constructing a circuit with two LEDs

Using another wire, resistor, and LED add another light to your breadboard. The LED should be connected to port 12. Go back to the "Blink program" and modify the code to make both lights blink.

Save your completed program as "SecXXX_TeamXX_TwoBlinkingLights.ino."

Example Code for Task 3

```
int led = 13;
int led2 = 12;

void setup() {
pinMode(led, OUTPUT);
pinMode(led2, OUTPUT);
}

void loop() {
digitalWrite(led, HIGH);
delay(1000);
digitalWrite(led, LOW);
delay(1000);
digitalWrite(led2, HIGH);
delay(1000);
digitalWrite(led2, LOW);
delay(1000);
}
```

Task 4 – Binary Numbers

Build and program a circuit, by modifying the "Blink" program,that counts from 0 to 16 using only 5 LEDs.Binary is a base 2 counting system that only uses the digits 1 and 0. All numbers and values can be expressed in binary form. The following table shows all the binary representations from the numbers 0 to 16:

Table 1. Decimal to Binary Numbers

Decimal Number	Binary Number
0	00000
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000
9	01001
10	01010

11	01011
12	01100
13	01101
14	01110
15	01111
16	10000

Your team must use 5 LEDs to represent the binary digits in the table above. A “1” indicates a lit LED and a “0” is an unlit LED. For example, when the 5 LEDs are lit in the pattern in figure 1, the number should be read as 13.

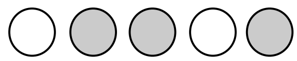

Figure 1. Lit LEDs Representing 13 in Binary

Save your completed program as “SecXXX_TeamXX_BinaryNumbers.ino.”

Task 5 – Battlestar Galactica

Build and program a circuit, by modifying the “Blink” program,with 9 LEDs that flash back and forth in a straight line. Battlestar Galactica has a landing strip of running lights. Your team should replicate one bank of LEDs that light up successively in a straight line within one row/column of lights. The link below gives an example of the lighting succession that should be used:

http://www.youtube.com/watch?v=za33Fe5Ygvc

Save your completed program as “SecXXX_TeamXX_BattlestarGalactica.ino.”

Task 6 – Jeopardy!

Build and program a circuit, by modifying the “Blink” program, with 9 LEDs that replicates the timer used after a contestant buzzes in on the game show “Jeopardy!”.A link below gives an example of the lighting succession that should be used:

http://www.youtube.com/watch?v=xJno60x3T1A

Save your completed program as “SecXXX_TeamXX_Jeopardy.ino.”

Task 6H – Knight Rider (Honors Students Only)

Complete Task 6. In addition, Build and program a circuit, by modifying the “Blink” program, with 9 LEDs that chase themselves in a straight line as seen in the 1980’s television program “Knight Rider”.A link below gives an example of the lighting succession that should be used:

http://www.youtube.com/watch?v=VgMpZFDnlEU

Save your completed program as “SecXXX_TeamXX_KnightRider.ino.”

Task 7 – Obtaining a quality resource

Find a magazine article, journal article, government document, or book that shows a practical application of microcontrollers. Provide a complete reference for the item. Include information from your reference in the Background portion of your technical report.

Project Assessment (300 project points)

Intermediate Deliverable 1 (50 points)
Prior to the end of class on Wednesday, September 12 (sections 002 and 007) or Thursday, September 13 (sections 010 and 015) students should complete Tasks 1 – 3 and demonstrate completion of the tasks to their instructor or primary TA.

Intermediate Deliverable 2 (10 points)
Before class on Wednesday, September 19 (sections 002 and 007) or Thursday, September 13 (sections 010 and 014), each team should submit one e-mail containing all Arduino program files to their primary teaching assistant. (Students in the regular sections will submit 3 programs, and students in the honors sections will submit 4 programs). The sender of the e-mail should cc all teammates on the e-mail.

Intermediate Deliverable 3 (90 points)
In class on Wednesday, September 19 (sections 002 and 007) or Thursday, September 13 (sections 010 and 014), teams will build a 9 LED circuit and then demonstrate each of their submitted programs. An individual team member will be chosen at random to demonstrate each program. All team members should be prepared to answer questions regarding the content of the programs.

Final Deliverable (150 points)
Each student will complete an individual technical report in the form of a 1 – 2 page memo. The memo should include background information including real-world applications associated with microcontrollers (see Task 7), a summary of the tasks accomplished during the Computing Project 1, a summary of the programming techniques used including a brief discussion on loops, and a peer evaluation.

In class during the week of September 24, students will have an opportunity to work on their memo, and the Engineering Librarian will discuss appropriate citation styles and library resources for inclusion in technical reports. The memo should follow the FEP Assignment Policy with regards to Formatting of Word-Processed Work Submitted as Part of an Assignment. The completed memo should be uploaded to the individual section BlackBoard page (not the master course) by 4:20pm on Monday, October 1 (sections 002 and 007) or Tuesday, October 2 (sections 010 and 015).

Peer Evaluation
Include the Peer Evaluation in your memo. There are 100 total points to be allocated.

Your Name: Points Assigned:
Tasks you completed:

Team Member 1 Name: Points Assigned:
Tasks Member 1 completed:

Team Member 2 Name: Points Assigned:
Tasks Member 2 completed:

Submitted by: Kellie Schneider
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Freshman Engineering Program - University of Arkansas
Fall Semester 2012

Robotics Project 1

LEGO Mindstorms Basics

Topic Summary

Outcomes

At the end of the Engineering Design Project: LEGO Mindstorms, each student should possess:

1. experience constructing a LEGO Mindstorms robot;
2. experience programming with LEGO Mindstorms;
3. experience with light sensors and bump sensors;
4. experience working on a team;
5. an ability to construct a technical report.

Project Tasks

Task 1 – Forming a team and obtaining a Mindstorm kit

In class on Monday, September 10 or Tuesday, September 11, students will be assigned to teams of three or four. Locate your team, introduce yourselves, exchange contact information and record the information in the table provided. Complete the LEGO Mindstorm Liability Form, and obtain your assigned Mindstorm kit.

Team #	Team Name:	
Member Name	Email	Phone

Task 2 – Constructing a basic robot

Use the provided instruction manual to assemble your basic robot. Begin with Step 1 (on page 8) and continue the assembly through Step 17 (on page 22). Implement the program depicted on page 22 of the instruction manual.

Task 3 – Completing the "Drive in Square" tutorial

You will need access to the LEGO Mindstorms Education NXT 2.1 Programming software. The software is installed on all computers in the FEP Computer Lab (ENGR 337). You may also install the software to your personal laptop by visiting the TA office hours.

In groups of two, students should complete the "Drive in Square" tutorial. To access the tutorial, open the LEGO Mindstorms Education NXT 2.1 Programming software. From the main page, expand the “Common Palette” by clicking on the “+” and choose “08. Drive in Square”. The Building Guide indicates the robot assembly required for the tutorial. “Drive in Square” requires the “driving base” completed in Task 2. The Programming Guide includes step-by-step instructions for completing the tutorial. Once you have completed the tutorial, download the program to your robot and test it. Make modifications as necessary to the parameters in your program until your robot drives in a square.

Save your completed program as “SecXXX_TeamXX_DriveInSquare.rbt.”

Task 4 – Modifying your robot

Modify for your robot to include a light sensor and a bump sensor. Use steps 22 – 23 in the instruction manual to add the light sensor, and use steps 26 – 28 to add the bump sensor. Test your sensors by using implementing the programs on page 35 and 45, respectively. (Note that we have had difficulty in implementing the program on page 35.)

Task 4H – Modifying your robot (Honors Students Only)

Complete Task 4. In addition, modify for your robot to include an ultrasonic sensor. Use steps 20 – 21 in the instruction manual. Implement the program depicted on page 31 of the assembly guide.

Task 5 – Completing the “Follow A Line” tutorial

In groups of two, students should complete the “Follow A Line” tutorial. To access the tutorial, open the LEGO Mindstorms Education NXT 2.1 Programming software. From the main page, expand the “Common Palette” by clicking on the “+” and choose “17. Follow A Line”. The Building Guide indicates the robot assembly required for the tutorial. “Follow A Line” requires the “driving base” completed in Task 2 and the “light module down” completed in Task 4. The Programming Guide includes step-by-step instructions for completing the tutorial. Once you have completed the tutorial, download the program to your robot and test it. Make modifications as necessary to the parameters in your program until your robot follows a line.

Save your completed program as “SecXXX_TeamXX_FollowALine.rbt.”

Task 6 – Completing the “Detect Touch” tutorial

In groups of two, students should complete the “Detect Touch” tutorial. To access the tutorial, open the LEGO Mindstorms Education NXT 2.1 Programming software. From the main page, expand the “Common Palette” by clicking on the “+” and choose “18. Detect Touch”. The Building Guide indicates the robot assembly required for the tutorial. “Detect Touch” requires the “driving base” completed in Task 2 and the “touch module front”. Note that in Task 4, you created the “touch module back” attachment, so you will need to modify your program accordingly. The Programming Guide includes step-by-step instructions for completing the tutorial. Once you have completed the tutorial, download the program to your robot and test it. Make modifications as necessary to the parameters in your program until your robot stops when the bump sensor encounters an object.

Save your completed program as “SecXXX_TeamXX_DetectTouch.rbt.”

Task 6H – Completing the "Sensor Bumper" tutorial (Honors Students Only)

Complete Task 6. In groups of two, students should also complete the "Sensor Bumper" tutorial. To access the tutorial, open the LEGO Mindstorms Education NXT 2.1 Programming software. From the main page, expand the "Common Palette" by clicking on the "+" and choose "19. Sensor Bumper". The Building Guide indicates the robot assembly required for the tutorial. "Sensor Bumper" requires the "driving base" completed in Task 2 as well as the "touch module back" and "ultrasonic module" completed in Task 4H. The Programming Guide includes step-by-step instructions for completing the tutorial. Once you have completed the tutorial, download the program to your robot and test it. Your program should drive forward until an ultrasonic sensor encounters an object then travel backward until the bumper sensor encounters an object. Modify your code so this action is repeated 3 times.

Save your completed program as "SecXXX_TeamXX_SensorBumper.rbt."

Task 7 – Completing the "Calibrate Sensor" tutorial

In groups of two, students should complete the "Calibrate Sensor" tutorial. To access the tutorial, open the LEGO Mindstorms Education NXT 2.1 Programming software. From the main page, expand the "Complete Palette" by clicking on the "+" and choose "34. Calibrate Sensor".The Building Guide indicates the robot assembly required for the tutorial. "Calibrate Sensor" requires the "driving base" completed in Task 2 and the "light module down" completed in Task 4. The Programming Guide includes step-by-step instructions for completing the tutorial. Once you have completed the tutorial, download the program to your robot and test it. Make modifications as necessary to the parameters in your program until your sensor is properly calibrated.

Save your completed program as "SecXXX_TeamXX_CalibrateSensor.rbt."

Task 8 – Obtaining a quality resource

Find a magazine article, journal article, government document, or book that shows a practical application of robotics. Provide a complete reference for the item. Include information from your reference in the Background portion of your technical report.

Project Assessment (300 project points)

Intermediate Deliverable 1 (50 points)
Prior to the end of class on Wednesday, September 12 (sections 001 and 008) or Thursday, September 13 (sections 009 and 016) students should complete Tasks 1 – 3 and demonstrate completion of the tasks to their instructor or primary TA.

Intermediate Deliverable 2 (10 points)
Before class on Wednesday, September 19 (sections 001 and 008) or Thursday, September 13 (sections 009 and 016), each team should submit one e-mail containing all robot program files to their primary teaching assistant. (Students in the regular sections will submit 4 programs, and students in the honors sections will submit 5 programs). The sender of the e-mail should cc all teammates on the e-mail.

Intermediate Deliverable 3 (90 points)
In class on Wednesday, September 19 (sections 001 and 008) or Thursday, September 13 (sections 009 and 016), teams will demonstrate their implementation of the tutorials associated with the project. An individual team member will be chosen at random to perform each task. All team members should be prepared to answer questions regarding the content of the programs.

Final Deliverable (150 points)

Each student will complete an individual technical report in the form of a 1 – 2 page memo. The memo should include background information including real-world applications associated with robotics (see Task 8), a summary of the tasks accomplished during the Robotics Project 1, a summary of the programming techniques used including a brief discussion on loops, and a peer evaluation.

In class during the week of September 24, students will have an opportunity to work on their memo, and the Engineering Librarian will discuss appropriate citation styles and library resources for inclusion in technical reports. The memo should follow the FEP Assignment Policy with regards to Formatting of Word-Processed Work Submitted as Part of an Assignment. The completed memo should be uploaded to the individual section BlackBoard page (not the master course) by 4:20pm on Monday, October 1 (sections 001 and 008) or Tuesday, October 2 (sections 009 and 016).

Peer Evaluation
Include the Peer Evaluation in your memo. There are 100 total points to be allocated.

Your Name: Points Assigned:
Tasks you completed:

Team Member 1 Name: Points Assigned:
Tasks Member 1 completed:

Team Member 2 Name: Points Assigned:
Tasks Member 2 completed:

Team Member 3 Name: Points Assigned:
Tasks Member 3 Completed:

Additional Tutorials
In preparation for Project 2, students are encouraged to continue working with their robot and completing additional tutorials. The following tutorials may be useful in the next project:

- Common Palette
    - Driving
        - Drive Forward, Reverse, Accelerate, Curve Turn, Point Turn, My Block 1, Parking Bay
    - Sensors
        - Detect Distance, Detect Dark Line, Follow a Line, Detect Touch, Sensor Bumper
- Complete Palette
    - React to Distance, React to Light, Rotation Sensor, Reset Rotation Sensor, Calibrate Sensor, My Block 2

Submitted by: Kellie Schneider
University of Arkansas
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Freshman Engineering Program - University of Arkansas
Fall Semester 2012

Structures Project 1
West Point Bridge Design
Topic Summary

Outcomes

At the end of Engineering Design Project1: West Point Bridge Design, each student should possess:

1. experience using the engineering design process;
2. a basic understanding of compression and tension forces in truss systems;
3. a basic understanding of design optimization;
4. experience working on a team;
5. an ability to construct a technical report.

Project Tasks

Task 1- Form a team

In class on Monday, September 10 or Tuesday, September 11, students will be assigned to teams of two or three. Locate your team, introduce yourselves, exchange contact information and record the information in the table provided.

Team #	Team Name:	
Member Name	Email	Phone

Task 2 – Getting Started with the West Point Bridge Design Software

Students wishing to download the West Point Bridge Design 2012 software may do so at http://bridgecontest.usma.edu/download.htm. The software will also be available in the computer lab. When the software loads, choose "Create a New Bridge Design" and use the Bridge Design Setup Wizard. Read the design requirement and indicate that you are not participating in a local bridge contest. Select your site configuration, the deck material, and loading configuration given the design specification from West Point Bridge Design

Problem Statement and Design Objective

You are a civil engineer working for the Department of Transportation. You have been assigned responsibility for the design of a truss bridge to carry a two-lane highway across a river valley. Your objective is to design a truss bridge that costs as little as possible while still passing the load test with no member failures.

Design Specifications

For a complete listing of the design specifications, select the “Help” button on the Design Project Setup Wizard.

Contest Information

Select “No” on the Local Contest Information page of the Setup Wizard. We are not participating in an official contest although there will be a competitive component to some of the project grading.

Deck Elevation and Support Configuration

The total cost of the design is the Site Cost plus the Truss Cost. In general, designs that increase Site Cost tend to reduce the Truss Cost. Try to find the best balance between these two competing costs. For more information on selecting a site configuration, select the “Help” button.

Deck Material and Truck Loading

You may select either Medium-Strength or High-Strength concrete for the deck of your bridge. To learn more about the trade-offs associated with the materials, use the “Help” button. For this project, we will use the “Standard 225kN Truck” loading.

Truss Templates

You may use one of the built-in truss templates or you may create your own. To learn more about truss stability, select the “Help” button.

Title Block

Include your team name and give the project a meaningful ID so you may keep track of your various designs.

Truss Design

Follow the instructions to activate the drawing board and create your truss design. Run the Load Test to check the strength of your design. Strengthen any members that fail and run the Load Test again. Repeat this process until you have a successful design.

Task 3 – Designing your Bridges

Use the West Point Bridge Design Software to create three bridges with the design specifications shown below. The only requirement for these bridges is that you submit a "successful design" for each scenario.

Bridge A

Deck Elevation: 24 meters

Support Configuration: standard abutments, pier, and no cable anchorages

Loading: Standard 225kN Truck

Save your completed program as "SecXXX_TeamXX_BridgeA.bdc."

Bridge B

Deck Elevation: 12 meters

Support Configuration: arch abutments, no pier, and no cable anchorages

Loading: Standard 225kN Truck

Save your completed program as "SecXXX_TeamXX_BridgeB.bdc."

Bridge C

Deck Elevation: 4 meters

Support Configuration: standard abutments, no pier

Loading: Standard 225kN Truck

Save your completed program as "SecXXX_TeamXX_BridgeC.bdc."

Task 3 H – Additional Designing your Bridges (Honors Only)

Use the West Point Bridge Design Software to create three bridges with the design specifications shown below. The only requirement for these bridges is that you submit a "successful design" for each scenario.

Bridge D

Deck Elevation: 24 meters

Support Configuration: standard abutments, pier, and no cable anchorages

Loading: Permit 472kN Truck

Save your completed program as "SecXXX_TeamXX_BridgeD.bdc."

Bridge E

Deck Elevation: 12 meters

Support Configuration: arch abutments, no pier, and no cable anchorages

Loading: Permit 472kN Truck

Save your completed program as "SecXXX_TeamXX_BridgeE.bdc."

Bridge F

Deck Elevation: 4 meters

Support Configuration: standard abutments, no pier

Loading: Permit 472kN Truck

Save your completed program as "SecXXX_TeamXX_BridgeF.bdc."

Task 4- Experimentation

Continue using the West Point Bridge Design Software to determine the cheapest combination of materials and bridge design for various combinations of elevation and support configurations.

Task 5 – Obtaining a quality resource

Find a magazine article, journal article, government document, or book that documents a structural design failure. Provide a complete reference for the item. Include information from your reference in the Background portion of your technical report.

Project Assessment (300 project points)

Intermediate Deliverable 1 (50 points)

Prior to 4:30 pm on Monday, September 17 (sections 003 and 006) or Tuesday, September 18 (sections 011 and 014) each team should submit one e-mail containing all three (six for Honors) bridge design files to their primary teaching assistant. The sender of the e-mail should cc all teammates on the e-mail.

Intermediate Deliverable 2 (100 points)

In class on Wednesday, September 19 (sections 003 and 006) or Thursday, September 20 (sections 011 and 014), teams will be given a set of requirements for the Deck elevation, Support Configuration, and Load. During the class period, teams are to create the least expensive bridge which will successfully support the load. The designs will be compared against the other teams for cost. All team members should be prepared to answer questions regarding the content of the programs. Teams must submit their design before the end of class.

Final Deliverable (150 points)

Each student will complete an individual technical report in the form of a 1 – 2 page memo. The memo should include background information including an instance of structural design failure (see Task 5), a summary of the tasks accomplished during the Structures Project 1, a summary of the team's designs, and a peer evaluation.

In class during the week of September 24, students will have an opportunity to work on their memo, and the Engineering Librarian will discuss appropriate citation styles and library resources for inclusion in technical reports. The memo should follow the FEP Assignment Policy with regards to Formatting of Word-Processed Work Submitted as Part of an Assignment. The completed memo should be uploaded to the individual section BlackBoard page (not the master course) by 4:20pm on Monday, October 1 (sections 003 and 006) or Tuesday, October 2 (sections 011 and 014).

Peer Evaluation

Include the Peer Evaluation in your memo. There are 100 total points to be allocated.

Your Name: Points Assigned:
Tasks you completed:

Team Member 1 Name: Points Assigned:
Tasks Member 1 completed:

Team Member 2 Name: Points Assigned:
Tasks Member 2 completed:

Team Member 3 Name: Points Assigned:
Tasks Member 3 Completed:

Submitted by: Tom Shepard
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Water Balloon Launcher Design Project

ENGR 150

Note to Instructors: Students rank their interest in building a compressed air cannon, catapult or trebuchet for their design and are split into teams accordingly.

Objective: Design, build and test aremotely triggered water balloon launcher for distance, accuracy, and consistency.

Key Dates:

– Design ready for initial testing: October 23rd
(device must successfully launch a water balloon towards target by end of lab on this date)

– Final testing: October 30th

– Final Report Due: November 6th

Design Rules:

1. Your launcher must have at least 3 layers of safety built in.

2. Your team must complete a safety report before building and testing.

3. Your launcher must be made from scratch. Individual components such as wheels, ball bearings, fasteners, may all be purchased but the body must be built/shaped by the team.

4. Your launcher must be remotely launched from a distance of at least 8 ft.

5. UST will cover up to $100per project. Students may use free materials which will not count towards the $100, but their cost must be included in the bill of materials.

6. Only the water balloons provided may be used, teams are responsible for filling them to the desired volume.

Final Testing:

1. At the final testing teams will have 10 minutes to launch a maximum of 10 balloons.

2. Teams may make adjustments during the 10 minutes.

3. Balloons will be measured based on where they first impact the ground.

4. Balloons which break during launch will be measured based on where the rubber first impacts the ground.

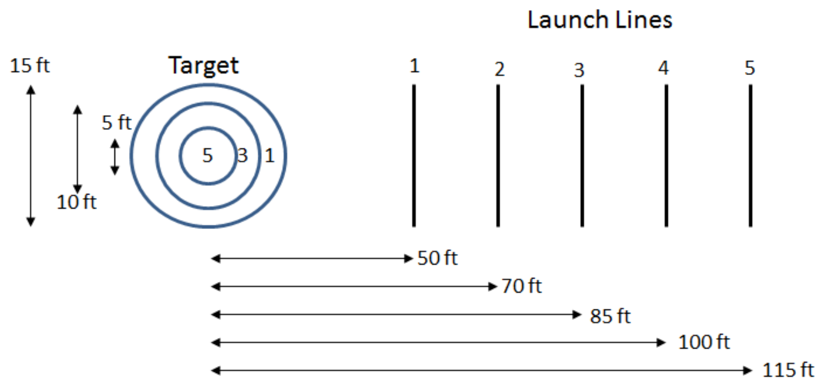
5. All parts of the launcher must remain behind the chosen launch line.

Performance criteria:

A team's overall performance score will be the sum of all balloons which score points during the final testing. Any design which is damaged so badly it is deemed unsafe to launch, will receive a performance score of 0 for any remaining balloons.

The target has 3 scoring rings worth 1 pt., 3 pts., and 5 pts. Points are also determined by how far from the target the launcher is placed. A launcher placed 50 ft. from the target will receive a distance score of 1 pt. while a launcher placed 115 ft. from the target will receive a distance score of 5 pts. The total score for a balloon is: target score x distance score. For example, a balloon which is launched from 70 ft. which lands in the 3 pt. ring would earn a score of: 2 x 3 = 6 pts. The total performance score for a team will be calculated by summing up the score for each balloon in the final test.

Performance score = sum of (target score x distance score) (for all balloons in final testing)



The performance grade for each team is determined by the overall final testing performance score from:

Performance Grade	Total Performance Score
A	>30
B	25-30
C	20-24
D	15-19
F	<15

Grading:

25% - working initial design that meets constraints by initial testing deadline

25% - Performance grade

25% - final report

25% - group member assessment

** Points will be lost for failing to adhere to your safety report guidelines

Extra Credit:

5% - extra credit for team with highest (final test points)/(material cost)

2% - design looks professional

Final Report:

The final report must be typed, Times New Roman font size 12, normal 1” margins and 1.5 line spacing. It should include the following sections while being concise, yet thorough. The audience for your report is a 1st semester engineering student just learning about the engineering design process. The length should be roughly 6-10 pages. The final report is to be e-mailed to the instructor on the due date.

Cover page – team member names, date, lab day/time, photo/detailed sketch of final design (optional name of final design)

Body – The main body of the paper should be broken into the different steps of the engineering design process. Each section should define the specific step, discuss why it is important to include in an engineering design problem, and detail what your team specifically did for that step and the results which were reached.

Though one frequently needs to jump backwards in the process in order to move forward, the different steps are:

1. Identify the need/problem and its constraints
2. Research the problem
3. Develop possible solutions
4. Select the best possible solution(s)
5. Construct & prototype
6. Test & evaluate the solution
7. Communicate the solution
    a. final testing performance
    b. energy efficiency
    c. what worked well
    d. what did not work well
    e. major lessons learned during the project
    f. bill of materials
8. Redesign (suggestions for future improvements)

References – Include all references which were cited in your report.

Submitted by: Michael Woodburn
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Modular Bridge Cardboard Project

Background

This project is not only a test of design function, but also a test of constructability and teamwork.

Goal

The goal of this project is to create a modular bridge spanning 22 feet. The first team to construct their bridge from the modules and have two members go out to the center of it without any team member, bridge component, or construction component touching the ground beneath wins.

Span

The bridge is to be constructed to span between planters in the courtyard between the 1400 and 1500 wings of the academic center. You may place your materials anywhere outside of the dead zone in Figure 1 on either side before construction. If anything touches the ground in the dead zone during construction or loading: construction material, tool, or person, your team must quickly disassemble your bridge and start over. You may walk in the dead zone for disassembly.

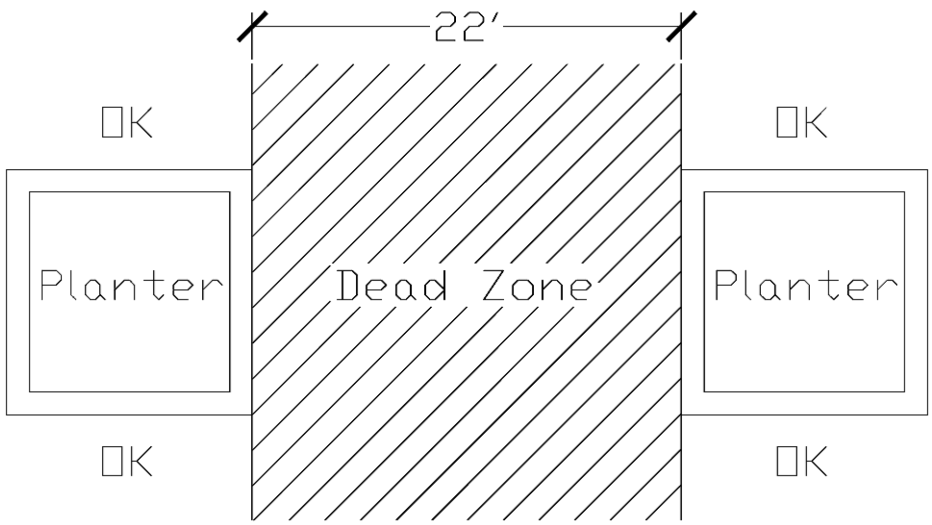

Figure 1: Assembly Site

Modules

Each module of the bridge must fit within a 34" x 42" x 8' box. You may use as many modules as you need. Modules must be composed entirely of cardboard, duct-tape, rope, adhesive and paint. If you're uncertain if you can use a particular material or substance, consult your instructor.

Assembly

The modules of your bridge must fit together without any adhesive. Your bridge must be assemblable, disassemblable, and reassemblable. For the assembly of your bridge, you may make cardboard tools, but they also must fit within a 34” x 42” x 8’ box. You are also allowed to use rope for bridge assembly. Also, you may not use the tree or any anchor points to aid in assembly.

Loading

The bridge should hold the weight of 2 team members within 3 ft from the center without deflecting enough for anything or anyone to touch the ground in the dead zone. The planters are approximately 16 inches off the ground.

Weight

There is no limit imposed on how much your bridge or the modules can weigh, but heavier modules will generally be more difficult to maneuver and take longer to fit into place. Also, consider your ability and health when design and assembling. No part of this competition is worth an injury. You must also be able to move your modules to and from the assembly site in a reasonable amount of time.

A heavier bridge may be required to support heavier team members, but heavier team members also have advantages for assembling a heavier bridge.

Competition

On assembly day, heats of teams will gather their modules next to where their bridges will be assembled. Before the start of assembly, all modules and construction tools must be disassembled such that each fits within its 34” x 42” x 8’ space. The rope must also be disconnected from anything else without any knots tied in it. After the instructor indicates to start, the first team to assemble their bridge, remove any construction rope, and load their bridge with 2 members from their team will advance to the next heat.

Budget

You must itemize your expenditures and provide receipts. Your expenditures must not exceed $25. Most of your materials should be donated or free.

Storing Materials

Non-hazardous materials and modules may be stored in the corresponding room of the Engineering Project Space should you choose to use that facility before assembly day. You may not store materials or modules at the assembly site before that day.

Team members:
Bridge name:
Section:

Modular Bridge Rubric

Rubric:

Only appropriate materials used: _______/10
All modules and tools fit within required dimensions: _______/10
Originality of design: _______/10
Assembled without touching the ground in the dead zone: _______/20
Speed of construction: _______/10
Supports own weight without touching the ground in the dead zone: _______/20
Supports team’s weight: _______/20
Ranking extra credit: _______

Total: _______/100

Design, Construct, and Test a Water Filtration System

Submitted by: Truc Ngo
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ENGR 101 – INTRODUCTION TO ENGINEERING
GROUP PROJECT

Learning Objectives:

By the end of this project, students will be able to:

- Effectively participate in a team to brainstorm ideas and develop work plan
- Creatively design and build a simple water filtration system
- Organize and deliver an oral presentation to a group of audience
- Have enhanced understanding of how engineering skills and knowledge can be applied to developing solutions to sustainability problems around the world.

Deliverables

- One mid-project report: design concepts and work plan
- One 5-minute long, final PowerPoint presentation
- Demonstration of the water filtration system

Project Description

If you were born and grew up in a developed country, most likely you never had to worry about not having clean water to drink or use for daily purposes. However, there are still many people in the world (1.1 billion people or 1/6 of the world population) who lack access to clean water. Contaminated water has caused many deaths especially among children in developing countries. According a statistics, half of the world's hospital beds are filled with people suffering from water-borne diseases, and nearly 20% of children deaths under the age of five worldwide are due to a water-related disease. (Data sources: http://thewaterproject.org and http://cleanwaterfortheworld.org).

This project introduces students to the concept of utilizing their engineering skills and knowledge towards building a simple prototype of a sustainable water filtration system that can be implemented in parts of the world where access to clean water is still a daily struggle. Students will be working in groups to construct the water filtration system out of ordinary materials such as charcoal, sand, gravel, cotton balls/sheets, plastic bottles/containers, PVC pipes, cardboard, tapes, etc. To increase students' interaction outside of classroom, each group is required to recruit a non-engineering student from within the Sustainability Living Learning Community. Commitment from the non-engineering group member must be finalized by 10/22.

Students will be given one full lecture class period to brainstorm ideas, come up with design features and alternatives for the system, and decide on a work plan for the group. Each group will then meet outside of class to construct the water filtration system and perform initial testing. The non-engineering student in the group is expected to participate in the construction and testing of the system and the final demonstration of the system in class. Although the remaining project activities are optional to this non-engineering student, the group is expected to keep all group members involved and up to date with project plan and progress.

Project Evaluation

Project evaluation will be based on the following criteria (total to 100 points):

1. Mid-project group report: 15 points
2. Final oral presentation: 25 points
3. Teamwork: 10 points
4. Final product demonstration:
    a. System design: 30 points, evaluated based on design features and system integration.
    b. System performance: 20 points, evaluated based on the Total Dissolved Solids (TDS) concentration and pH value of filtered solution. Lower PPM reading indicates higher water purity; closer to pH value of 7 means more neutral water.

Project Timeline

Date	Activity	Notes
Oct. 10 (regular class hour)	Project assignment Group formation	Each group is required to recruit 1 to 2 non-engineering students from within the Sustainability LLC to join their group.
Oct. 22 (regular class hour)	Research/Brainstorm ideas Formulate alternative designs Develop work plan and schedule	Class time will be available for this activity. Each group is responsible to involve their non-engineering teammate(s) into the project activities.
Oct. 29 (beginning of class)	Mid-Project Report due	One per group, approximately two pages long, with appropriate drawings (may be drawn by hand). See detailed requirements for this first report below.
Nov. 12 (regular class hour)	Oral presentation	Each group will have 5 minutes to present. Hardcopy of the PowerPoint slides will need to be submitted to class professor at the beginning of class (4 slides per page, stapled). See below for detailed requirements for the presentation.
Nov. 14 (to be confirmed)	Final product demonstration	All groups will have their water filtration systems ready to demonstrate. All team members are expected to be present and participate.

Mid-Project Report: Design Concept and Work Plan:

- Use Word for your report, mostly in paragraph format but bullet points are also accepted if used appropriately.
- Class number and name, professor's name, project title, date of submission, group assigned number, and all group members' names must appear on top of the first page of the report.
- Report should be approximately 2-page long, with appropriate drawing(s) of your water filtration system (your design may evolve throughout the project and your final system could be different than this preliminary one).
- Must include at least three alternative designs that your group considered, either original or taken from others (must be cited if ideas taken from others).
- Must include a work plan that your group has agreed on to achieve the project objectives, with specific schedule that your group will try to adhere to.

Final Presentation:

- Use PowerPoint for your presentation.
- Presentation should be 5-minute long.
- Not all group members are required to talk during the presentation.
- Must include one cover slide with project title and all group members' names.
- Must include one slide about the individual contribution of each group member.
- Must discuss alternative designs that your group considered.
- Must discuss how your group came to decide on the final design.
- Must state what kind of environment/location your particular system is suitable for (i.e. design with an implementation purpose in mind).
- Any other thought/comment/discussion that your group touched on during the project regarding engineering solutions to sustainability problems around the world is a plus.

Submitted by: Erin Baker
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Engin 113 -Fall 2012

Project: Energy, Environmental, and Economic Analysis of an Energy Technology

Choose a specific, cutting edge energy-related technology that is aimed at improving the environment. The technology can be used to generate electricity, provide heat, provide transportation, or can be an energy-intensive end-use product. The technology should be very new or not even on the market yet. It can be a part of a technology (such as a new blade design for a wind turbine).

Your job is to do a thorough evaluation of this new technology. Your team will be in the role of a consultant. As part of the project, you must choose a perspective to evaluate the technology from. That is, you must decide if you are evaluating the technology from the point of view of a consumer, a utility, a manufacturer, etc.

You must also choose two technologies with which to compare your technology. One should be a close substitute (i.e. an alternative or “old” version of the technology). The other should be the norm in society. For example, if you are evaluating purely organic solar cells, you would compare this technology to traditional silicon solar cells and to coal-fired electricity generation (or perhaps the electricity mix in the Pioneer Valley).

The project has four main parts: Technology, Energy, Environment, and Economics.

Technology: describe the technology, how it works, how it integrates with any related systems, provide pictures and diagrams. If possible, draw a diagram using Pro-E. Discuss how the new technology is different from previous versions.

Energy: describe the energy in and energy out of the technology. For example, if it is a generator of electricity: how much energy is in the resource, how much is captured by the technology, where are efficiency losses. If it is an appliance, talk about the efficiency and what causes efficiency losses and where the energy goes.

Environment: for this part you do a comparative analysis of the environmental effects of your technology and the other two comparison technologies. Include the key pollutants discussed in class (CO_2, CO, SO_2, NO_x, VOC) as well as any other relevant issues such as toxics, water pollution, nuclear waste, etc.

Economics: for this part of the project do an analysis of the costs of the technology, and compare it with published costs of the two comparison technologies. Discuss the details that drive the costs, i.e. materials, difficulty to manufacture, installation, useful life, etc. Provide a levelized cost for your technology.

Each Team must prepare the following deliverables:

1. Initial written proposal.
2. Oral progress report with slides.
3. Draft final written report.
4. Final presentation with slides and/or other visual aids.
5. Final written report.

Initial written proposal. Due October 1. This should be a brief write-up of what your team proposes to do. It should include which project you are doing; the technology or good your team with analyze, specific and different responsibilities for each team member; and a timeline with milestones.

Oral progress report with slides. Due Oct. 22. Two team members will present the progress so far on the project. Present the timeline from the proposal and discuss the milestones that have been achieved. Present initial results. Present plan for finishing project.

Draft Final written report. Due Nov. 16. This is your only chance for feedback on your written report. See the written report assessment template for guidelines.

Final Presentation with slides and/or other visual aids. Due Nov. 26. The other two team members will present the final report. This presentation will be limited to 10 minutes. Be sure to practice the presentation for time and clarity.

Final Written report. Due Nov. 30. This is a professional report. It should include an executive summary; introduction; sections on technology, energy, environment, and economics, (or product, drawings, energy efficiency, and design improvement) and a conclusion. Figures and tables should be in the body of the text and referred to by number. It should be written using formal language with correct grammar and spelling.

Some of the things we will be looking for are:

- Quality of your analysis, assembly drawings (where appropriate), graphs, etc.
- Presentation of the results in graphical and/or tabular form.
- Readability, presentability, highlights, title, abstract, results, spelling, punctuation, etc.

Each person's major contribution to the project must be clearly indicated in both the written report and the oral presentation. This is to be done by indicating on each drawing, graph, table, spreadsheet, computer program, etc. the person primarily responsible for producing it as well as the name of the person who checked it and the date it was checked.

Preparing a report requires considering the reader. The structure of a report should help the reader grasp the recommendations and several major factors which support it. A good report is **not** a chronology of analysis, but a clearly articulated statement of recommendations and supporting arguments.

Examples of energy technologies:

Solar PV:
- Crystalline –SI
- thin film
- concentrating
- Purely organic solar cells.
- third generation

Solar Thermal Power
Solar Hot water

Wind
- on shore
- off shore
- rooftop
- other concepts

Ocean Power
Geothermal power
Geothermal heat

Integrated Gasified Combined Cycle power generation from Coal
Natural gas combined cycle
Electricity from biomass

Carbon capture and storage
- with coal
- with natural gas
- with biomass

Nuclear power
- Fusion
- Fission
  - LWR
  - Gen IV
  - Small Long Lived Core

Combined Heat and Power

Liquid biofuels
- cellulosic ethanol
- gasoline and diesel from cellulosic biomass
- methanol
- corn-based ethanol

Electric vehicles
- Hybrid E electric Vehicles
- Plug in HEV
- EV

Super efficient Internal Combustion Engines
Hydrogen fuel cells

<u>End use energy intensive goods</u>

Tankless water heaters
Compare paper towels with hand blowers.

Example Proposal for 113

Wind Spire: Initial Written Proposal

For our project, we are planning to evaluate the new wind turbine, known as the Wind Spire. The Wind Spire is a thin cylindrical turbine measuring 30 feet high and about four feet wide. It is compact and more affordable than traditional wind turbines and can power an entire household. Wind Spire has the potential to be the next step in wind power technology. We plan to compare this new technology to traditional wind turbines and to the societal norm (i.e. coalpower plant).

Our group plans to split up each of the four main parts of this project: technology, energy, environment, and economics. As of right now we plan to have *J* work on technology, assessing how the Wind Spire operates and how it is different from the technology of traditional wind turbines. *A* plans to analyze the energy in and energy out of the Wind Spire, discussing energy efficiency or efficiency losses of the Wind Spire compared to that of traditional wind turbines and coal power plants. *D* is working on the environment part of the project, analyzing the environmental effects of the Wind Spire compared to traditional turbines and coal. *B* will work on the economics portion of the project, comparing the costs of the technologies and analyzing the factors that determine costs. We also plan to work on an AutoCAD rendering of the Wind Spire to aide with the technology part of the project.

Our group's timeline is going to be based on the initial timeline of the project outlined by the class structure and including our own milestones to break up the project deadlines. We plan to meet at about the half-way point between each deadline and again the day before the project is due for last minute polishing of the assignment. Therefore, we plan to meet on October 27th and November 3rd before the oral report with slides is due. We plan to have research on each of our individual segments of the project and come with any questions or comments ready on the 27th and begin working on our slides. Then on the 3rd we will pull together all our completed research and do any last minute touch-ups to complete the oral presentation. We have a similar attempt planned out for all the other deadlines for this project. For example, we plan to meet on the 10th and 17th of November before the written draft is due. Also, we are meeting on November 27th and December 1st before the final presentation and final written project is due. If necessary we can meet at other times if it is deemed necessary.

Overall, we are all extremely excited to begin working on this project and everyone has a very positive attitude toward the successful completion of this project! We are excited that we are becoming involved with a technology that is so new and cutting-edge, and that has the potential to be a standard technology in a few short years. Our group, The Purple Cobraz, gets along well and is working hard already to make this project a success!

Project Format – Project I Energy, Environmental, Economic analysis of an energy technology.

I. Introduction

The introduction should start with a clear statement of what the paper is about (in the first 1-3 sentences). "In this report we evaluate the effectiveness of using porous materials in sidewalks in order to reduce the problem of storm water runoff."

Then you can include brief motivation (why this technology is interesting or important) "One of the expected effects of climate change is an increase in extreme precipitation events, leading to problems with excess storm water runoff" etc.

For this particular project, you need to clearly establish the perspective of the analysis; and the comparison technologies. This should be done in the introduction.

The rest of the introduction section should lay out what the report is going to do. This is sometimes called signposting. It is a good idea to specifically outline the report by section. "In Section 2 we describe the problem of storm water runoff in detail. In Section 3 we describe a number of alternatives for addressing this problem. In Section 4 we define the evaluation criteria that we will be using. Etc…"

In general: Please number sections and subsections; it makes it much easier to follow the organization.

II. Technology

In this section describe your technology. You should have a picture of the actual technology, and you should have some kind of diagram explaining how it works. After reading this section, the reader should have a good idea of how the specific technology you are researching works.

III. Energy

In this section describe the efficiency of your technology. What is the "energy in"? What kind of energy comes out? Where are the losses along the way? What would constitute an ideal efficiency for this technology?

This section should compare your technology's efficiency with the comparison technologies. Make sure you are comparing on an even playing field. You should include some kind of table comparing the efficiencies.

If you are doing a vehicle, you need to be careful that all of the efficiencies can be compared. For example, it is not useful to give the MPG for one car and the miles/kWh for another car; or to give a mixed metric telling what MPG the car gets on gas and how far it can go on a kW. Choose one metric; make the assumptions you need to; and compare all vehicles on that metric.

IV. Environment

In this section you discuss the environmental impacts (or lack thereof) of your technology, and compare it to the comparison technologies. You can start out with the benefits of your technology, for example, that it has no or low CO_2 emissions, and compare it with the CO_2 emissions of the other technologies. Again, be careful to compare on an even basis, such as emissions per kWh.

Then, go on to discuss any other environmental impacts of your technology. Be sure to also discuss (but in far less detail) other impacts of the comparison technologies as well.

Again, it is a good idea to have some kind of table here comparing the technologies.

V. Economics

In this section discuss the economics of the technology. Specifically, include a calculation of a levelized cost of electricity for electricity technologies; or some levelized cost per mile (including the capital costs) for vehicles; or some levelized cost per Btu of heat for a heater.

You can also discuss other issues, such as if the technology has a higher initial cost than its comparison technologies; subsidies; other incentives.

Again, a table comparing the technologies is a very good idea.

This is also a good section to include some sensitivity analysis. If you had to make any major assumptions to do the economic analysis, then present graphs showing how these assumptions impact your results.

VI. Conclusion

This section should briefly summarize the report: "In this report, we evaluated multiple technologies for porous surfaces." It should provide a concise summing up of your conclusions "Replacing existing impervious surfaces with porous surfaces is quite expensive compared to the benefits received; however, using porous materials whenever surfaces need to be built appears to be quite cost effective in terms of…"

It is a good idea to put some kind of summarizing table here, so that we can see the three technologies side by side with all important evaluation criteria laid out.

VII. Bibliography

Bibliographies should follow the CSE format, preferably the citation-name system. For detailed information on this system see: http://www.libraries.psu.edu/psul/lls/students/cse_citation.html

For general information about citation styles see: http://www.library.umass.edu/services/instruction/instructional-services-for-students/using-citation-styles/

You should include at least two peer-reviewed references (journal articles or books).

VIII. Figures and Tables

Figures and tables should be in the body of the paper, NOT in the appendix. Figures and tables should be numbered and labeled ("Cost of porous materials"). If the figure or table is from some other source, then should be labeled as such (usually on the lower right-hand corner you write "Source: EIA [put webpage here]"

Project I				
Criteria	**Distinguished**	**Proficient**	**Basic**	**Unacceptable**
Introduction	The specific technology or product is clearly specified. The perspective of the paper, and the comparison technologies are clearly specified; and their relevance is made clear. The groundwork for paper easy to predict because important topics that will be discussed are specifically mentioned.	The specific technology or product is specified. The perspective of the paper, and the comparison technologies are specified. An attempt is made as to their relevance, but may be slightly unclear, or lacking in insight or originality. Organization for rest of the paper stated.	May be unclear (hard to tell which technology is the focus, or what the perspective is), appear unoriginal, or offer relatively little that is new; provides little around which to structure the paper.	no reference to the technology, perspective, or relevance.
Content -- general	Clear examples to support specific topic sentences and to support the overall purpose; reader gains important insight; depth of coverage without being redundant.	Examples support most topic sentences and support general purpose; reader gains some insight; Topics adequately addressed but not in the detail or depth expected.	Examples support some topic sentences; reader gains little insight; The report shows little of the writer's own work, relying instead on quotes and paraphrasing that are poorly connected.	The report relies on stringing together quotes or close paraphrasing; Failure to support statements, with major content omitted;
Technology	Clear description of technology with figures and diagrams. Reader understands how technology works and why it is of interest.	Description of technology with figures and diagrams, but less clear or dynamic. Reader has some understanding of how technology works and why it is of interest.	Description of technology vague or unclear and lacking helpful figures and diagrams. Reader has some understanding of how technology works and why it is of interest.	Very hard to understand how the technology works..

Energy Analysis	A clear description is given of the key energy transformations that take place, and of the efficiency of the technology	A description is given of the key energy transformations that take place, and of the efficiency of the technology, but less clear	Description of energy transformation is missing or very vague. Discussion of the efficiency of the technology is weak	There is no discussion of the energy transformations or efficiency
Economic Analysis	A thorough, rigorous analysis of the economic costs and benefits of the technology is presented. A single metric is used to compare the main technology and the two comparison technologies. Reader can follow analysis and has all information needed to check calculations	An economic analysis is presented. A single metric is used to compare technologies. Analysis is hard to follow or not all supporting information is given.	A single metric is not given to compare the three technologies, leaving the reader unsure about how to compare them. The paper relies too heavily on published values, and does not go into detail about capital costs and so on.	Economic analysis is missing or impossible to understand.
Environmental Analysis	A thorough, rigorous analysis of the environmental benefits and problems of the technology is given. The technology is carefully compared with the two comparison technologies. Reader can follow and understand the relevance of different environmental issues.	An analysis of the environmental benefits and problems of the technology is given. Some points may be missing or not clear. The technology is compared with the two comparison technologies. Relevance of different environmental issues not always clear.	Key environmental issues are not addressed, or not addressed clearly and convincingly. The technology is not compared directly to the comparison technologies. Tables and figures not well thought out.	Environmental analysis is missing or very difficult to understand.

Organization	The ideas are arranged logically to support the purpose. Transitions link paragraphs. It's easy to follow the line reasoning. Subheadings are used throughout the paper allowing the reader move easily through the text. Paragraphs have solid topic sentences.	The ideas are arranged logically to support the central purpose Transitions usually link paragraphs. For the most part, the reader can follow the line of reasoning. Subheadings are used throughout the paper to guide the reader without undue confusion; a few paragraphs without strong topic sentences.	In general, ideas are arranged logically, but sometimes ideas fail to make sense together. The reader is fairly clear about what writer intends. While subheadings are used, the content beneath them does not follow; many paragraphs without topic sentences.	Ideas are not logically. organized. Frequently, ideas fail to make sense together. The reader cannot identify a line of reasoning. Subheadings not used. Few or no topic sentences.
Tone for an academic research paper.	Consistently professional and appropriate. No casual language such as "cheap" or "kids"	Generally professional and appropriate.	Not consistently professional or appropriate.	Not professional or appropriate.
Sentence Structure	Sentences are well-phrased and varied in length and type. They flow smoothly from one to another with no run on sentences or comma splices.	Sentences are correct with minor variety in length and structure. The flow from sentence to sentence is generally smooth although some run on sentences are present.	Some sentences are awkwardly constructed so that the reader is occasionally distracted. Run on sentences are present or Short, simple and compound sentences prevail.	Errors in sentence structure are frequent enough to be a major distraction to the reader. Run on's and fragments common.
Word Choice	Word choice is consistently precise and accurate. The writer uses the active voice.	Word choice is generally good. The writer often finds words that are more precise and effective. Unnecessary words are occasionally used.	Word choice is merely adequate, and the range of words is limited. Some words are used inappropriately. unnecessary words are fairly common.	Many words are used inappropriately, confusing the reader. It is difficult for the reader to understand what the writer is trying to express.

Grammar, Spelling, Writing Mechanics (punctuation, italics, capitalization, etc.	Essentially free of grammatical errors; The writing is free or almost free of errors.	A few grammatical errors; There are occasional errors, but they don't represent a major distraction or obscure meaning.	Several grammatical errors; The writing has many errors, and the reader is distracted by them.	Pattern of ungrammatical writing; There are so many errors that meaning is obscured. The reader is confused and stops reading.
Conclusion	The writer makes succinct and precise conclusions based on the evidence given in report.	Some of the conclusions are not supported.	Conclusions are uninteresting and some conclusions are not supported;	There is little or no indication that the writer tried to synthesize the information or draw conclusions based on the evidence in paper.
Reference Quality	All data is referenced. References are papers or well respected websites such as EIA. Multiple sources are cited for important data.	All data is referenced, but some of the references are general web sites. Only a signle source is given for most data	Some data is not referenced.	Considerable data is not referenced. The references that exist are low quality.

Submitted by: Erin Baker
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Project: Redesign of a Consumer Good to Reduce Energy Usage

Choose a specific consumer good. The objective is to suggest a re-design of the product that will reduce energy usage (or improve the environment in other ways). Note, that you may save energy usage in the manufacture of good or in the use of the good. The good must be inexpensive enough for your team to buy a copy and take it apart. It must have moving parts, enough parts to make it interesting, not so many parts to make it too difficult. You will be responsible for purchasing one or more of the goods in order to analyze it.

In carrying out the project you should assume that you are working for a large national or international corporation and that you are carrying out this investigation at the request of its chief executive officer (CEO). The CEO wants to make this product more "green". It may be more "green" by using less energy itself, by requiring less energy or materials in its manufacture, or by being less toxic.

The project has four main parts: Technology, Redesigned product, Energy & Environment, and Economics.

Technology: describe how the original product works. Include assembly drawings using Pro-E of the original product. Be sure to include both the individual parts and the entire product.

Redesigned product: describe your redesign including assembly drawings.

Energy & environment: Discuss the energy efficiency of the product, and how your redesign saves energy or is more "green."

Economics: Discuss the costs of your product before and after redesign. Include a levelized cost if appropriate.

Example Proposal for 113

Wind Spire: Initial Written Proposal

For our project, we are planning to evaluate the new wind turbine, known as the Wind Spire. The Wind Spire is a thin cylindrical turbine measuring 30 feet high and about four feet wide. It is compact and more affordable than traditional wind turbines and can power an entire household. Wind Spire has the potential to be the next step in wind power technology. We plan to compare this new technology to traditional wind turbines and to the societal norm (i.e. coalpower plant).

Our group plans to split up each of the four main parts of this project: technology, energy, environment, and economics. As of right now we plan to have *J* work on technology, assessing how the Wind Spire operates and how it is different from the technology of traditional wind turbines. *A* plans to analyze the energy in and energy out of the Wind Spire, discussing energy efficiency or efficiency losses of the Wind Spire compared to that of traditional wind turbines and coal power plants. *D* is working on the environment part of the project, analyzing the environmental effects of the Wind Spire compared to traditional turbines and coal. *B* will work on the economics portion of the project, comparing the costs of the technologies and analyzing the factors that determine costs. We also plan to work on an AutoCAD rendering of the Wind Spire to aide with the technology part of the project.

Our group's timeline is going to be based on the initial timeline of the project outlined by the class structure and including our own milestones to break up the project deadlines. We plan to meet at about the half-way point between each deadline and again the day before the project is due for last minute polishing of the assignment. Therefore, we plan to meet on October 27th and November 3rd before the oral report with slides is due. We plan to have research on each of our individual segments of the project and come with any questions or comments ready on the 27th and begin working on our slides. Then on the 3rd we will pull together all our completed research and do any last minute touch-ups to complete the oral presentation. We have a similar attempt planned out for all the other deadlines for this project. For example, we plan to meet on the 10th and 17th of November before the written draft is due. Also, we are meeting on November 27th and December 1st before the final presentation and final written project is due. If necessary we can meet at other times if it is deemed necessary.

Overall, we are all extremely excited to begin working on this project and everyone has a very positive attitude toward the successful completion of this project! We are excited that we are becoming involved with a technology that is so new and cutting-edge, and that has the potential to be a standard technology in a few short years. Our group, The Purple Cobraz, gets along well and is working hard already to make this project a success!

Project Format – Project II Design of a consumer good.

I. Introduction

The introduction should start with a clear statement of what the paper is about (in the first 1-3 sentences). “In this report we evaluate the effectiveness of using porous materials in sidewalks in order to reduce the problem of storm water runoff.”

Then you can include brief motivation (why this product is interesting or important to redesign) “One of the expected effects of climate change is an increase in extreme precipitation events, leading to problems with excess storm water runoff” etc.

You need to clearly establish the perspective of the analysis. You should also make it clear what you will be comparing your redesigned product to (the current product, other products on the market, etc). This should be done in the introduction.

The rest of the introduction section should lay out what the report is going to do. This is sometimes called signposting. It is a good idea to specifically outline the report by section. “In Section 2 we describe the problem of storm water runoff in detail. In Section 3 we describe a number of alternatives for addressing this problem. In Section 4 we define the evaluation criteria that we will be using. Etc…”

In general: Please number sections and subsections; it makes it much easier to follow the organization.

II. Description of the product.

In this section describe your product. You should have a picture of the actual product; potentially a diagram explaining how it works; and the Pro-E drawings. The pro-E drawings must include the individual parts, an engineering drawing of the entire product, and an exploded view.

After reading this section, the reader should have a good idea of how the specific product works and what it does.

III. Description of the redesigned product

In this section describe your redesign. In general, this should NOT be a narrative (i.e. a narrative says “first we tried this, but it wasn’t strong enough, so then we tried that…”). Rather, describe the redesigned product and give the justification for your choices (“We increased…in order to assure a strength of at least…”). This section should include pro-E drawings of the redesign. If you built a prototype, then include photos.

IV. Evaluation of the redesigned product

This section may include any experiments you performed to test the effectiveness of your redesign (i.e. strength, speed, airflow, etc). The experiments may be approximations (that is, if you don’t have a prototype you need to think about how to run experiments that get at the idea of your prototype).

a. Energy &/or the environment

If your product has improved energy usage (either directly or through its manufacture) then discuss it here. Estimate how much energy is saved. Compare with the original product and other products on the market.

If your product is more “green”, then discuss it here. Give specific values for the improvements. Compare with original and others on the market.

Include any other evaluation criteria (looks, lightness, convenience, accuracy, etc)

It may be appropriate to include tables to compare the aspects of your redesigned product, the original, and others on the market.

V. Economics

In this section discuss the economics of the redesign. Do a cost estimate and compare the redesigned product with original and others on market. If the redesign changes the amount of time the product will last or the number of uses it will get, then be sure to calculate the levelized cost per unit of time, or the cost per use.

You can also discuss other issues, such as if the redesigned technology has a higher initial cost than its comparison technologies; or is able to take advantage of subsidies or other incentives.

This is also a good section to include some sensitivity analysis. If you had to make any major assumptions to do the economic analysis, then present graphs showing how these assumptions impact your results.

VI. Conclusion

This section should briefly summarize the report: “In this report, we evaluated multiple technologies for porous surfaces.” It should provide a concise summing up of your conclusions “Replacing existing impervious surfaces with porous surfaces is quite expansive compared to the benefits received; however, using porous materials whenever surfaces need to be built appears to be quite cost effective in terms of…”

It is a good idea to put some kind of summarizing table here, so that we can see how the redesigned product stacks up with the original product and any other comparisons, on all important evaluation criteria laid out.

VII. Bibliography

Bibliographies should follow the CSE format, preferably the citation-name system. For detailed information on this system see: http://www.libraries.psu.edu/psul/lls/students/cse_citation.html

For general information about citation styles see:
http://www.library.umass.edu/services/instruction/instructional-services-for-students/using-citation-styles/

You should include at least two peer-reviewed references (journal articles or books).

VIII. Figures and Tables

Figures and tables should be in the body of the paper, NOT in the appendix. Figures and tables should be numbered and labeled ("Cost of porous materials). If the figure or table is from some other source, then should be labeled as such (usually on the lower right-hand corner you write "Source: EIA [put webpage here]"

PROJECT II (Product Redesign)				
Criteria	**Distinguished**	**Proficient**	**Basic**	**Unacceptable**
Introduction	The product is clearly specified. The perspective of the paper, and goals for the redesign are clearly specified; and their relevance is made clear. The groundwork for paper easy to predict because important topics that will be discussed are specifically mentioned.	The product is specified. The perspective of the paper, and the goals for the redesign are specified. An attempt is made as to their relevance, but may be slightly unclear, or lacking in insight or originality. Organization for rest of the paper stated.	May be unclear (hard to tell exactly what the product is or is for, or the purpose of the redesign is), appears unoriginal, or offers relatively little that is new; provides little around which to structure the paper.	no reference to the product, the goals of the redesign, or the relevance.
Content -- general	Clear examples to support specific topic sentences and to support the overall purpose; reader gains important insight; depth of coverage without being redundant.	Examples support most topic sentences and support general purpose; reader gains some insight; Topics adequately addressed but not in the detail or depth expected.	Examples support some topic sentences; reader gains little insight; The report shows little of the writer's own work, relying instead on quotes and paraphrasing that are poorly connected.	The report relies on stringing together quotes or close paraphrasing; Failure to support statements, with major content omitted;
Product Description	Clear description of product and how it works with figures and diagrams. Reader understands how product works and why it is of interest.	Description of product with figures and diagrams, but less clear or dynamic. Reader has some understanding of how technology works and why it is of interest.	Description of product vague or unclear and lacking helpful figures and diagrams. Reader has some understanding of how technology works and why it is of interest.	Very hard to understand how the product works or why we should car.

Product redesign	A clear description is given of the key goals of the redesign and a description of the redesign itself, referring to figures and diagrams.	A description is given of the redesign itself, referring to figures and diagrams.	The description of the redesign is not clear, no reference to any figures or diagrams.	It is unclear what is being proposed for the redesign.
Pro-E drawings	Drawings of original (and possibly redesigned) product are present, correct, and clearly presented	Drawings of original product are slightly incomplete. Drawings are not presented clearly.	Key drawings are missing. Some drawings appear inaccurate.	The drawings are missing, incorrect, or inaccurate
Economic Analysis	A thorough, rigorous analysis of the economic costs and benefits of the redesigned product versus the original product is presented. A single metric is used to compare the two products. Reader can follow analysis and has all information needed to check calculations	An economic analysis is presented. A single metric is used to compare products. Analysis is hard to follow or not all supporting information is given.	A single metric is not given to compare the products, leaving the reader unsure about how to compare them.	Economic analysis is missing or impossible to understand.
Analysis of other issues	A thorough, rigorous analysis of any other key issues (such as safety, convenience, environmental benefits) is given. The products are carefully compared. Reader can follow and understand the relevance of different issues.	An analysis of other key issues (such as safety, convenience, environmental benefits) is given; but some points may be missing or not clear. The products are compared. Reader can follow and understand the relevance of different issues.	Key issues are not addressed, or not addressed clearly and convincingly. The redesigned product is not compared directly to the original product. Tables and figures not well thought out.	Analysis is missing or very difficult to understand.

Organization	The ideas are arranged logically to support the purpose. Transitions link paragraphs. It's easy to follow the line reasoning. Subheadings are used throughout the paper allowing the reader move easily through the text. Paragraphs have solid topic sentences.	The ideas are arranged logically to support the central purpose Transitions usually link paragraphs. For the most part, the reader can follow the line of reasoning. Subheadings are used throughout the paper to guide the reader without undue confusion; a few paragraphs without strong topic sentences.	In general, ideas are arranged logically, but sometimes ideas fail to make sense together. The reader is fairly clear about what writer intends. While subheadings are used, the content beneath them does not follow; many paragraphs without topic sentences.	Ideas are not logically. organized. Frequently, ideas fail to make sense together. The reader cannot identify a line of reasoning. Subheadings not used. Few or no topic sentences.
Tone for an academic research paper.	Consistently professional and appropriate. No casual language such as "cheap" or "kids"	Generally professional and appropriate.	Not consistently professional or appropriate.	Not professional or appropriate.
Sentence Structure	Sentences are well-phrased and varied in length and type. They flow smoothly from one to another with no run on sentences or comma splices.	Sentences are correct with minor variety in length and structure. The flow from sentence to sentence is generally smooth although some run on sentences are present.	Some sentences are awkwardly constructed so that the reader is occasionally distracted. Run on sentences are present or Short, simple and compound sentences prevail.	Errors in sentence structure are frequent enough to be a major distraction to the reader. Run on's and fragments common.
Word Choice	Word choice is consistently precise and accurate. The writer uses the active voice.	Word choice is generally good. The writer often finds words that are more precise and effective. Unnecessary words are occasionally used.	Word choice is merely adequate, and the range of words is limited. Some words are used inappropriately. unnecessary words are fairly common.	Many words are used inappropriately, confusing the reader. It is difficult for the reader to understand what the writer is trying to express.

Grammar, Spelling, Writing Mechanics (punctuation, italics, capitalization, etc.	Essentially free of grammatical errors; The writing is free or almost free of errors.	A few grammatical errors; There are occasional errors, but they don't represent a major distraction or obscure meaning.	Several grammatical errors; The writing has many errors, and the reader is distracted by them.	Pattern of ungrammatical writing; There are so many errors that meaning is obscured. The reader is confused and stops reading.
Conclusion	The writer makes succinct and precise conclusions based on the evidence given in report.	Some of the conclusions are not supported.	Conclusions are uninteresting and some conclusions are not supported;	There is little or no indication that the writer tried to synthesize the information or draw conclusions based on the evidence in paper.
Reference Quality	All data is referenced. References are papers or well respected websites such as EIA. Multiple sources are cited for important data.	All data is referenced, but some of the references are general web sites. Only a single source is given for most data	Some data is not referenced.	Considerable data is not referenced. The references that exist are low quality.

Tamarin and Macaw Enrichment "Tree"

Submitted by: Cecelia Wigal
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UTC CECS ENGR 1850 Project Proposal
CMW 9-25-12

Project Proposal:
Tamarin & Macaw Enrichment "Tree"

Problem Statement:
Tamarins and Macaws at the Chattanooga Zoo need enrichment devices that simulate behavior in the wild. These devices must be natural looking (i.e. made of wood), be safe for the animals using them, and be built to be used over and over again. The Tamarins and Macaws need "trees" with holes of different sizes, depths, and angles to hide food or objects inside for them to try to retrieve. Trees could be just a trunk (for Tamarins) or tree like with branches for the Macaws.

Background and Substantiation:

The Chattanooga Zoo has 6 Cotton-Top Tamarins, 2 Pied Tamarins and 6 Macaw parrots. The Tamarins are small primates that come from the rainforests of South America and the Macaws are large, colorful parrots living in the rainforests of Central & South America. Tamarins are small-bodied monkeys – the Cotton-Top Tamarins have a fan of long, white hair on their heads, and the Pied Tamarins are bald. Both Tamarin species are some of the most endangered primates in the world, mostly due to habitat loss of their rainforest home and an increase in the local pet trade. They are omnivores, eating fruit, vegetation, tree sap, insects, small lizards, and eggs. At the Chattanooga Zoo we feed them a primate diet along with fruits, vegetables, meal worms and marmoset diet. Macaws boast large, powerful beaks that easily crack nuts and seeds, while their dry, scaly tongues have a bone inside them that makes them an effective tool for tapping into fruits. Macaws also have gripping toes that they use to latch onto branches and to grab, hold, and examine items. The birds sport graceful tails that are typically very long. There are 17 species of Macaws, and several are endangered. These playful birds are popular pets, and many are illegally trapped for that trade. The rain forest homes of many Macaw species are also disappearing at an alarming rate.

Design Objectives:
It is desired that the enrichment "trees"

- Be natural looking (i.e. not made out of neon pink plastic) for placement in their exhibit
- Be safe for the Tamarinsand Macaws to bite into and work with
- Be easy to secure to existing locations in the exhibit
- Be easy to remove from exhibit for cleaning
- Be easy to clean
- Be easy for the animals to climb
- Be easy for the animals to hold onto

- Vary in size of access holes for Macaw beaks and feet and Tamarin hands and fingers.

Design Functions:
It is desired that the enrichment "trees"

- Hold food
- Hold objects
- Hide food
- Hide objects
- Attract animals
- Challenge animals

Design Constraints:
The enrichment trees must be natural looking. The designs and materials must be approved by the Chattanooga Zoo staff before buying and building.

Deliverables:

1. **Testing of the "enrichment trees" before completion is required**. This should be done directly with the Zoo staff and Tamarins & Macaws at the Chattanooga Zoo.
2. Adequate evidence of the design process.
   - Understanding of present designs
   - Understanding of seat rocker functions, objectives, constraints, and standards and their relationships
   - Brainstorming sketches and lists
   - Selection of Solution
     - Demonstration of the Decision Matrix
     - Detailed/Annotated hand sketches
3. SolidWorks 3D models of parts (includes 2D constraints and dimensions)
4. Completed SolidWorks 3D Assembly of device
5. Supporting device part and assembly drawings including
   - Multi-view presentation drawing of Assembly with isometric view and overall dimensions
   - Exploded view, with balloons and parts list
   - Detail Drawing of each, non-standardized part, completely dimensioned with appropriate title block included
   - Specialty" views as appropriate to completely define the part(s) or assembly. Examples of specialty views include
     - Section Views
     - Auxiliary Views
     - Detail Views
     - Broken Views
     - Positional Representations
6. Instructions on how to build the device (important!)

UTC CECS ENGR 1850 Project Proposal
CMW 9-25-12

Project Customer
Jordan O'Rylee
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Chattanooga Zoo
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Financial Limit:
TBD

Design and Build a Concrete Canoe Display Stand

Submitted by: Cecelia Wigal
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Design and Build a Concrete Canoe Display Stand

Submitted by: Cecedia Wigal
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Project Proposal: Concrete Canoe Display Stand

Problem Statement:

The American Society of Civil Engineers (ASCE) student chapter concrete canoe team needs a unique and attractive stand to safely display and transport their canoe during the final product display portion of competition at the ASCE Southeast Conference in March, 2013.

Figure 1.0: Concrete Canoe Team and "The Night Rambler" at the ASCE Southeast Conference 2012

Background & Substantiation:

The National Concrete Canoe Competition (NCCC) is often called the Olympics of Civil Engineering because the competition requires a team of students to design and build a streamlined lightweight canoe out of reinforced concrete and pit it against other canoe teams from universities all over the world in five challenging sprint and endurance races. The competition is broken into 4 equally weighted sections: the design report, the oral presentation, the races, and the final product display.

The product display is the projection of an environment inspired by the canoe's theme and name; it can include everything from multimedia art to engineering demonstrations of techniques used to construct and develop the canoe design. In most of the other university displays, the canoe is nestled in the center of the environment, proudly displayed by an inventive and unique stand; however, last year UTC's canoe, The Night Rambler was towering above eye level. Their display was also somewhat less inventive than others.

This year ASCE is inviting underclassmen in the 1850 class to be part of the concrete canoe team and build an attractive and unique stand to take to this year's competition and possibly future competitions. In addition, the concrete canoe team would be delighted if any members of the 1850 project design team could attend the 2013 ASCE Southeast Conference as part of our team and participate in the final product display.

Device Objectives:

It is desired that the Concrete Canoe Display Stand

- Be attractive in appearance
- Be professional in appearance
- Be versatile enough to match multiple themes
- Be durable enough to use for multiple years
- Be safe when holding the canoe in an heavily populated area
- Be easy to place the canoe in
- Be easy to remove the canoe from
- Be quick to place the canoe in
- Be quick to remove the canoe from
- Be static in its area
- Be mobile to its area
- Securely hold canoe until it is removed
- Appropriately display canoe at the required height
- Be safe to the canoe (do not damage it)

Device Functions:

It is desired that the Concrete Canoe Display Stand

- Support canoe
- Fix canoe position
- Display canoe
- Support Team Theme
- Transport Canoe
- Present Team Theme

Device Constraints:

The Concrete Canoe Display Stand Must

- Be fabricated and finished by January 1st (with aid of ASCE members if necessary)
- Not exceed Concrete Canoe team budget for the stand
- Be able to be assembled in 30 minutes or less

In addition, any purchases of material for the project must be approved by the customer (the concrete canoe team)

Deliverables:

1. Testing of the "Concrete Canoe Display Stand" before completion is required. This should be done directly with the Concrete Canoe Team to eliminate project failure.

2. Adequate evidence of the design process.
   - Understanding of present designs
   - Understanding of seat rocker functions, objectives, constraints, and standards and their relationships
   - Brainstorming sketches and lists
   - Selection of Solution
     - Demonstration of the Decision Matrix
     - Detailed/Annotated hand sketches
3. SolidWorks 3D models of parts (includes 2D constraints and dimensions)
4. Completed SolidWorks 3D Assembly of device
5. Supporting device part and assembly drawings including
   - Multi-view presentation drawing of Assembly with isometric view and overall dimensions
   - Exploded view, with balloons and parts list
   - Detail Drawing of each, non-standardized part, completely dimensioned with appropriate title block included
   - Specialty" views as appropriate to completely define the part(s) or assembly. Examples of specialty views include
     - Section Views
     - Auxiliary Views
     - Detail Views
     - Broken Views
     - Positional Representations
6. Instructions on how to build the device (important!)

Project Customer:

The ASCE concrete canoe team is the customer for this project. The project management for the team includes:

Team Role:	Name:	UTC email	Phone #
Co - Captain	Rachel Garrard	rpc185@mocs.utc.edu	931-409-2320
Co - Captain	Haley Robert	kqn176@mocs.utc.edu	931-215-7442
Project Manager	Brandon Ennis	brandon-ennis@mocs.utc.edu	

Project Budget:

The project budget should not exceed $400 unless approved by the canoe team captain prior to the selection of a design and construction of the stand. If a stand design is presented that is clearly going to meet the objectives stated and is of remarkably better quality than other alternatives, it is likely the team will be open to increasing the budget.

Design a Walker for a Disabled Boy

Submitted by: Cecelia Wigal
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Signal Centers

Project Proposal: <u>Aiden Cruise Control Walker</u>

Problem Statement

Aiden is a three-year old boy. He has cerebral palsy, epilepsy, and is in the management phase of leukemia. He needs help walking, but has difficulty controlling his walker. He tends to turn sideways in his walker and "cruise". He needs a device to allow him to walk properly.

Background and Substantiation

Due to his leukemia treatments, Aiden's performance varies from day to day. Some days he needs more help than on others; on some days he is more affected by his condition. He does not yet walk independently. His left side tends to be weaker. When he is in his walker, this left-side weakness causes him to continually drift to one side. He compensates for this by turning sideways and shuffling sideways ("cruising"). He needs a device that will help him walk properly.

Device Objectives

It is desired that the walker

- compensate for Aiden's left-side weakness
- allow Aiden to walk correctly without turning sideways
- allow Aiden to enter it independently
- allow Aiden to exit the device independently.
- be transportable (between school and home, etc.)
- be safe for Aiden to use
- be easy to clean

Design Functions

It is desired that the walker

- facilitate Aiden's physical development
- encourage walking
- provide independent mobility (for Aiden)
- Support Aiden's weight

Design Constraints

Safety and flexibility are the most important constraints. For example,

- There must be no rough or sharp edges,
- The surface must be smooth.
- Paint must be non-toxic.
- Any wood surfaces must be sealed.
- There should not be any choking / strangulation hazards
- There should not be any pinching or entrapment hazards

These constraints are underdefined – not specific or measurable. Further understanding of the project will result in defining more specific and measureable constraints.

Deliverables

At a minimum the teams will provide, based on course requirements:

1. **Beta testing of the walker before completion is required**. This should be done directly with Aiden (substitutions allowed only with explicit permission) to eliminate project failure.
2. Adequate evidence of the design process.
    - *Understanding of present designs*
    - *Understanding of device functions, objectives, constraints, and standards and their relationships*
    - *Brainstorming sketches and lists*
    - *Selection of Solution*
        - *Demonstration of the Decision Matrix*
        - *Detailed/Annotated hand sketches*
3. *SolidWorks 3D models of parts (includes 2D constraints and dimensions)*
4. *Completed SolidWorks 3D Assembly of device*
5. *Supporting device part and assembly drawings including*
    - *Multi-view presentation drawing of Assembly with isometric view and overall dimensions*
    - *Exploded view, with balloons and parts list*
    - *Detail Drawing of each, non-standardized part, completely dimensioned with appropriate title block included*
    - *Specialty" views as appropriate to completely define the part(s) or assembly. Examples of specialty views include*
        - *Section Views*
        - *Auxiliary Views*
        - *Detail Views*
        - *Broken Views*
        - *Positional Representations*
6. Instructions on how to build the device (important!)

Project Customer

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Signal Centers

Project Budget

Grant: Educational Grant with UTC Engineering Department and Signal Centers

Financial limit: One goal in the design is to make a product that is reasonably priced. Some of the material, however, may be expensive, so a maximum expense has been built into the project – the expenses for the project should not go over $400.00 without special permission from Dr. Wigal.

Bridge Component Tests

Submitted by: Feng-Ju Hsieh
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ENGR 100

Bridge Component Tests

Purpose

The purpose of this activity is to simulate the "Research and Development" aspect of engineering. Your team will act as "engineering researchers" completing a series of component tests to determine the strength and characteristics of the bridge materials. In the end, you will compose an individual memo addressed to the design team summarizing your findings and recommendations. Once this is completed, you will then switch roles, becoming the "designer", and use this information directly to design and build your team's prototype bridge.

Group Assignment

The class will work together on this assignment, with groups completing different tests and then sharing the results. The following is a list of tests:

Test 1 - Tension Test

Test 2 - Compression Test

Test 3 – Torsion and Bending Test

Test 4 - Fishline Tension Test (Optional)

At the end of class, each team will write their results (tables, graphs, findings) on the board for everyone to copy. Each team will then present and explain their findings and we will have a short discussion about how these findings will be useful for bridge design.

Individual Assignment

Each person will be responsible for writing a memo summarizing the results of the tests and making recommendations to a fictitious design team. The purpose of writing this memo, even though you are essentially the design team for whom it is written, is to be introduced to the fundamentals of technical writing.

Feel free to experiment! If you have any ideas about how to change a test or perform additional tests, please let the instructor/TA know.

Test 1 - Tension Test

Objective

The objective of the tension test is to determine a recommended overlap distance for two tongue depressors in tension (taking into account strength and total span length).

Procedure

1. Build the test specimens by gluing two tongue depressors together using different lengths of overlap (max. < 3/4"). Be sure to test at least 3 specimens for a given overlap distance to ensure more accurate results. Reinforce the hole with extra pieces of tongue depressor.
2. Place the sticks in the vice on the testing platform and reinforce the hole at the other end with tape. Test the sticks by pulling straight up with the force gauge. Record the forces (in lbs) required to break each of the specimens in your notebook. Also note how each specimen failed!
3. If you are getting inconsistent results, create several more specimens and try to standardize your testing methods.

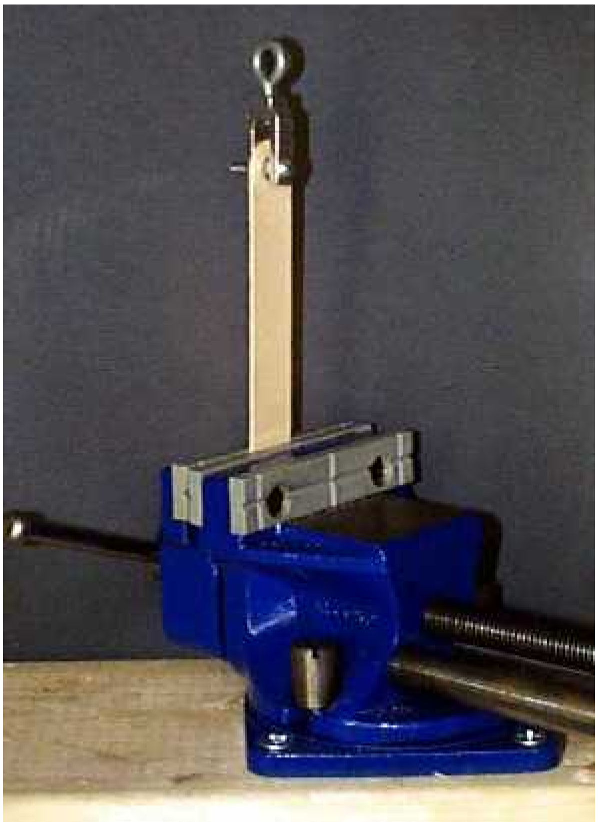

Figure 1. Tension Test

Deliverables (to be included in the memo)

1. How did the different specimens fail?
2. Why you think they may have failed at different places?
3. What is the relationship between failure force and overlap length? From examining the results, what would you recommend for an overlap length? Why?

If you have more time…

Do a similar test using elmers or wood glue. How do the results compare?

Test 2 - Compression Test

Objective

The objective for Test 2 is to determine a maximum length that designers should not exceed, to ensure adequate strength from compressions members.

Procedure

1. Use a ruler to prepare several specimens for the compression test ranging in length from 3" to about 10". For members greater than 6", glue two tongue depressors together with a 1" overlap length and then cut the ends to the desired length. Prepare at least 2 samples for each length to ensure some level of accuracy.
2. To test the specimens, place them upright on the scale and push down as shown in Figure 2 (using pliers may be easier on your hands). Record the force (in grams) required to bend the specimen. Convert the grams to lbs in EXCEL.

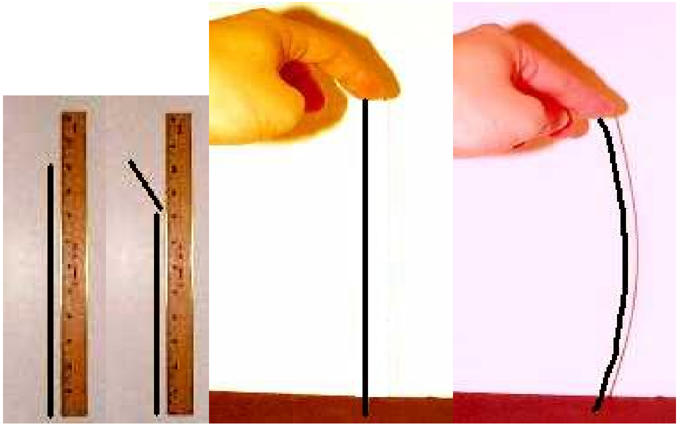

Figure 2. Compression Test

Deliverables (to be included in the memo)

1. Does the location of the 1" overlap glue joint (end or middle) affect the buckling strength?
2. Create a table in Excel showing the specimen length in one column and the failure force in another.
3. Plot the Force (lb) vs. Length (in) **(For accuracy, use "x-y scatter" graph <u>not</u> a line graph).**
4. Look at the graph to see how the force changes as the length changes. Is there a particular point on the graph where the force required to buckle the specimen decreases signficantly with little change in length? If so, the bridge design team should be notified of this length so they can avoid designing a bridge with compression members that are prone to buckle under smaller loads.

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LEGO® MINDSTORMS® NXT Lab 1

This lab session is to introduce you how to connect your LEGO Mindstorms NXT brick and Wii remote controller (Wiimote) to the laptop or computer via Bluetooth wireless protocol.

Lab Sections

A. Use the LEGO Mindstorms NXT software to connect NXT brick to your computer
B. Connect Wii remote controller to your computer.
C. Run NI LabVIEW sample program and use Wiimote to control NXT Tribot.

Software

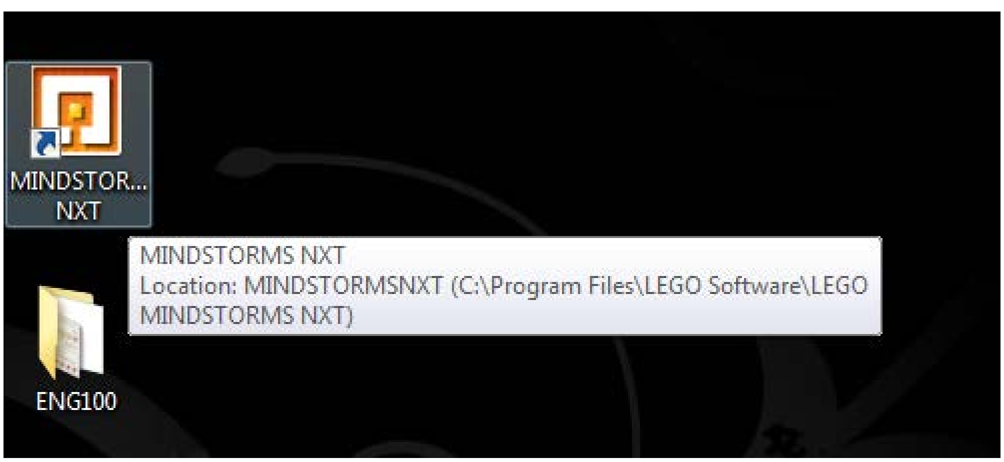
- Lego Mindstorms NXT.
- NI LabVIEW with Lego NXT toolkit.

Hardware

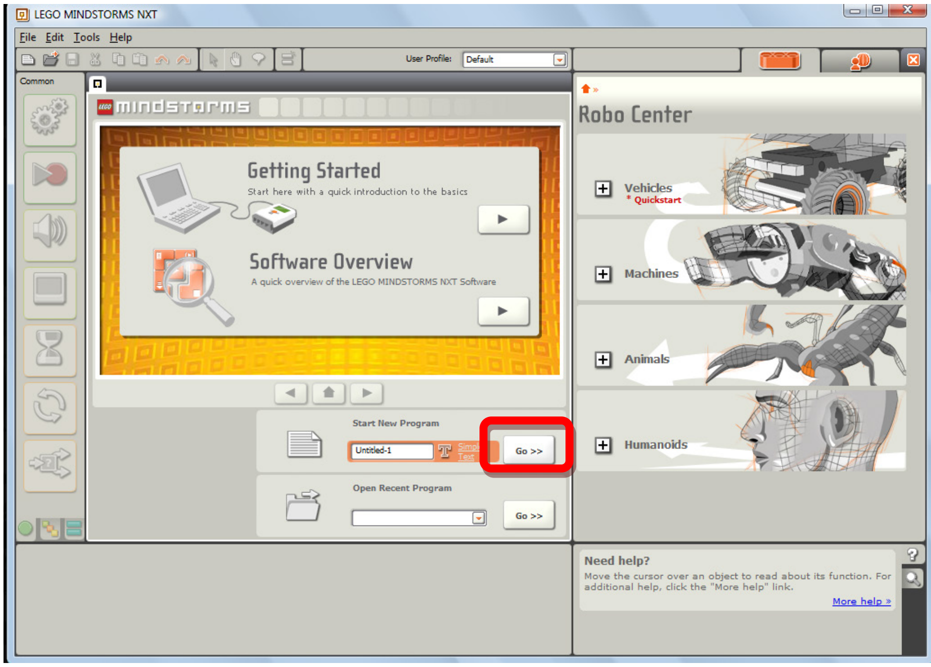
- Lego Mindstorms NXT Tribot.
- Wii remote controller.
- Laptop or computer with D-Link Bluetooth DBT-120 dongle.

Part A: Connect NXT to the Laptop via Bluetooth

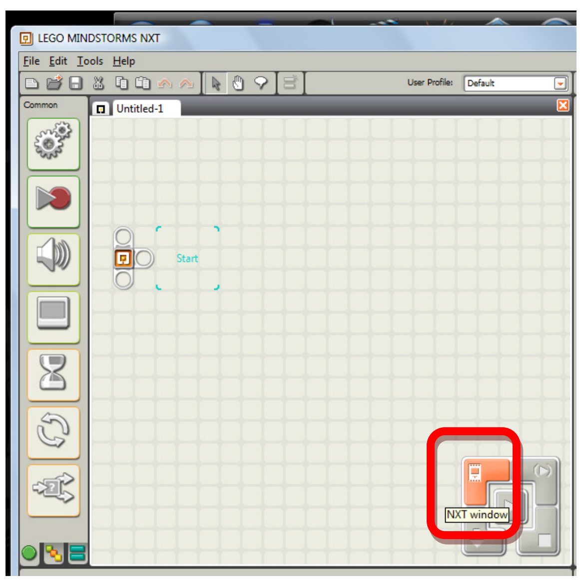
1. Plug in D-Link DBT120 Bluetooth dongle into one of the computer's USB port.
2. Double Click on the Mindstorms NXT icon on your computer's desktop to open the Mindstorms NXT software.



3. Go to **File >> New** to create a new project or just click on **Go>>** button on the screen.

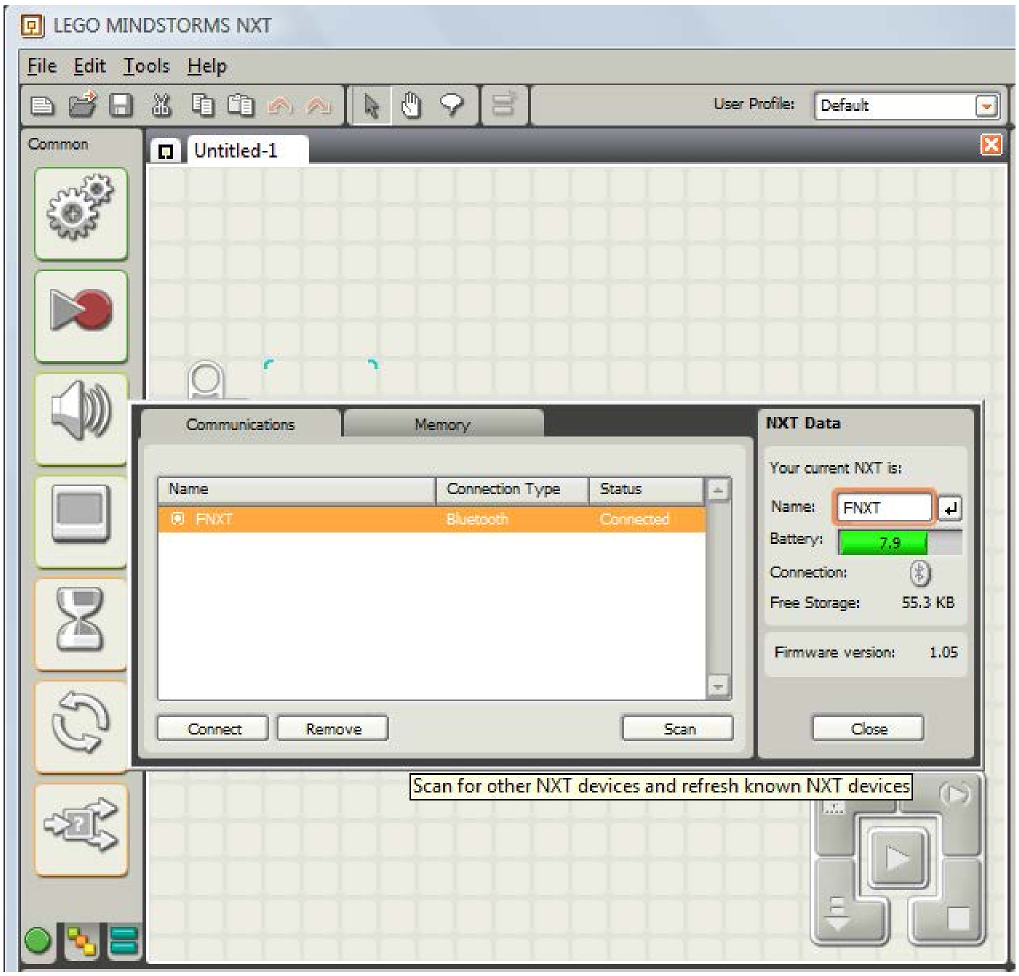


4. Press the orange, square **Enter** button on the Mindstorms NXT brick to turn the robot on
5. Make sure you have Bluetooth icon and "**<**" shown on the upper left corner of the NXT screen. If not , try to use the arrow button on the NXT brick to choose **Bluetooth** icon and press the orange **Enter** button and choose **ON/Off** icon to turn on Bluetooth function of NXT and also make use NXT brick is visible to other Bluetooth device by choosing **Visibility icon>>Visible**.
6. Click on the **NXT Window** button on the lower right of the screen as shown here:



7. There will be a connection dialog window prompt out. If you have everything setup correctly, you can see the detailed information about your NXT brick including battery life, free storage space on the NXT block, and the version of the firmware installed, which indicates that the connection is established. If you can't have the NXT connected now, click on the **Scan** button to detect the NXT brick that is visible to the PC. The name of

your NXT brick should appear on the list of the dialog window. Click on your robot's name, and then click **Connect.** You may have the query prompt out on your NXT brick windows to ask you to key in passkey, just press Orange button to accept the default value (1234). Once you establish the connection, you can see the icon on upper left corner of your NXT brick windows changed from "**<**" to "**<>**" to indicate you the connection is established.



8. Click on the **Memory** tab at the top of the dialog window to see what programs are currently loaded onto the NXT block.
9. Close the dialog window, and now you can try to program the code in NXT environment or close the whole NXT programming environment and go to the section B to connect Wiimote to your PC. Notice that once you close the Mindstorms NXT program, the icon on your NXT brick windows will change back to "**<**".

Questions:

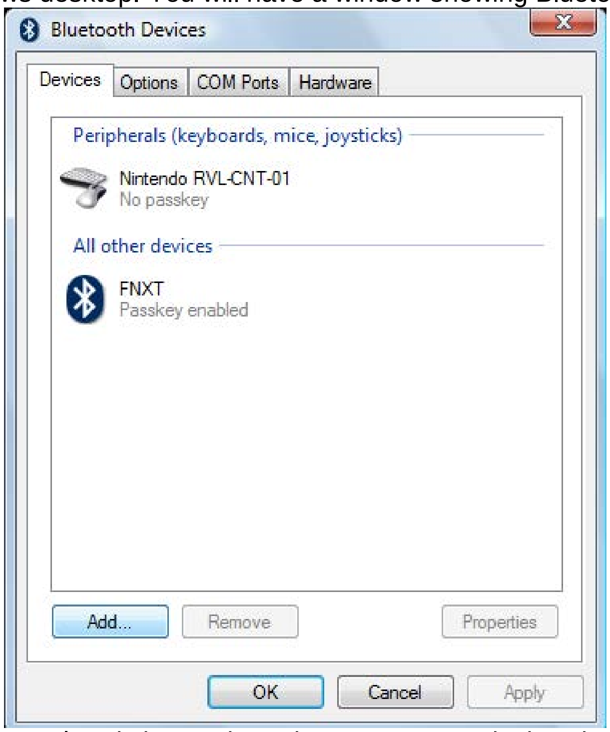
a) What should you do if you want to change the name of your robot?

b) What should you do if you want to download the program to your robot but the memory is full already?

Part B: Connect Wiimote to the Computer

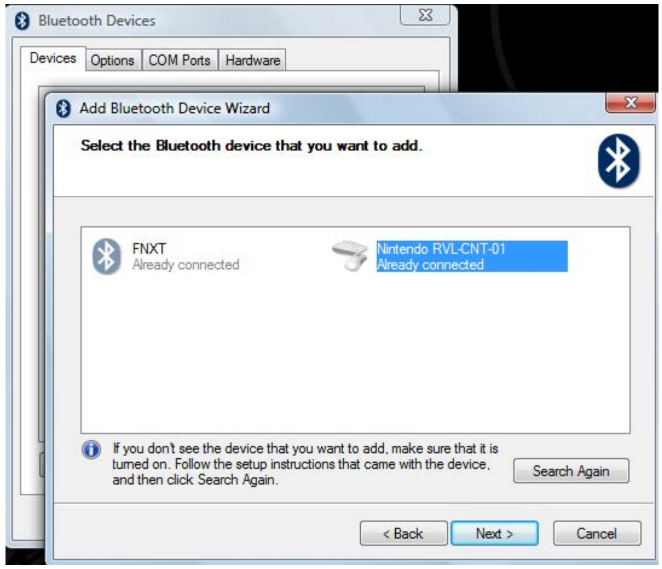
Before this part of exercise, make sure you have plugged in the Bluetooth dongle and finished Part A exercise. Now check that the Wiimote has batteries in it. And follow the procedure.

1. Double Click on the Bluetooth icon on the notification area of windows task bar, i.e. lower left side of windows desktop. You will have a window showing Bluetooth Devices.

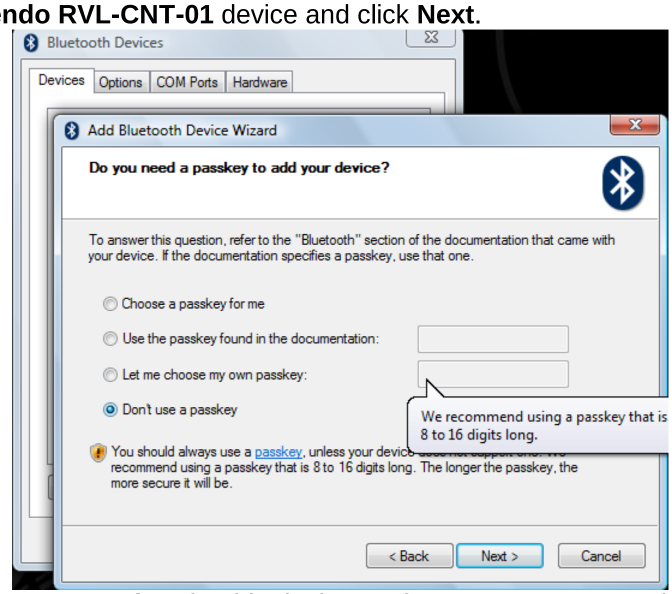


2. Click **Add**, even you already have Nintendo RVL-CNT-01 device shown on your list.

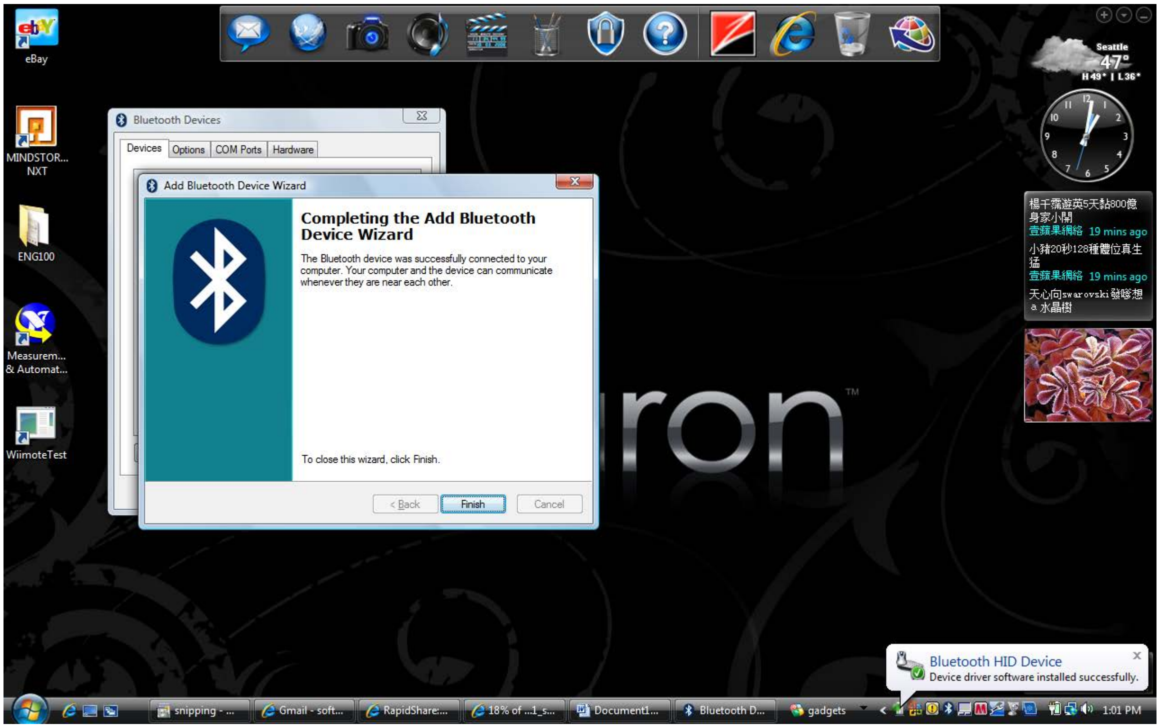
3. Press and hold **1** and **2** buttons of Wiimote at the same time for a while until you see the LEDs flash on and off. Check the **check box** of dialog and click **Next**.
4. Wait for a while for window to search Bluetooth devices. And you will see the following window if you have Wiimote around you.



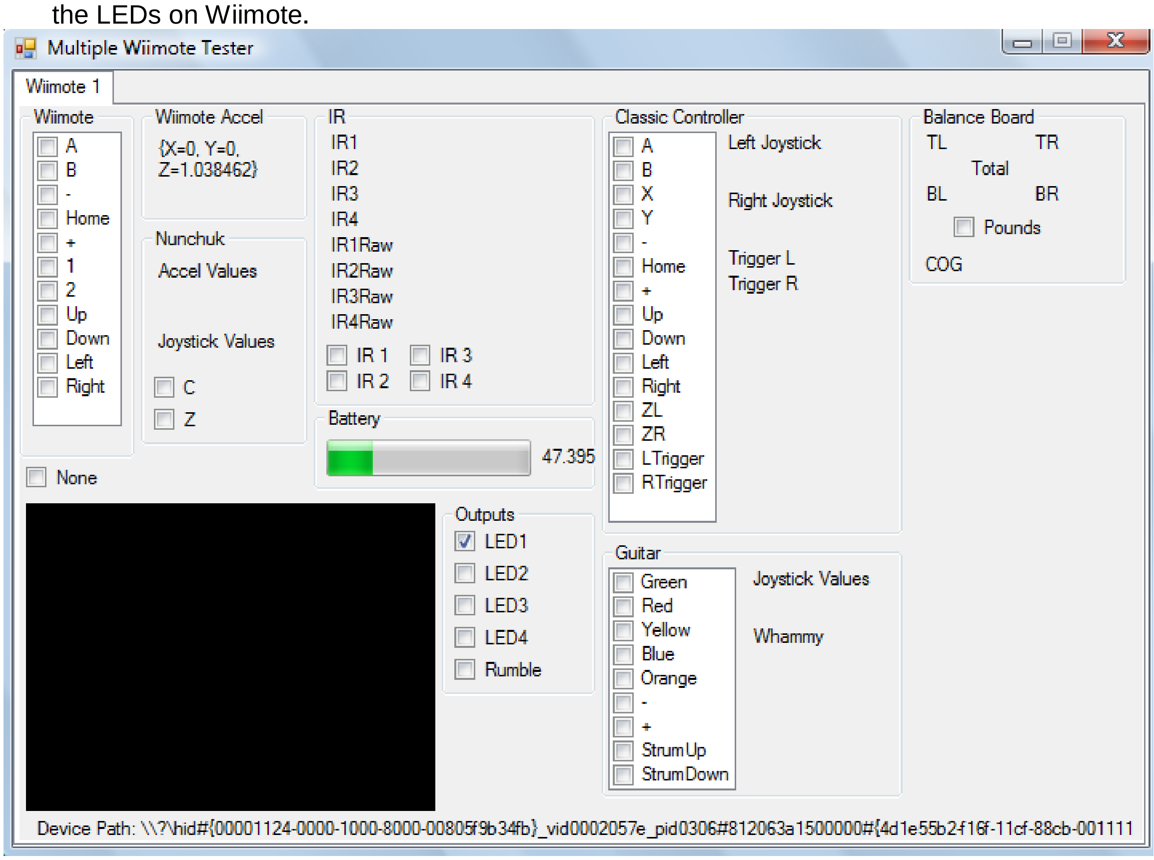
5. Choose **Nintendo RVL-CNT-01** device and click **Next.**



6. Select **Don't use a passkey** for this device. Before you move on, make sure the LED on your Wiimote are still flashing, or you may need to press and hold **1** and **2** buttons of your Wiimote again to make it flash before you click **Next.**
7. Now click **Next**, you will see that the window will try to connect and install the driver for your Wiimote.

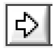


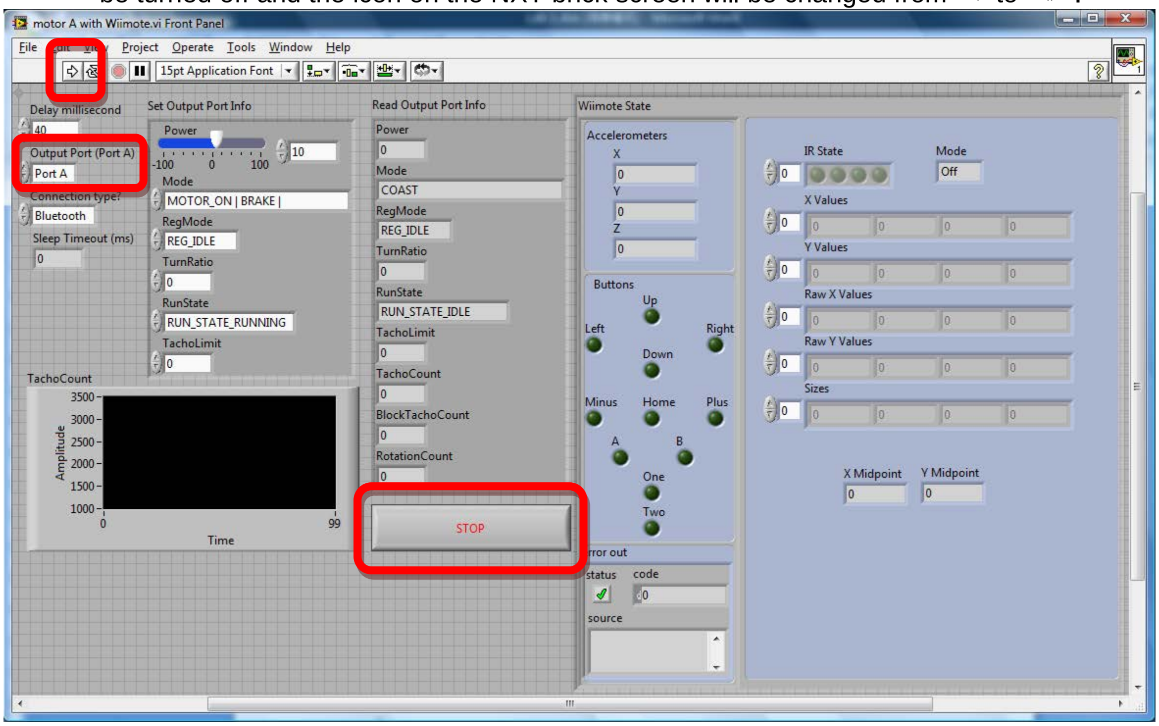
8. Now you have Wiimote connected with your PC. Double Click on **Wiimote Test** icon on your Desktop to check if you can actually read the sensor data from Wiimote and control the LEDs on Wiimote.



Part C: Run LabVIEW Sample Program

For this part of exercise, you will see that we can achieve much more functionality than LEGO Mindstorms NXT program. For example, we can use LabVIEW to accomplish the communication between different kinds of Bluetooth devices and won't be constrained in communication between NXT bricks and PC. Before starting this part of exercise, make sure you already finish the exercise of Part A and B correctly. Follow the procedure to run the sample program. In this demo, you will be able to use Wiimote to control the rotation speed and direction of motor A of LEGO NXT brick by flipping Wiimote forward and backward.

1. Double click on the file, **motor A with Wiimote.vi**, located on the **Desktop>>ENG100>> My LabVIEW example>>run in pc**, to invoke LabVIEW programming environment and prepare to run the demo program.
2. Click on the **run** button  on the LabVIEW Toolbar to run the demo program. Notice that the system will take a few seconds to connect Wiimote and NXT brick to your PC. Once the connection is established, you will see that the lights of LEDs on Wiimote will be turned off and the icon on the NXT brick screen will be changed from "**<**" to "**<>**".



3. On the left half part of LabVIEW window is the control and information of NXT brick. You can try to control different motor of NXT brick by changing Output Port from Port A to Port B or C. On the right half part of windows is the information about Wiimote Status. You can see the readings of different sensors and tell which button is pressed.
4. Press button **A** on your Wiimote to stop the demo program, or use mouse to click on **STOP** button located on the middle of demo program window.

Questions:

a) What should you do if you have error alert message shown up?

b) How to use Wiimote to control motor B and C at the same time?

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Lab #1 - Drag Race

OBJECTIVES

By the end of this laboratory, you will:

- Be aware of the lab safety rules and procedures followed by USD Engineering.
- Have become more familiar with some of the LEGO NXT elements that will be used throughout the semester.
- Have worked in a team to complete your first engineering design challenge including design, test, and improvement phases.

DELIVERABLES

- Completed *Student Questionnaire*
- Signed *Laboratory Safety Practices and Rules of Conduct*
- Compete in the drag race competition.

INTRODUCTION

Welcome to your first Engineering laboratory at USD! During the semester, you will perform a variety of activities to help you develop fundamental engineering skills and an understanding of some of the different disciplines in engineering.

During the first several weeks of the semester, the labs will use LEGO NXT to introduce elements of the engineering design process and fundamental ideas needed to build successful robots. As the semester progresses, the challenges will become more open-ended and more challenging. Depending on your experiences, many aspects of this lab may be familiar to you already. If that's the case, you should your lab partners learn the ideas. This will help reinforce what you know, and it will help you continue to develop the collaborative teamwork skills needed to be a successful engineer. Don't hesitate to ask for help if you have problems completing any part of the lab.

SAFETY FIRST!

Throughout your study at USD you will have many lab classes where you have a chance to apply the ideas that are presented to you in lectures. As you progress through one of the engineering majors you will have the opportunity to use a wide range of machines, instruments and test equipment. As you are introduced to specific equipment you will be told how to use it safely. Today you will complete the *Laboratory Safety Practices and Rules of Conduct* form, sign on the last page of the handout and turn it in to your lab instructor. Please take these policies seriously. Students who do not comply with these or other department policies will be asked to leave the lab.

L'EGGO My LEGO!

Your lab instructor will assign you to a team for the remainder of this lab. Teams will change several times throughout the semester so that you have an opportunity to work with most of the others in the class.

Your team will be given a set of LEGO NXT components. These components will be used throughout the semester to design increasingly complex robots. Your first reaction might be to ask why we are using LEGOs in an engineering course. Although the LEGO NXT system was designed to make it very easy to build simple robots, it was also engineered to be a system that can be extendedwith new components and electronics. There are several companies making some of these NXT enhancements. In fact, USD's 2006-07 Electrical Engineering Senior Design Project was to modify the NXT system to allow it to read Radio Frequency ID (RFID) chips. These RFID chips are small electronic tags that can be used to track the location of things such as medical charts in a hospital, or cartons of clothing shipped to Wal*Mart.

You should spend 10 minutes or so examining the NXT components. You won't be using the controller or the sensors this week, so you should focus on the wheels, axles, gears and connectors. How can you combine these items to make a vehicle? The Appendix summarizes some principles of LEGO construction and has notes on gears, but there are many ways to build things with these elements.

DESIGN CHALLENGE #1 – LEGO DRAG RACE

Challenge: To design and build a LEGO vehicle that travels the greatest distance when powered only by a rubber band.

Procedure:

Phase I:

- You have 30 minutes to design, build and test a rubber-band powered vehicle. The official rubber-bands will be supplied by the instructor. You may use only one rubber band and any items in the LEGO kit.
- The winner is determined as the longest distance traveled. The distance traveled is defined as distance from the start line to the LEGO piece closest to the start line.

Phase II:

- You will have 15 minutes to redesign your vehicle. You may not begin to redesign until after all teams have completed Phase I.
- No points will be awarded in Phase II.
- Teams will compete in the reverse order of Phase I.

Phase III:

- You have 15 minutes to re-design your vehicle once more. You may not begin to redesign until after all teams have completed Phase II.
- The winner is determined as the longest distance traveled.
- Teams will compete in random order determined by the instructor.

Scoring:

Your score will be based 70% on distance traveled (30 pts max for Phase I and 40 pts max for phase III) and 30% on the overall creativity and aesthetics of your vehicle. The *Design & Aesthetics* points will be evaluated before the final round of the competition.

Total Points available for this lab: 100

Scoring Guideline:

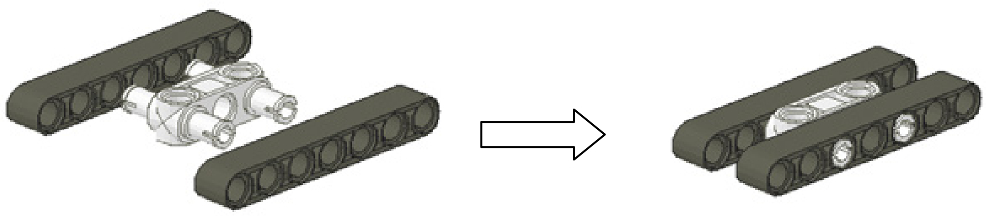
Phase I Distance	**Design & Aesthetics**	**Phase III Distance**
30 pts - Winner!	30 pts - Best design	40 pts - Winner!
28 pts - Moved 15+ ft	28 pts - Outstanding	38 pts - Moved 15+ ft
26 pts - Moved 10+ ft	26 pts - Some clever features	34 pts - Moved 10+ ft
23 pts - Moved forward	23 pts - Good	30 pts - Moved forward
20 pts - Moved	20 pts - Nothing special	26 pts - Moved
15 pts - Didn't Move	15 pts - Downright ugly	20 pts - Didn't Move
0 pts– No entry		0 pts– No entry

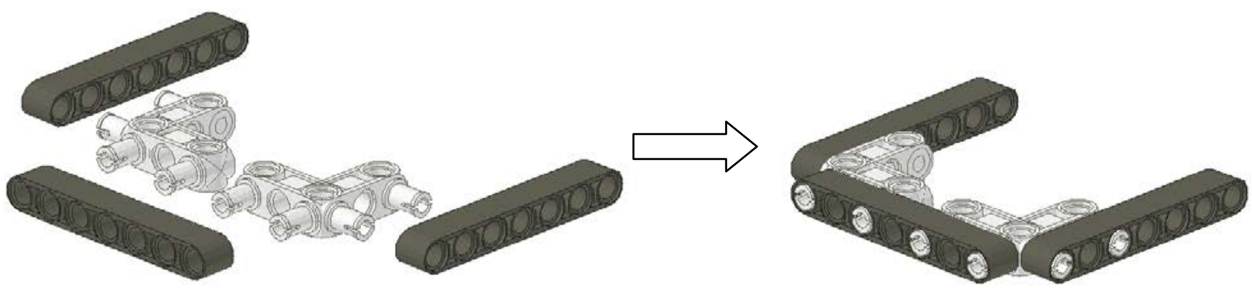
CLEAN-UP

After you have finished with the challenge you should completely dismantle your vehicle, place the parts in the tote, and return everything to your lab instructor.

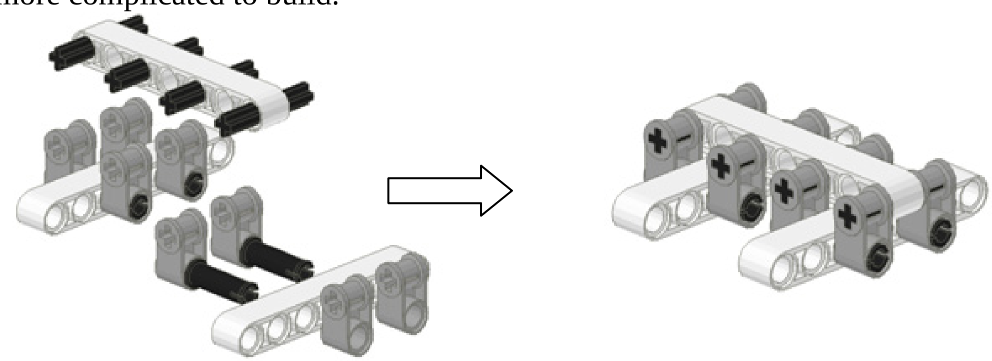
APPENDIX
LEGO NXT Construction Tips

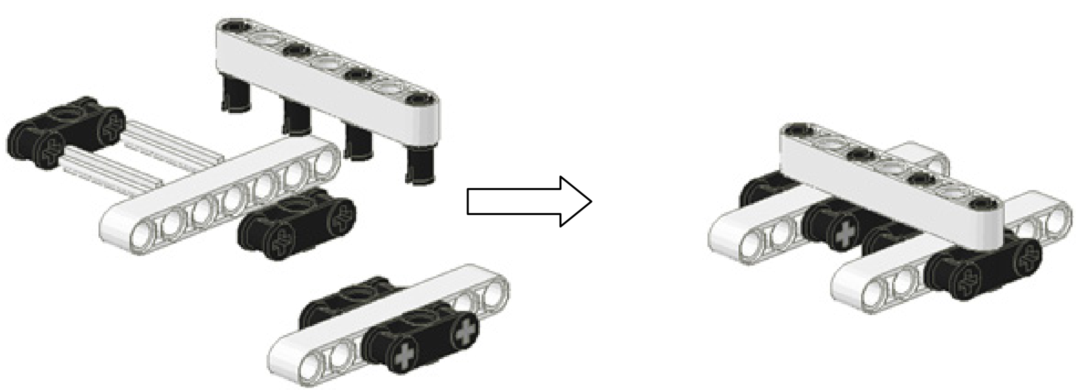
When building your robot you may need to make strong connections that will support tension or compression. These pictures illustrate some simple ways to connect components. In each case the figure on the left is an exploded view version of the completed assembly on the right.
The dark beams in these figures will support compression, but can come apart under tension.





In the figures below, additional the beams have been reinforced to support both compression and tension, but they are much more complicated to build.





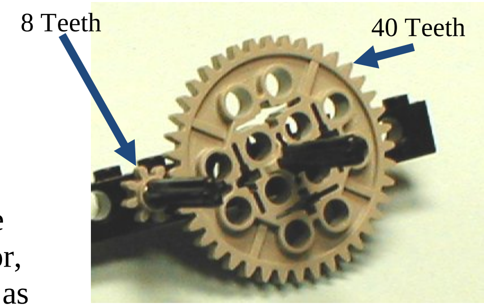
LEGO NXT Gear Tips

(From materials at the Carnegie Mellon University Robotics Institute)

The LEGO NXT system comes with several types of gears that can be used to change the speed or force delivered by the motor, or to rotate parts of your robot. This page illustrates the use of some of these gears.

Spur gears are the most common gear in the LEGO NXT system.
Spur gears do three things:

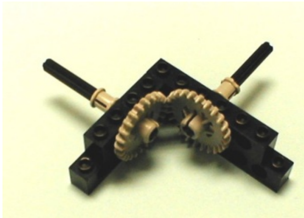
- Change the speed of rotation
- Change the torque delivered
- Cause a change in direction



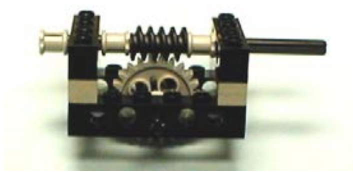
Mating spur gears rotate in opposite directions. The gear ratio is the ratio of the number of teeth on one gear to the number of teeth on the other gear. For the gears shown at the right the gear ratio is 40 to 8 or, 5:1. This also means the 40 tooth gear's axle has 5 times the torque as the 8 tooth gear's axle and 1/5 the rotational speed.

Idler gears are spur gears placed between two identically sized gears. Idler gears do not change the gear ratio. They do cause the gears on either side to turn in the same direction. Here the 40 tooth gear acts as an idler gear between two 8T gears.

*Bevel gears*mesh at a 90 degree angle. The gear ratio rules remain the same, but the axles are perpendicular to one another. LEGO NXT includes unusual bevel gears with curved teeth that mesh with spur gears and bevel gears.



Worm gears have a single tooth that wraps around its axis of rotation. Because it acts as a gear with one tooth it has a very high gear ratio.You can turn the worm gear's axle, but you can't turn the spur gear's axle.



Belts & pulleys are related to gears. They change speed and torque, but:

- Pulleys transfer their force by the friction of the belts, rather than direct contact with the teeth of gears. As a result the belts can slip.
- The pulleys rotate in the same direction.

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Lab #2 – Shuttle Race

OBJECTIVES

By the end of this laboratory, you will:

- Have become familiar with more of the LEGO NXT elements that will be used throughout the semester.
- Have constructed your first LEGO robot in ENGR 101 and made it move autonomously.
- Have conducted an experiment involving measurements, data collection and analysis.
- Have completed the Design Challenge #2: The Robot Shuttle Race including design, test, and improvement phases

DELIVERABLES

By the end this lab period -

- A functional LEGO robot able to move forward and backward on its own.
- A set of data characterizing the movement of your robot.

At the beginning of next lab period -

- A typed, two-page brief write-up**(one submission per team)** that includes the following sections:
  1. Names of team members (right justified)
  2. A title of "Lab 2 Technical Brief" (centered)
  3. Awell-formatted graph (with appropriate title and axis labels) that represents the movement characteristics of your robot
  4. Adescription of how your team will use the graph in implementing the shuttle moves
  5. A flow-chart (may be hand-drawn) for the shuttle move task
- A program ready on your robot to execute the shuttle moves.

By the end the next lab period -

- Completed the Design Challenge #2: The Robot Shuttle Race

INTRODUCTION

Last week you completed a car powered by a rubber band with LEGO components. It's time now to get a bit more sophisticated and build your first robot using the same LEGOMindstormsNXT Kit. A robot is a device that executes a preset task without operator's intervention. In this lab, you are going to build a car-like mobile robot which can execute a basic task of moving forward and backward autonomously.

Your lab instructor will assign you to a team and will give you a set of LEGOMindstorms NXT components. Make note of the label number on the set, as you will continue to use the same set for next week. Now open and inspect the set; use the component sheet as guide to quickly go over the contents. Make sure the major components such as the NXT Brick, motors, and sensors are there. Let the instructor know if you have any problems. If not, proceed to complete the following tasks.

TASK 1: Constructing a LEGO Robot That Goes

Your first task for this lab is to construct a robot that can move. Instructions for constructing such a basic robot can be accessed through CE6, under Lab folder (look for file titled "2-Motor NXT Vehicle Instructions". While some of you may wish to design and build your own robot – and you may do so if your team decides to, it is highly recommended that you as a team begin by following the instructions so that everyone is familiar with the basics. If you are already comfortable building using LEGO components, you should let other team members do most of the construction work. You will have many opportunities in the weeks to come to expand and come up with your own robot design to meet various challenges. Show your completed robot to the instructor when you complete this task.

TASK2: Characterizing the Movements of Your Robot

Working with the robot you have, devise an experiment to determinerelationship between the distance traveled and time your robot runs (or the number of times the motor turns). Here movement characteristics meansthe relationships between distances traveled and time (or number of motor turns/rotations) of your robot. Knowing the movement characteristics will enable you to command or program your robot to go for any set distance. Collect as many data points as you can so you can reasonably use them to generate a graph in Excel. Use XY scatter plot to generate your graph. Your graph should show a trendline with displayed equation. You should also set the y-intercept to zero as your robot should travel zero distance at time zero (or rotation zero). Show the instructor the result when you're finished with this task.

TASK 3: Programming for the Shuttle Race Design Challenge

Your robot will be used to compete in the "Shuttle Race" design challenge next week (see details on the design challenge on page 4). In order to complete the challenge, it should be able to move forward and backward on commands. Create a program that will command your robot to go back and forth 3 times for a certain distance. The distances do not matter this week, but you might consider next week's challenge when writing your program. Name the program 'Shuttle I' and save it on your robot and on your file space on the Engineering network. You'll need to have this ready to go at the beginning of the lab next week. It may also be a good idea for each team member to have a copy of the program in case of unexpected absences/tardiness next week.

Wrap-up

After you have finished with the tasks you should return all unused parts in the tote, thenstore your robot and the tote in the area assigned by instructor. Clean up your work area completely, and have your lab instructor inspect it before leaving.

Design Challenge #2: The Robot Shuttle Race

Challenge: To design and build a LEGO robot that can complete the shuttle line drill, namely, moving between a starting line and other lines spaced progressively apart (as shown in Figure 1). The distances between the lines will be given at the time of competition at the beginning of next lab period.

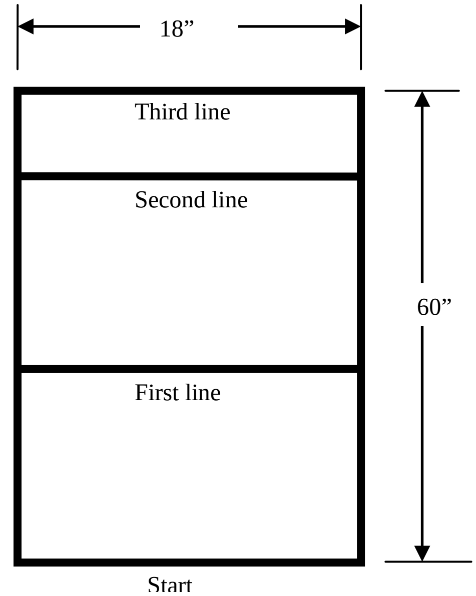

Figure 1: Shuttle Race Course Layout

Rules:

- The robot must start behind the starting line.
- After the initial start, the robot needs only to touch each line for all subsequent shuttle moves. The robot, however, may not touch any other line beyond the one it is trying to reach. For example, the robot can touch only line 1 when completing leg one of the race; touching line 2 or 3 will be considered failing leg one.
- Any robot touched by an operator after it has started is disqualified.
- The robot must return back behind the starting line at the end of the third leg run. Completion time is taken when your entire robot crosses the starting line.
- The team who can successfully complete all legs of the shuttle run in the fastest time will win.

Procedure:

Phase I:

- After the instructor reveals the specific layout of the shuttle course, you have 10 minutes to set up your robot and adjust your program. You will need to use the previous results that you obtained on the relationship between robot’s travel distance and time (or number of rotations) to predict how much time (or how many rotations) you should input into your program in order to achieve the objectives of this challenge. You may conduct up to 2 test runs during this setup period. No additional work is allowed at the end of this period.
- Team will compete in random order determined by the instructor. Your robot must be ready to go when called.

Phase II:

- You have 10 minutes to improve your program and re-configure your robot if necessary. You may not begin this phase until after all teams have completed Phase I. You may conduct 1 test run only during this phase.
- Team will compete in random order determined by the instructor. Your robot must be ready to go when called.

Grading:

Your performance score for each trial will be based on the following metric. The best score of the two trials will be taken as your final grade for this challenge.

100 pts – Champion
95 pts – Complete 3 legs of shuttle
85 pts – Complete 2 legs of shuttle
75 pts – Complete 1leg of shuttle
60 pts – moved
50 pts – didn’t move
0 pts – no entry

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LAB #3 – SENSORS ARE SNAZZY!

OBJECTIVES

By the end of this laboratory, you will:

- Have become more familiar with some of the LEGO NXT sensors that will be used throughout the semester, specifically touch, light, and ultrasonic sensors
- Be able to view sensor output on LEGO NXT Brick
- Have written and executed computer code to control a LEGO NXT robot with sensors
- Have completed the third design challenge including design, test, and improvement phases

DELIVERABLES

- Demonstrated flowchart, code, and successful operation for Design Tasks A.2, B.3, and C.2 to instructor
- NXT-G computer code for Design Challenge #3
- Completed the Design Challenge #3 "The Robot Shuttle Race with Sensors"
- Store all components in lab in designated area

INTRODUCTION

We've begun learning about LEGO NXT components. Today, we will experiment with sensors: specifically light, ultrasonic, and touch sensors. Using these components will allow us to complete more sophisticated tasks and help get us ready for our final design challenge in ENGR 101. Next week, we'll use these sensors in Design Challenge #3: The Robot Shuttle Race with Sensors.

A. TOUCH SENSOR

A.1.Viewing Output of Touch Sensor on NXT Brick

- Add a touch sensor to your robot and connect it to Port 1.
- Press orange *Select* button to turn on NXT Brick.
- Cycle Left or Right using gray triangle buttons on NXT Brick to get to *View*
- Select *View* using orange button
- Cycle Left or Right and then Select *Touch*
- Choose the Port being used by the sensor
- Press the orange tip on the sensor. Does the display change?

A.2. Touch Sensor Application

Design Task: Robot waits until a touch sensor is pushed and then moves forward and says "Good job!"

Write a flowchart and NXT-G code to complete this task. Execute your code and demonstrate for your instructor.

B. LIGHT SENSOR

B.1. Calibrate Light Sensor

- Add a light sensor to your robot and connect it to Port 2.
- It is a good idea to calibrate your light sensor each time you start using it in a new environment such as the lab or competition area.
- Use *Calibrate Sensors* from the *Tools* menu. Be sure NXT Brick is connected (and not on *View*) before you select this or dialog box will be grayed out. You only need to calibrate once per location after turning the Brick on.
- Follow directions on the Brick.
  - Point light sensor toward material that should measure as dark. (Note that you will probably have a number greater than 100 displayed. Don't worry. This is not a percentage of reflected light but the actual sensor reading between 0 and 1023.) Press orange Enter button on Brick.
  - Point toward material that should measure as bright. (A larger value should be displayed than what you had over the dark area. Again, this is not a percentage so it is ok for it to be much greater than 100.) Press orange Enter button on Brick.

B.2. Viewing Output of Light Sensor on NXT Brick

- As you did in Part A.1., on your NXT Brick, select *View* then select *"Reflected Light"* Sensor (*not the one with the* *)
- Choose the Port being used by the sensor
- Point the sensor toward the table. closer to the table? Farther from the table? How does the display change?
- What happens as you point the sensor at the tape on the floor? What happens when you point the sensor at other places on the floor?

B.3. Light Sensor Application

Design Task: Robot moves forward until it hits a line of tape on the floor.

Write a flowchart and NXT-G code to complete this task. Execute your code and demonstrate for your instructor. (You will need to decide what level to use as your trigger for the sensor.)

C. ULTRASONIC SENSOR

C.1. Viewing Output of Ultrasonic Sensor on NXT Brick

- Attach an ultrasonic sensor to your robot and connect it to Port 3.
- Select *View* and then Select "*Ultrasonic inch*" Sensor or "*Ultrasonic cm*" (remember which units you are using)
- Choose the Port being used by the sensor
- Point the sensor toward the table. What happens as you point the sensor closer to the table? Farther from the table? How does the display change?

C.2. Ultrasonic Sensor Application

Design Task: Robot moves to within 12 inches of a wall and then stops and moves backwards for 5 seconds.

Write a flowchart and NXT-G code to complete this task. Execute your code and demonstrate for your instructor.

Design Challenge #3 – The Robot Shuttle Race with Sensors

Challenge: To design and build a LEGO robot that can complete the shuttle line drill with sensors (as shown in Figure 1). The specific course will be laid out at the time of competition ***at the beginning of the next lab period***.

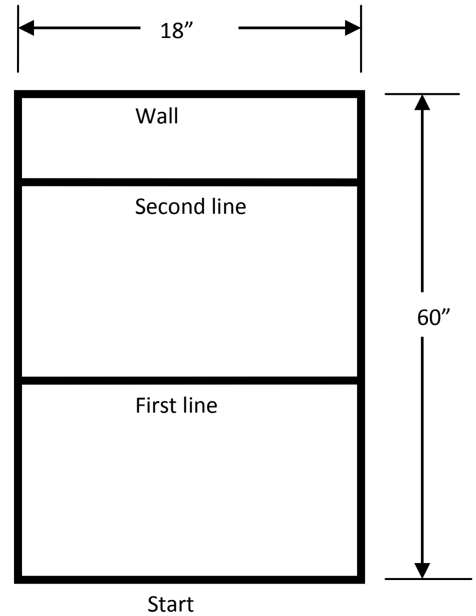

Figure 1: Shuttle Race Course Layout

Rules: (similar to Design Challenge #2 with some exceptions)

- ***NEW: Robot must***
  - Touch the first line based on using a light sensor and return to behind the start line.
  - Touch the second line based on distance from wall and then return to behind the start line
  - Bump into the “third line” (i.e. the wall) and return to behind the start line
- The robot must start behind the starting line which will be made from **white tape**.
- After the initial start, the robot may not touch any other line beyond the one it is trying to reach.
- Any robot touched by an operator after it has started is disqualified.
- The robot must return back behind the starting line at the end of the third leg run. Completion time is taken when your entire robot crosses the starting line.
- The team who can successfully complete all legs of the shuttle run in the fastest time will be the champion.

Phase I:

- After the instructor reveals the specific layout of the shuttle course, you have 10 minutes to set up your robot and adjust your program. You may conduct up to 2 test runs during this setup period. No additional work is allowed at the end of this period.
- Team will compete in random order determined by the instructor. Your robot must be ready to go when called.

Phase II (Optional):

- You have 10 minutes to improve your program and re-configure your robot if necessary. You may not begin this phase until after all teams have completed Phase I. You may conduct 1 test run only during this phase.
- Team will compete in random order determined by the instructor. Your robot must be ready to go when called.

Grading:

Your performance score for each trial will be based on the following metric. The best score of the two trials (if ran both phases) will be taken as your final grade for this challenge.

100 pts – Champion
95 pts – Complete 3 legs of shuttle
85 pts – Complete 2 legs of shuttle
75 pts – Complete 1leg of shuttle

60 pts – moved
50 pts – didn’t move
0 pts – no entry

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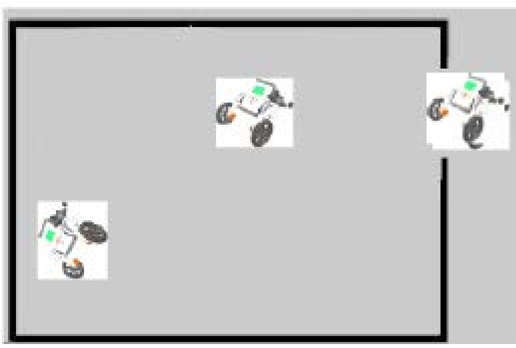
Design Challenge #4 – Breakout

Challenge: To design and build a LEGO robot that can find the exit of a box made out of electrical tape.



Rules:

- The robot will be placed by the instructor inside the box in a random position facing in a random direction.
- The robot must find its way out of the box without crossing the black electrical tape.
- We will use the soccer rule: Out means all parts of the robot have crossed the tape.
- You can increase the difficulty level (and your grade) by adding three obstacles (bricks) to the inside of the box. The location of the obstacles will be determined by the instructor.
- Any robot touched by an operator after it has started receives a penalty.
- Any robot crossing completely over the tape receives a penalty.

Trial I:

- Decide if you want to compete with or without the obstacles in the box.
- One robot will be placed into the box at a time.
- Teams will compete in random order determined by the instructor.
- Your robot must be ready to go when called.

Trial II:

- You have 20 minutes to improve your program and reconfigure your robot if necessary. You may not begin this phase until after all teams have completed Phase I.

- Decide if you want to compete with or without the obstacles in the box. You can change your mind.
- One robot will be placed into the box at a time.
- Teams will compete in random order determined by the instructor.
- Your robot must be ready to go when called.

Grading:

Your performance score for each trial will be based on the following metric. The best score of the two trials will be taken as your final grade for this challenge.

100 points – Fastest Escape with obstacles.

95 points – Your robot escapes from the box with obstacles within three minutes.

95 points – Your robot escapes from the box without obstacles within one minute.

90 points – Your robot escapes from the box without obstacles within three minutes.

80 points – Your robot doesn't find the exit within four minutes, but stays within the box.

70 points – Your robot reacts in a meaningful way to a black line or obstacle.

60 points – Your robot runs over the black tape or requires help.

50 points – You have built a robot.

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Design Challenge # 5 – Relay Race

Challenge: To work in a team of 6-8 members to design and build three different LEGO robots that can participate in a relay race and bring the puck to goal.

Rules:

- The first robot must start behind the starting line and at the center of the line, which is marked by black tape.
- The first robot retrieves a puck from inside a box (Box # 1) that is marked by white tape, brings the puck to the transfer point. The puck must cross the transfer point and stay within its boundaries (marked by a 12"-line of black tape) before the second robot can start the second leg of the race.
- The second robot must start out on the other side of the transfer point from the first robot, at any point along the marked 12"-line of black tape. This robot will have its own puck, bring the puck to Box # 2 (also marked by white tape) and drop it inside the box. The puck must stay completely inside Box # 2 before the third robot can start the third leg of the race.
- The third robot will start out right next to Box # 2 (closest wheel is within 4" of the box boundaries), orienting in any direction selected by the team. None of its components should cross the box boundary. This robot will also have its own puck. Its task is to bring the puck pass the goal line which is 6"-wide and marked by black tape.
- Robot can move the puck throughout the course using any method, as long as it has full control and possession of the puck. No kicking/throwing of the puck to the target is allowed.
- Team must make use of at least two different types of sensors (light, touch or ultrasonic) during the competition. Team will receive penalties for using fewer sensors.
- Team will receive bonus points if only one puck is used throughout the three legs of the race.

Competition:

- Decide if you want to use the brick post on either one of the white boxes. If so, you can choose to place the brick post anywhere around the white box.
- Decide if you want to strive for using only one puck throughout the three legs of the race.
- One team will compete at a time.
- Teams will compete in random order determined by the instructor.
- Your robots must be ready to go when called.
- Team will receive penalty when the next robot starts without previous robot completing its leg of the race.
- Team who completes all 3 legs of the race without violating any rules with the fastest time will win the competition.

Grading:

Your team performance score will be based on the following metric:

100 points – Completed all 3 legs with the puck at goal in fastest time.

95 points – Completed all 3 legs of the race correctly with the final puck at goal.

85 points – Have all three robots in the race, but only completed 2 legs of the race.

75 points – Have all three robots in the race, but only completed 1 leg of the race.

65 points – Have all three robots built, entered the competition. Robots moved around but were unable to complete any leg of the race correctly.

55 points – Have at least two robots built.

Bonus:

+ 5 points: Used one single puck throughout all three legs of the race.

Penalties:

– 5 points: Every time the next robot starts without previous robot completing its leg of the race.

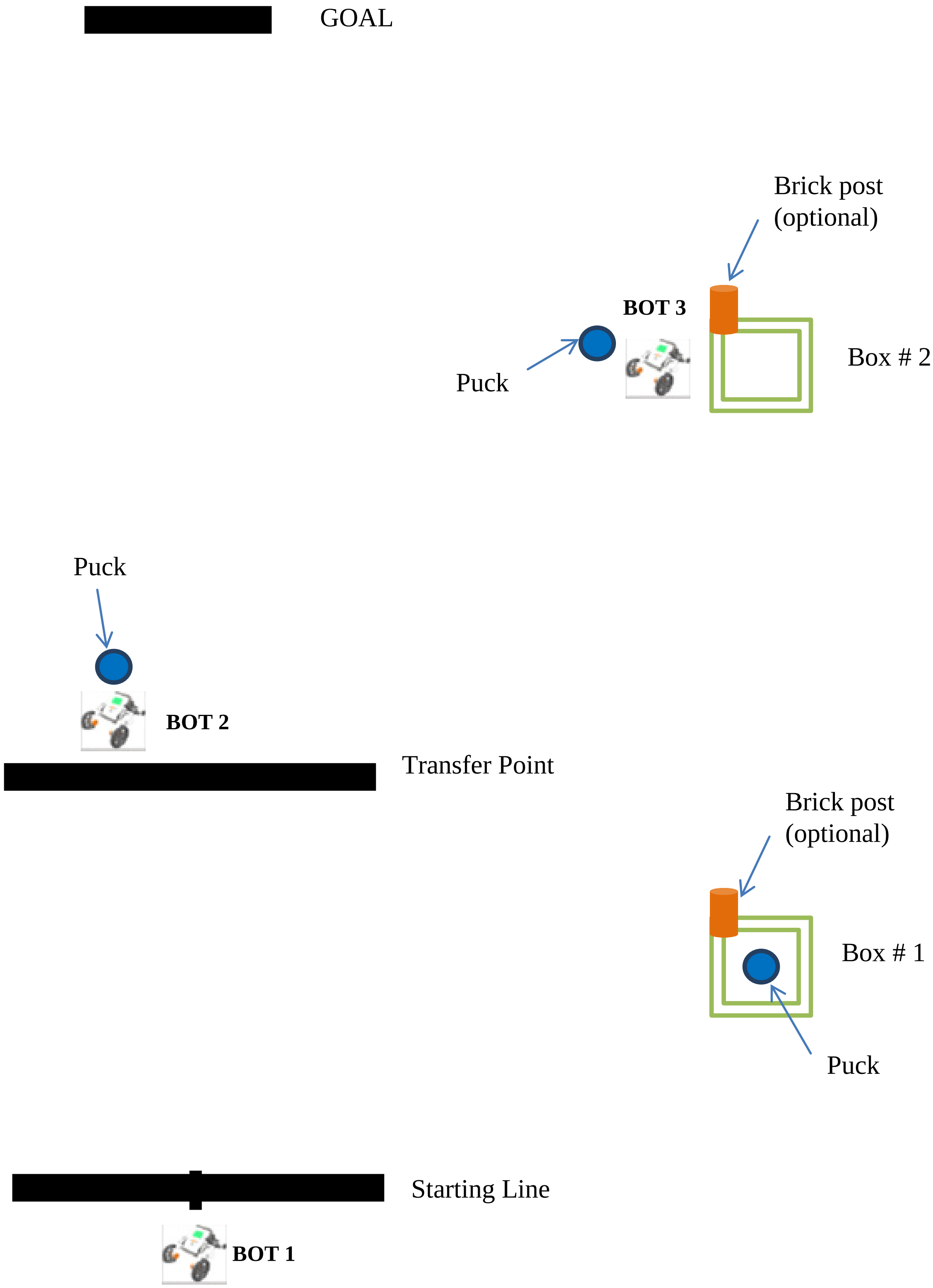
– 5 points: Used only one type of sensor in the race.

– 10 points: Used no sensors in the race.

– 2 points: Puck # 1 did not cross the transfer point completely.

– 2 points: Puck # 2 did not go inside Box # 2 completely.

– 2 points: Puck # 3 did not cross the goal line completely.


GOAL
Brick post
(optional)
BOT 3
Puck
Box # 2
Puck
BOT 2
Transfer Point
Brick post
(optional)
Box # 1
Puck
Starting Line
BOT 1

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Design Project Overview

Design, Build, and Document an Autonomous LEGO Robot that Navigates a Course and Retrieves a "Yellow Diamond"

Scope

This document describes the requirements of the major design project for ENGR 102.

Introduction

In ENGR 102, you will apply the engineering design process to a project which will span most of the semester. This project involves carrying out a complete engineering design project by employing the methods followed by practicing engineers. This semester your task is to propose, design, build, and document an autonomous LEGO robot that navigates a course and retrieves a "yellow diamond".

You will work on this project in teams of two to four. In order for you to complete your project by the end of the semester, it is essential that you create and follow a reasonable schedule.

Learning Objectives

The main learning objectives of this project are

- To continue to develop open-ended problem solving skills
- To gain experience in the practice of engineering by emulating engineers
- To develop skills in project planning and control
- To use skills and concepts related to Electrical, Industrial & Systems, and Mechanical Engineering in completing a design project
- To prepare accurate written documentation

Deliverables

By the completion of your project, you will have produced the following deliverables

- Project Concept Proposal
- Project Proposal
- Working autonomous LEGO robot
- Weekly status reports
- Written final report
- Oral presentations
- Peer assessment of team performance

Design Project Milestones

Due Date	Assignment(s)
Monday, February 28 (Week 6, Day 1)	Concept Proposal
Monday, March 28 (Week 10, Day 1)	Proposal
Wednesday, April 6 (Week 11)	Status Report 1
Wednesday, April 13 (Week 12)	Status Report 2
Wednesday, April 20 (Week 13, Day 2)	Status Report 3 Subsystem Test
Wednesday, April 27 (Week 14, Day 2)	Status Report 4 Design Project Binder Check
Monday, May 2 (Week 15, Day 1)	Design Review Presentation Deliverable (Word or PowerPoint)
Wednesday, May 4 (Week 15, Day 2)	Design Review Presentation Final Competition (Each team will compete on Courses 1 and 2)
Friday, May 13, 12 noon (Finals Week)	Final Design Project Binder

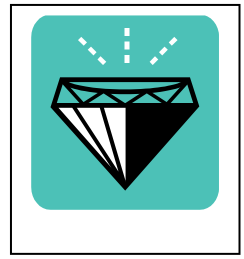
Project Grading (The project is worth 70% of your ENGR 102 grade)

Project grade based on

25%	Working autonomous LEGO robot
10%	Weekly Status Reports
10%	Concept Proposal
20%	Design Proposal
25%	Final Engineering Design Binder
10%	Design Review Presentation, homework, and activities related to the design project.

Individual contribution to the project team may raise or lower an individual's grade from the team project grade.

QUEST FOR THE YELLOW DIAMOND: RULES



Object of the competition
To capture the precious yellow diamond and return to the home position in the least amount of time while traversing obstacles. Bonus points will be awarded for retrieving the rare red ruby.

Rules

- At the start, your robot must be completely within the "home position" (white area on floor, measuring 15"x15").
- To leave the home position and enter the course, you must cross a "bridge" (black area on the floor next to "home").
- You must return to home by going back over the "bridge".
- Obstacles include a cave, a wall, and trees.
  - Trees are 8" high (height of a brick)
  - Wall is 4" high (made from multiple bricks)
  - Cave is approximately 17" high by 16" wide.
  - Trees are placed at least 15" from the cave, wall or other trees.
- Diamond and Ruby are on a pedestal. They must be picked up, not pushed back to home.
- Only 1 robot will be on the course at a time.
- There are two layouts of the course (see last page for map).
- Each course is approximately 6' by 9' overall. A moat defines the outside perimeter, marked by 2" black tape.
- The competition will occur during the last week of lab: each team's robot will go on its *Quest for the Yellow Diamond* once for each course.
- Each trial will last 4 minutes maximum.

Competition Scoring

10 pts Crossing the Bridge to enter the course
10 pts Reaching back 1/3 of course
20 pts Finding the Yellow Diamond or Red Ruby (part of robot is within 6" of the jewel).
15 pts Removing the Diamond or Ruby from its pedestal
15 pts Taking possession of the Yellow Diamond or Red Ruby
5 pts Returning to the front of the course (only if back 1/3 was reached)
10 pts Returning Home (2 wheels of robot completely within the black tape of Home)
        5 pts for 1 wheel of robot completely within the black tape of Home
15 pts Possessing Yellow Diamond at Home

Penalties:

Not using the Bridge when returning home: -5 pts

BONUS

Returning home with Red Ruby at least one time + 10 pts
Fastest time in section +10 pts

You will be given *3 attempts* on each course for full credit.
Additional attempts will be scored using: (1 - 0.1*Additional_Attempt_#)*Course Score
        For example, your *fourth* attempt will be worth at most 90 pts

Score: 0.5 * (Best Course 1 Score) + 0.5*(Best Course 2 Score) + BONUS

Bonus points may only be earned during the first *4 attempts* on each course.

Yellow Diamond and Red Ruby Information

- Yellow Diamond and Red Ruby will be
  - on a pedestal of 2.0” diameter and 3.6” height (See Figure 1)
    - Pedestal will be smooth clear plastic with a steel base
  - plastic balls of 3.1” diameter and approximately 400g mass
- Pedestals will have a light source at a height of approximately 3.1” (See Figure 1).

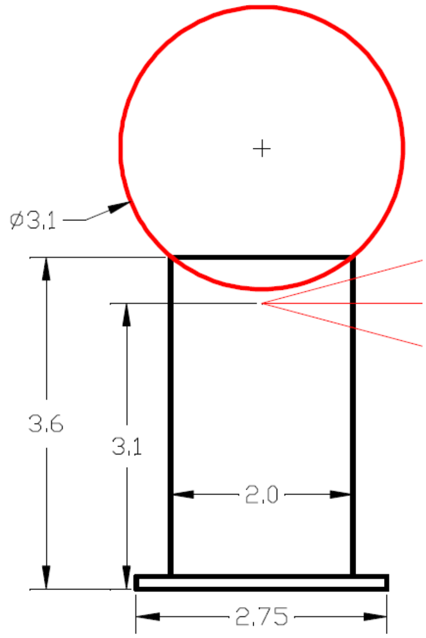
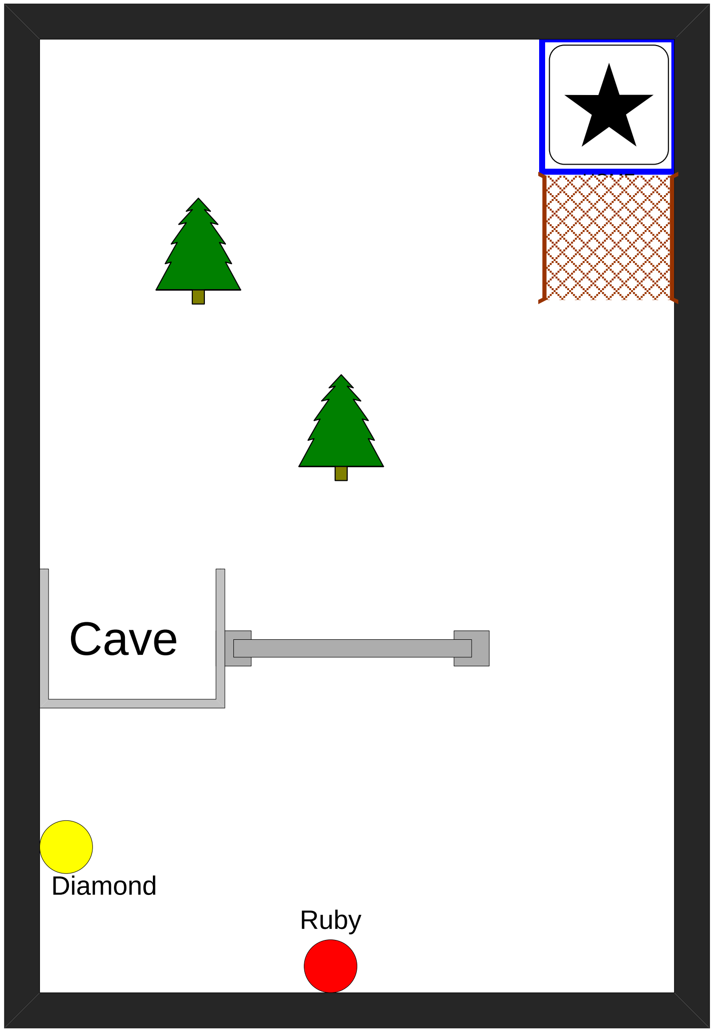
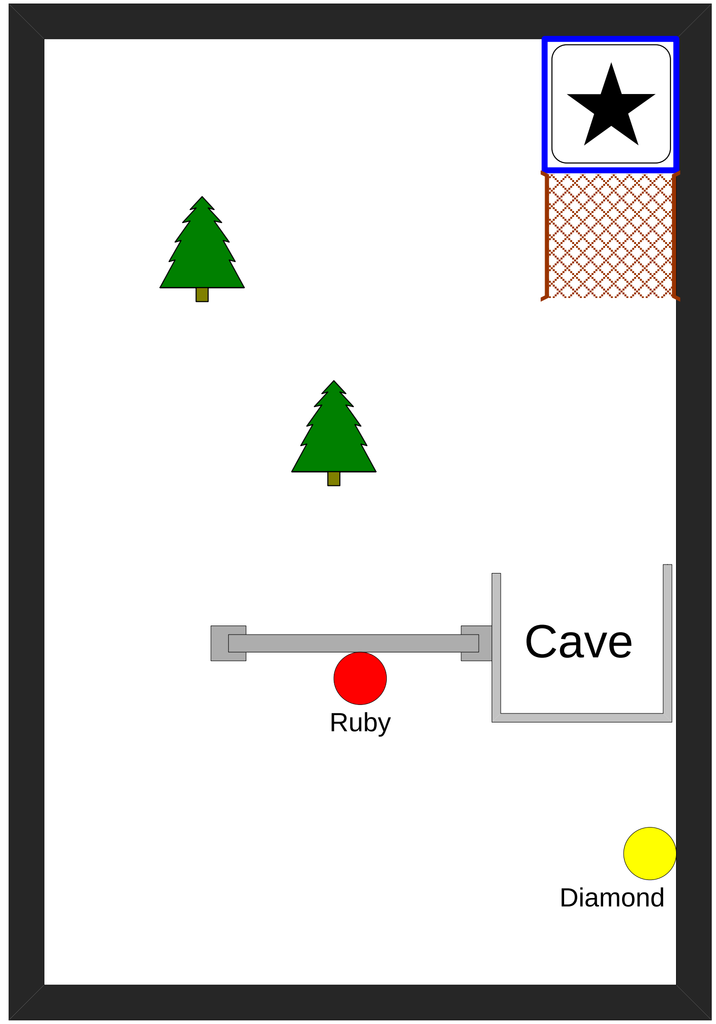


Figure 1 Schematic of ball and pedestal with dimensions indicated. Yellow diamond and red ruby will be balls on pedestals.



COURSE 1



COURSE 2

Project Proposal Guidelines

Introduction

The project proposal is a written document that describes what your group intends to accomplish this semester. After your instructor approves this proposal, it becomes the project plan.

In general, a proposal is a type of report that describes a future task and includes a complete plan of how to accomplish this task. If the task is related to solving an engineering problem, then the proposal should explain the existing problem and describe the procedure and steps for solving the problem, along with the resources required: costs, equipment, personnel, and a time schedule.

Each group will write a full design project proposal based on your concept proposal and the feedbacks that you have received from your instructor. **The final proposal is due at the beginning of class on Monday, March 28th**.

Organization and Format of Proposal

An extremely important part of your education is learning how to document your work and communicate it to others. You will need to write reports so that other engineers can understand them, as you will often not be available to clarify details. Sometimes the format and length of these reports are specified, sometimes not. In general, characteristics of any good report are:

- Concise
- Complete
- Clear
- Logical organization
- Free of grammar and spelling errors
- All figures and tables have numbers and captions and are referred to by their number
- All pages numbered sequentially, except for the title page.

A proposal should include:

A clear statement of what is being proposed and why.
An explanation of the task or problem.
A description of the plan for how to accomplish the task or solve the problem.
A description of methods, costs, personnel, and action schedules.

A given organization often uses a specific report format. Your proposal for your ENGR 102 project should have the following parts, many of which will appear in every report you prepare:

1) Title Page

This page should include:

- A clear, complete, and descriptive title.
- The name, title, and company of the person(s) to whom the report is directed.
- The name, title, and company of the writer(s).
- The date.

2) Purpose (of the Proposal Report)

Every report should include a statement of purpose. Briefly describe the objective of the report. For example: "This is the proposal for ENGR 102 from Team X. It describes the project plan for developing a robot to capture a jewel and return to the home position in the least amount of time."

3) Description of the Proposed System

This section should describe in detail how your system will operate. Your explanation should include words and drawings. Include a Table of Devices such as Table 1 with a description of each device.

Table 1: Sample Table of Devices

Label		**Component**	**Function**
1	Input	Light Sensor	Detect Jewel
2	Input	Light Sensor	Detect perimeter of course
3	Input	Ultrasonic Sensor	Detect cave
4	Input	*Unused*	
A	Output	Motor	Left Motion
B	Output	Motor	Right Motion
C	Output	Motor	Jewel retrieval

Drawings of the system should clearly show the location and type of all motors and sensors (e.g., see Figure 1. You may use Lego Digital Designer (free download at http://ldd.lego.com), or a very neat 3-view or perspective *scale* drawing of your system. For more information on Lego Digital Designer, see handout posted on CE6 (in the "Quest for the Yellow Diamond" folder).

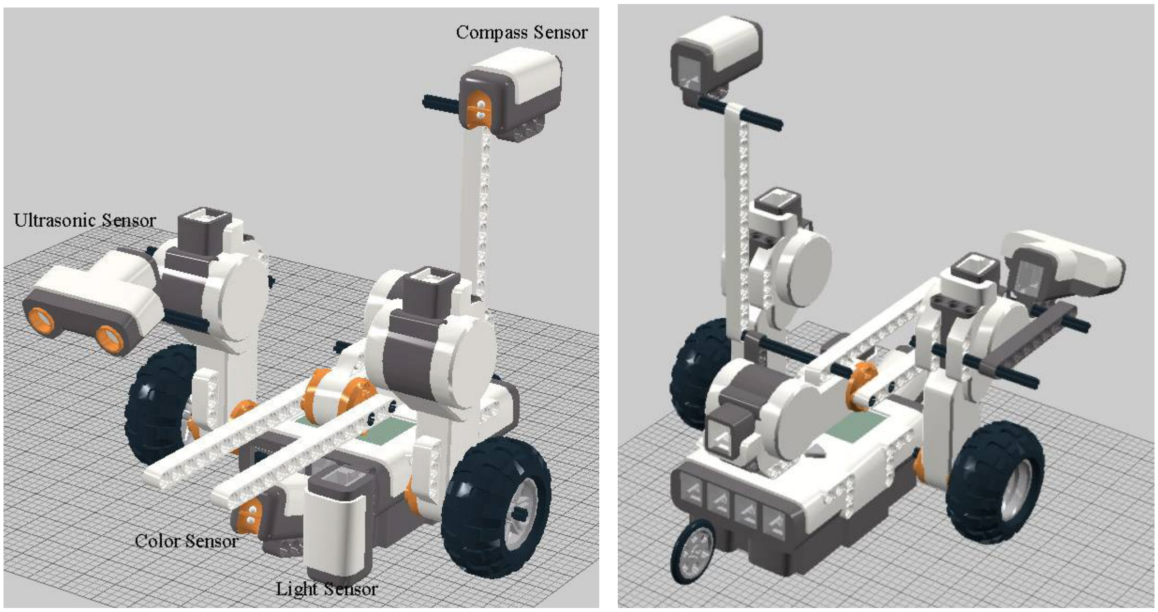


*Figure 1: Sample Lego Digital Designer model showing layout of major components. Your model should have at **least** this much detail, but need not have all **structural** elements.*

Break your overall system into *functional subsystems*. For example, detecting the yellow diamond might be a subsystem. The description of each subsystem includes the hardware as well as algorithms for accomplishing that function.

4) Activities and Time Schedule

Indicate how you will balance the workload for completing your project. Who is in charge of which tasks? Who is in charge of which subsystem?

Include a timetable for completing the project using a Gantt chart including all relevant activities and milestones. Make it as detailed as possible. Include known holidays or other nonworking days. This Gantt chart will be used to monitor your progress during the execution of the project so it is important for it to be complete and achievable. Display your timescale in weeks so that the chart is readable.

Sample Student Proposal

Refer to the sample student proposal from Spring 2008 posted on CE6 to see a "B" quality report. Note that the challenge has changed somewhat from Spring 2008 (do not copy and do not refer to "Sherwood Forest" or the "flag").

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Seismic Disasters

14:440:125 - Engineering Exploration

Project Abstract: Earthquakes have devastated nations for centuries. In 2010, there was a rash of earthquakes that had crippling effects. In January, a quake, with a 7.0 magnitude on the Richter scale, utterly overwhelmed Haiti with destruction. Chile was rocked by the 8.8 magnitude earthquake in February. The California-Mexico area was shaken with a 7.2 earthquake. In March of 2011 a 9.0 magnitude earthquake and resulting tsunami destroyed much of northern Japan.

In preparation for an earthquake, the local township has announced the Seismic Building Competition for the best building design, and you are invited to compete. The winner receives the best Engineer of the Year award. Construct a model building that is mechanically and structurally sound. The structural integrity of the building will be determined by the maximum seismic disturbance that the building is able to support.

Project Design: The task for your team is to design and build a 5 story building with bracing for provided dead, live, and lateral loading. The structure that withstands the maximum seismic disturbance wins the contest.

Each team of 4 will construct a five-story building prototype made of balsa wood. Structures should be constructed to a height of 30 inches A unidirectional earthquake shake table, with dimensions of 18 in by 15 in and a capacity of 50 lb, will be used for structure testing.

Model Dimensions and Details

- Building Plan Dimensions = 12 in x 12 in (outside-to-outside)
- Total building height = 30 in
- Minimum floor height = 3 in
- Diaphragms (floors) = 12 in x 12 in
- Base plate = 15 in x 15 in x 1/4 in should be fixed to the base of the structure. The base plate will also attach the structure to the shake table using mechanical clamps.
- Columns = 1/4 in x 1/4 in cross section. Built-up rectangular columns ½ in x ¼ in can be allowed at the **corners** if necessary. Interior edge columns are acceptable using allocated materials.
- Each floor can have a maximum of 6 columns.
- 1/8 in x 1/8 in pieces can not be used for columns.
- Braces = 1/8 in x 1/8 in cross section. Braces can be diagonal, cross, v-shaped, inverted v-shape, other design, or non-existent.
- Each group will get 8 glue sticks to complete structure and extra glue to affix tiles only.
- Strain gauges will be affixed to bracing to record strain, which will be used to calculate the stress in bracing.

Assessment
Each project will be evaluated in terms of the maximum acceleration or 'shake' that the structure is able to support without failure, and on the oral presentation. Each team member should keep record of project specifications (prototype/real structure), concepts used, and conclusions which should be included in the presentation.
Homework
Read materials on earthquakes and structural design; Define all highlighted terms in the project write-up *Hint: Physics Textbook* (include definitions in presentation); Summarize main points; Make at least one connection to your building design (to be included in presentation). Include one slide detailing Civil Engineering major (see Sakai Forum).

Presentation Rubric	
Adequate	▪ Goal(s) clearly stated. ▪ Math/Science concepts and methodologies used are correct and detailed properly. ▪ How goal was achieved is clearly stated. ▪ How do you know goal was achieved (assessment). ▪ Limitations. ▪ Topics and information learned (reflection). ▪ None of the presenters read verbatim. ▪ Transition between presents was smooth. ▪ Slides formatted properly: bullet points, efficient use of words, spelling/grammar correct.
Needs Improvement	▪ Goals are present but not completely clear. ▪ Math/Science concepts and methodologies used are incomplete and/or unclear. ▪ Incomplete assessment. ▪ Little or no reflection. ▪ Little to no limitations addressed. ▪ Some of the presenters read verbatim from slides/notecards ▪ Transition between presenters needs some work. ▪ Slides may be wordy, poorly formatted, and/or unpleasing.
Inadequate	▪ Goal unclearly stated or not present. ▪ Math/Science concepts and methodologies used are incorrect or not addressed. ▪ No reflection. ▪ No limitations addressed. ▪ Transition between presenters was not smooth ▪ Presenters read verbatim from slides/notecards ▪ Slides present but do not match presentation parameters.
Missing	▪ No presentation.

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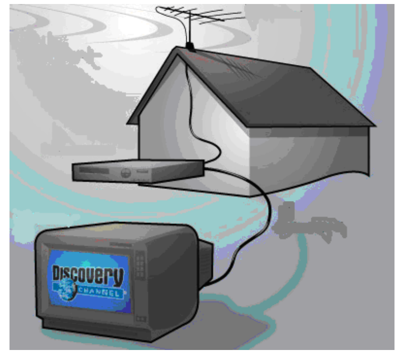
What's Inside the Black Box?

14:440:125 – Engineering Exploration

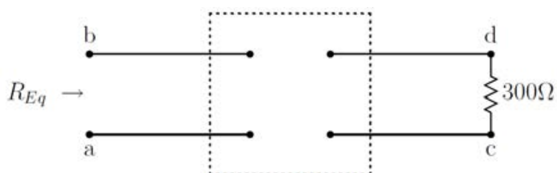


Project Abstract

Comvision is the largest cable company that supplies cable services to commercial buildings. In many commercial buildings built in the past, cable tv service is run from an outdoor antenna to several locations in the building. The standard cables used in the past were 300Ω cables. However, recent TVs have a 40Ω to70Ω cable connection, depending on the brand. If the resistance of incoming cable does not match what the TV cable connection requires, ghosts of previous images will linger on the TV screen making it impossible to watch the TV. One obvious solution to the problem is to replace all the 300Ω cables in the building cables that are 40Ω or 60Ω. This is expensive. A smart solution is to design an interfacing circuit between the 300Ω cable and the TV. Comvision is hosting a competition for the best circuit design. The best design wins the contract and receives a permanent job offer from Comvision.

Project Design

Consider the figure given below where the dotted box represents the interface between the cable and the TV. It contains the interface circuit. The terminals 'a' and 'b' are to be connected to TV and the terminals 'c' and 'd' are to be connected to the cable coming from an outdoor antenna. Assuming that the interface box is already connected to the cable coming from an outdoor antenna, the resistance of 300Ω between the terminals c and d is the equivalent resistance of the cable.



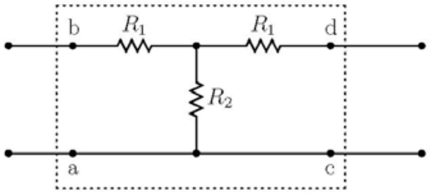
Block Diagram

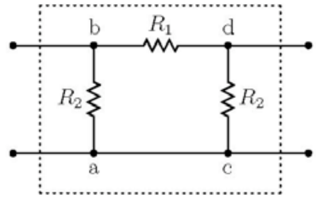
The mathematical design problem can then be expressed as follows: Design the interface circuit that should be in the dotted box such that the equivalent resistance REq between the terminals 'a' and 'b' is 50Ω.

Design Constraint 1: The terminal b cannot be interconnected to terminal d, They need to be distinctly different. The terminals a and c can be interconnected.

Design Constraint 2: The circuit designed need to be symmetrical. This implies that looking at the layout of the circuit either from the terminals a and b to the right or from the terminals c and d to the left must be the same. Such a symmetrical circuit allows us to connect either end of it to the cable, while the other end is connected to the TV. Each team must pick one of the designs shown below.

Below are two examples of symmetrical circuits that also satisfy Design Constraint 1:





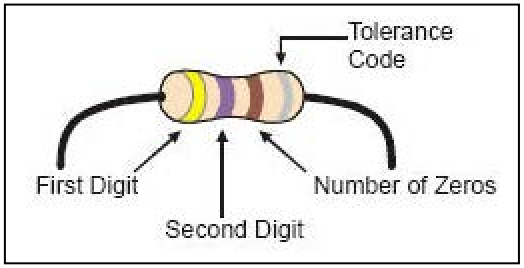
Assessment
Each project will be evaluated in terms of the circuit design, technical paper, and oral presentations. Each team member should keep record of project specifications, concepts, and conclusions.

Homework
Read 3 project papers and summarize main points (1 paragraph per paper). This assignment is to be included in the final draft of the technical paper and will not be collected separately.

Resistor Chart

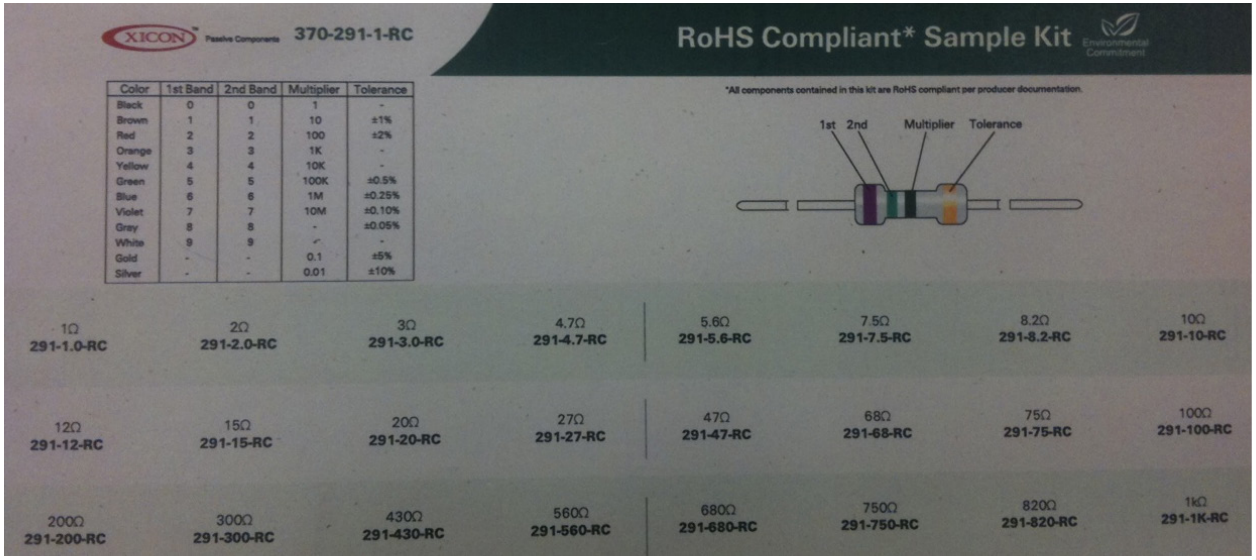
Table C-1:
Resistor Color Code Values

Digit	Color
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White



Example: 470Ω resistor:
4 = yellow
7 = violet
1 = brown
Add 1 zero to 47 to make 470,
So, 470 = yellow, violet, brown

Available Resistor Values



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Gas-less Car Competition

14:440:125 Engineering Exploration

Project Abstract:

- Greencorp Inc. is an environmentally friendly company that helps other companies to become more 'green'. Greencorp Inc. needs to design a wheeled vehicle to be used in production plants to transport products on an assembly line between stations as fast as possible. Greencorp Inc. is hosting a competition for Rutgers Engineers to construct 2 versions of a wheeled vehicle (one that travels with the greatest speed between two assembly line points, and one that travels the greatest distance). The vehicle is powered by a single mouse trap. The basic design costs $6. Any modifications come at an additional cost and weight; costs of materials to be purchased can be referenced from www.kelvin.com or from another source. The best product wins the competition and contract.

- Once the vehicle design is complete, Greencorp Inc. must determine the Cartesian coordinates of a new factory to manufacture these vehicles. The vehicles will be used in plants of five companies, each with their own demand for the vehicle.

Project Design Specifications:

- Design and build wheeled vehicle capable of traveling solely powered by a single mouse trap. Once the car is released, no human intervention is allowed.
- The design may be modified using materials supplied. The only part that must stay constant is the mousetrap itself.
- Determine the most optimal place to build a factory to build the vehicles. The companies buying the vehicles are located in the capital cities of the states indicated in the chart below. The optimal location will be where the distance to travel between companies is minimized keeping the demand in mind. The coordinates of the company sites are obtained using the latitude and longitude and translated into miles with respect to lat-long of (0, 0). The company sites and demands for each company are as follows (demand in millions pounds of the vehicle).

State	Arizona	California	Texas	North Dakota	New Jersey
Demand	300	900	1000	50	1000

- $X = (x,y)$ denotes the location of the new facility
- $P= (a_i,b_i)$ denotes the location of existing facility i, $i = 1,\ldots,m$
- w_i denotes the weight (or demand/flow) associated with travel between the new facility and existing facility i
- $d(X,P_i)$ denotes the distance between the new facility and existing facility (described by the distance calculations)

$$\text{Min } f(X) = \sum_i w_i d(X, P_i)$$

- Helpful terms: Moment of Inertia, Torque, Squared Euclidean distance, Manhattan (rectilinear) distance, Chebyshev distance, Euclidean distance. Weighted center method may not be used for this project.

Assessment:

- Each team will have three attempts and only the best attempt will be considered.
- Version 1- speed: The team with the fastest speed traveled (over a 15' distance) "wins". In case of a tie, the team traveling along the straightest line will win.
- Version 2-distance: The team with the longest distance "wins". In case of a tie, the team traveling along the straightest line will win.
- Identify at least 1 professor at Rutgers University who has research interests in car design. Make at least one relation of the research to your project.
- Each team will make a group presentation describing project specifications, concepts, data, and conclusions that describe how it works, why it works, and physics/math involved.
- Each group member will write their own technical report detailing all of the information about this project, requirements, limitations, design modifications with relevant math/science concepts, pictures, diagrams, etc.
- The presentation and technical paper will be your final exam. Further details about the paper will be provided to you.

Problem Solving Strategy
1. State the problem: Read problem at least 3x
2. Visualize, sketch, and translate English into Engineering (mathematical and scientific) terms.
3. Set specifications. Identify limitations and constraints.
4. Identify possible solution(s), analyze for viability.
5. Select most viable solution: dissect, research, design, and solve.
6. Check solution for consistency, evaluate, re-identify (step 1).

Presentation Rubric	
Adequate	▪ Goal(s) clearly stated. ▪ Math/Science concepts and methodologies used are correct and detailed properly. ▪ How goal was achieved is clearly stated. ▪ How do you know goal was achieved (assessment). ▪ Limitations. ▪ Topics and information learned (reflection). ▪ None of the presenters read verbatim. ▪ Transition between presents was smooth. ▪ Slides formatted properly: bullet points, efficient use of words, spelling/grammar correct.
Needs Improvement	▪ Goals are present but not completely clear. ▪ Math/Science concepts and methodologies used are incomplete and/or unclear. ▪ Incomplete assessment. ▪ Little or no reflection. ▪ Little to no limitations addressed. ▪ Some of the presenters read verbatim from slides/notecards ▪ Transition between presenters needs some work. ▪ Slides may be wordy, poorly formatted, and/or unpleasing.
Inadequate	▪ Goal unclearly stated or not present. ▪ Math/Science concepts and methodologies used are incorrect or not addressed. ▪ No reflection. ▪ No limitations addressed. ▪ Transition between presenters was not smooth

	▪ Presenters read verbatim from slides/notecards ▪ Slides present but do not match presentation parameters.
Missing	▪ No presentation.

Submitted by: Defne Apul
University of Toledo
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University of Toledo, Spring 2012
CIVE 1000 Freshmen Orientation for Civil Engineers
Instructor: Defne Apul, Ph.D., P.E.

Team Project (TP) on Sustainable Civil Engineering Technologies

This semester, you will work in teams to prepare a project that you will present in class using Powerpoint (or Prezi) and then at a professional conference (http://www.utoledo.edu/dl/sustainableu/index.html) using poster format. The project topic is sustainable civil engineering technologies. Each team will be assigned a project.

Team work and peer grading: Assignments TP1, TP2, TP3, and TP4 are related to the team project and should be submitted as a team. For these four assignments, you will be receiving one grade for the entire team. However, for each one of these assignments you will also be peer grading each other. Each team will receive one single grade for this assignment. However, a team member's grade may be made higher or lower by Dr. Apul or TAs

a) if peer evaluations show unequal contribution to the overall effort and/or
b) if Dr. Apul or TAs notice some unequal contribution by observing team product and dynamics

Important Advice

1. This a fairly detailed assignment that will lead to a public sharing of your work at the UT Sustainable U conference. This means, the teams need to meet at least once a week, likely twice a week until assignments project related assignments are are completed. It is quite possible that you will put in more hours into this class per week as you work on the team project. Other weeks will have lighter loads.
2. TAs and Dr. Apul are very excited about this project and want to help you as much as they can. Keep your TAs and Dr. Apul informed of your progress and your thoughts. Use their expertise to help you successfully complete the team project assignments. Show up during office hours. Use other communication means to work with them if necessary.

Project Topics

Each team will work on one of the following technologies:
<u>Structural:</u>
Low-carbon concrete versus traditional concrete
Low energy concrete klinker versus traditional klinker
Steel versus concrete
<u>Transportation</u>
Porous asphalt (also environmental) versus traditional asphalt
Porous concrete (also environmental) versus traditional concrete
Roundabouts versus traffic lights and stop signs
<u>Environmental</u>
Composting toilets versus flushed toilets
Rainwater harvesting versus municipal water use in toilets and in irrigation
Green roofs versus traditional roofs
Combined heat and power (CHP) at wastewater treatment plants versus without CHP
Living machines versus centralized wastewater treatment plants
<u>Geotechnical</u>
Bioreactor landfills versus traditional landfill
Beneficial reuse of dredged sediments versus placement in confined disposal facility (CDF)
Geothermal energy versus fossil fuel energy

TP1: Success Skills: Personal and Technical Skills

(Team assignment, 7 points)

Work with your team members to prepare one final word document that has answers to following questions. Once your responses are typed up and your document is ready, print and bring the document to class to turn it in before class on. **Only one document should be submitted per team.**

Question 0: Fill in the box below for your team

Project topic:	
Names of team members:	
Your team's weekly meeting time and place	

Question 1

All of you are bringing with you some ideas on what you need to do to be successful in the civil engineering program and in your career. Some of these skills may or may not overlap with skills you will need to be successful in the CIVE 1000 team project assigned to you. These skills can be thought of in terms of personal attributes and technical skills. Both are equally important for your career but unfortunately some students ignore one or the other. What are these attributes? In other words, what do you need to be successful in your project, in the civil eng. program, and in your career? I would like you to be conscious about what you need to be doing to be successful. Also, I want the team projects to run as smoothly as possible and knowing upfront what is needed from each one of you will help make your project be successful. For these reasons, I am asking you to fill out tables 1 and 2 below. Each person should contribute with at least two ideas for each category for that person to receive full credit for this question. Also, to help you with brainstorming, I have provided (after Table 2) the ideas from last year's students. Feel free to use these ideas and expand on them.

Table 1: Personal attributes necessary for you to be successful in this team project and in the civil eng. program (and in your career)

Personal attributes necessary for success of team project		Personal attributes necessary for you to be successful in civil eng. program and in your career	
Idea / Attribute	Name of person contributing this idea	Idea / Attribute	Name of person contributing this idea
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	

Table 2: Technical skills necessary for you to be successful in this team project and in the civil eng. program (and in your career)

Technical skills necessary for success of team project		Technical skills necessary for you to be successful in civil eng. program and in your career	
Idea / Skill	Name of person contributing this idea	Idea / Skill	Name of person contributing this idea
1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	

Past Student's Tips for Success!

How To Be A Successful Student/Group Member		
Important Qualities	**Important Actions**	**Important Skills**
Persistence	Meet on a regular basis, at least once a week	Teamwork
Leadership	Do not be bossy because it is a team effort	Communication
Positive Attitude	Find Inspiration	Time management
Dependability	Make Goals	Organization
Honesty	Dividing the workload	Brainstorming
Dedication	Motivate each other	Cooperation
Patience	Think outside of the box	Compromising
Energy	Be positive, Encourage others	
Punctuality	Complete assigned tasks	
Perseverance	Ask questions to clarify expectations of the project	
Flexibility	Have respect for each other	
Responsibility	Thorough research	
Effort, Work Ethic	Elect a team leader (to submits assignments)	
Creativity	Understanding the teams strengths and weaknesses	
Willingness to Learn	Understanding the teams goals	
Open-mindedness	Participation from all Group Members	
	Plan out a schedule	
	Do not procrastinate	
	Be Prepared	
	Find statistics	
	Estimate time of construction and total cost	
	Have Fun!	

Question 2

I want you to get started with your research right away. To do this, let's have you find some websites that might provide potentially helpful information for your project. Please do a little google search on the topic of your project and fill in Table 3 below. You may later find out that these websites may or may not be that helpful but you need to get started somewhere! Each person should provide at least two website resources. A minimum of 10 websites are needed for full points for this assignment.

Table 3: Preliminary resources to get started on the project

Website address	Website brief description and how it may be helpful for your project	Name of person locating this resource

Question 3:

You need to delegate work and set deadlines to be able to successfully complete the project. Some work ahead of you is listed below:

- Registering for the Sustainable U conference
- Submitting an abstract for the Sustainable U conference
- researching information
- compiling information
- determining what to present and what to leave out
- preparingpowerpoint
- practicingpowerpoint before in class presentation
- preparing poster
- printing poster
- preparing different sections of the powerpoint and poster. These sections are:
    - introduction
    - technical performance
    - economic performance
    - environmental performance
    - social performance
- relation to sustainable rating system
- summary

Use the table below to help you delegate tasks and assign deadlines. This table is meant to help you get started. As project progresses

Person responsible	Task	Due date for when that task will be done

TP2: Conference abstract submission

(Team assignment, **5 points)**

Every profession has professional conferences. Typically, a person attends a conference to network with others, share some expertise, and learn from other presenters and colleagues. You will be presenting at the Sustainable U conference (http://www.utoledo.edu/dl/sustainableu/index.html). To be able to present a poster, you need to submit an abstract so they include you in the program. Look up online what 'abstract' means. You will find out that abstracts are used both in presentations and in technical reports.

To complete TP2, go to http://www.utoledo.edu/dl/sustainableu/index.html, click on 'submit your abstract' at the bottom of page and follow directions. **Note that each team will submit one abstract. In addition, each student must register for the conference.**

To help you put together your abstract, I pasted below a draft that you can fill in with your own information.

Abstract Title: Evaluation of _________ as a sustainable civil engineering technology

Abstract Text: Various sustainable design approaches are emerging in the geotechnical, transportation, environmental, and structural aspects of civil engineering. Within __________ engineering, a promising technology is __________. The goal of this study was evaluate the performance of this technology in comparison to its traditional alternative; __________ . In this presentation, we introduce the technology and compare its technical, economic, environmental, and social performance to ________. We also present the role of this technology in emerging sustainable rating systems such as _______.

TP3: Class Presentation

(Team assignment, 15 points)

Presentation format:

0. Cover slide (one slide) (title of the presentation, your names)

1.Introduction (2-4 slides)

- introduce what the traditional technology is and what the issues with it are
- once you have laid out some potential issues with the current technology, introduce the 'sustainable' technology as a potential alternative to the traditional system. Describe your 'sustainable' technology. How does it work, what does it do, how is it different? Some of this discussion may be (should be) included later on in the presentation where you will be discussing performance metrics. But here, you need to briefly introduce the technology so people know what you are talking about.
- determine if there is an example of this technology on campus or locally in Toledo area and present photos of these applications along with how well you think they may be working

2. Objectives (1 slide)

- State the objectives (goals) of your study. This slide should contain a sentences that reads like this: "the goal of this study was to evaluate ___________ and compare its technical, social, economic, environmental performance to its traditional alternative ___________"

2. Technical, economic, environmental, and social performance (3-7 slides)

Each technology may have slightly different performance expectations. Pick the appropriate metrics relevant to your own technology. At a minimum, your performance evaluation should include cost, and some other environmental, technical, and social considerations.

Some performance metrics to consider are [this is NOT a comprehensive list. You need to develop your own list and organize the slides so they flow in a logical order]:

-maintenance requirements
-corrodibility
-reliability
-strength
-safety
-practicality
-permeability
-life cycle cost (initial cost, operation cost, end of life cost)
-life cycle environmental impacts
- human health and ecosystem health impacts
-social implications
- ethical considerations

3. Relation to sustainable rating systems (1-3 slides)

Discuss which rating system may be applicable to your technology. Very briefly introduce that rating system. Then, discuss if your technology may help obtain points towards achieving any of the credits included in the rating system. Possible rating systems to consider are LEED, GreenRoads, and Sustainable Infrastructures Rating System.

4. Conclusions (1 slide)

Based on your earlier comparison, conclude if the 'sustainable' technology is really sustainable or not. To do this, you may find yourself summarize some main points discussed in earlier slides. You may consider presenting (perhaps in a table format) advantages and disadvantages of the technology as a way to summarize what was said earlier. You should have a final conclusion on what your comparison of the new technology to the traditional system showed. Think of conclusions slide as the ultimate slide to summarize what you found related to the objectives you presented earlier. Also note that conclusions slide should not introduce any new information.

5. Acknowledgements (either at the end or below on the slide that has the figure that is not yours)
If you copy pasted any figures/images from anywhere to do your presentation, you should acknowledge this either on the slide where you have the figure (use small text) or you can have one acknowledgements slide in the end where you say from where came each one of the figures that were not your own creations.

6. Thank you (1 slide) (optional)
Typically we end the presentation with a thank you for your attention type of statement. Then, we open up the floor to questions.

Other requirements
Everyone in your team should present **at least** one slide. You will be peer grading each other on this assignment (as well as each one of the TP assignments). Students not having contributed positively and effectively to preparing the presentation, doing the work, practicing, etc. will receive lower grades. Often, the value each student added to the presentation shows at the time when the team is presenting.

As a team, you should practice your presentation **at least** two times before coming in to class to present it. Maintain eye contact and confidence while presenting. Dress code should be business casual during your presentation. No hats, no jeans or pants with holes. Please show professionalism. Google 'business casual' if you are not sure. In general, get used to Googling and finding online information to any concept or words you may be unclear about.

General slide guidelines:

- Each slide should have a title.
- Avoid too much text.
- Add relevant figures/photos as needed. Do NOT add these just to make the slide more interesting.
- You should be very clear about what point you will be making on each slide. The slide should be designed to help you make that point. The slide is an aid. Do not abuse it but use it effectively.

Grading Scheme for Assignment 5

1. (5 points) Effective communication
   Points are taken off if you:
   - Are not professional
   - Are not engaged in the presentation
   - Do not face and talkto the audience
   - Seem you are not prepared
   - Slides are not well put together
2. (9 points) Technical depth and quality of work presented
   Technical depth refers to content you will discuss regarding technical, economic (means you must present cost numbers!), environmental, social considerations.
3. (1 points) Ability to handle or answer questions. (Expect questions from Dr. Apul and TAs. All students are also encouraged to ask questions.)

TP4: Team Project Poster Presentation

(Team assignment, 20 points)

- You will be preparing a poster on your work to present at the upcoming Sustainability conference at UT. Here is the link to the conference webpage:
- All students planning on attending the conference should register online (at the conference website) **by October 1st.**
- Poster size should be minimum 3ft tall. Width can be anywhere between 4 to 5 ft.
- Use online resources to help you prepare the poster. Here are two helpful links:
    - http://www.ncsu.edu/project/posters/NewSite/index.html
    - http://utwatersustainability.wikispaces.com/file/view/how+to+prepare+a+poster.pdf

Grading Scheme for TP4:

Your poster presentation will receive a grade based on the following criteria:

- (4 points) Team members are professional, confident, and on top of their work
- (2 point) Poster is easy to read from an appropriate distance.
- (7 point) Poster is visually appealing, well organized and easy to follow. Poster uses explicit numbering, column bars, row bars, or some other means to guide viewer how to move through the poster. Poster is neat and appealing to look at. Content is clear and easy to understand. Unnecessary details are not presented. Graphics and other visuals enhance presentation. There is a good balance between text and graphics.
- (7 points) Poster has all necessary content including but not limited to:
    - Title, authors, affiliations, contact info
    - Abstract
    - Objectives
    - Performance evaluation
        - Technical performance
        - Environmental performance
        - Social performance
        - Economic performance
    - Relation to sustainable rating system
    - Conclusions
    - Other relevant sections

Chemical Engineering Process Design Competition

Submitted by: Mike Duncan
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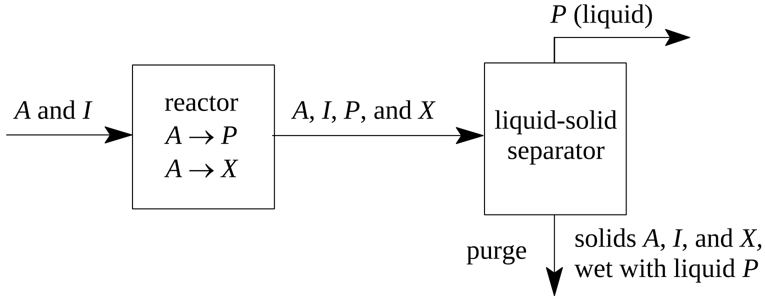
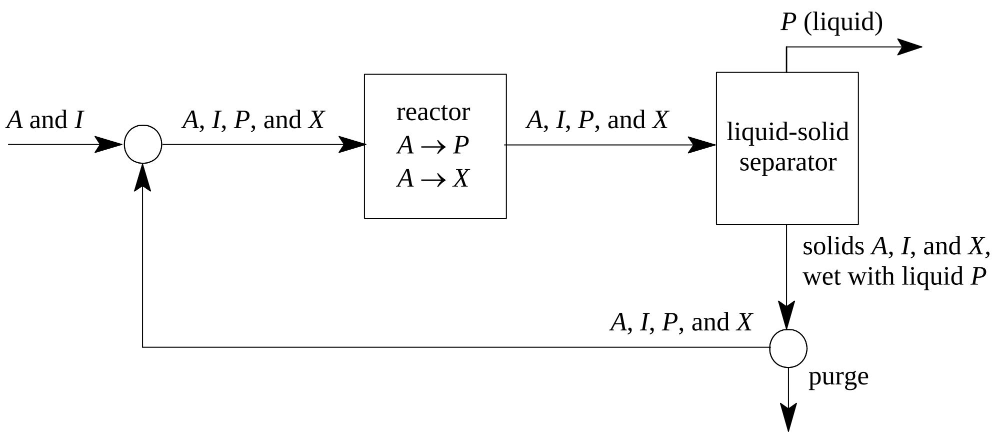
Design Competition Overview - 2012

Produce P by the reaction $A \rightarrow P$, which is accompanied by a parallel reaction, $A \rightarrow X$. Both reactions are irreversible and both reactions are incomplete. Reactant A is available only as a mixture with inert impurity I. A, I, and P have identical boiling points; we obtain pure P with a liquid-solid separator.

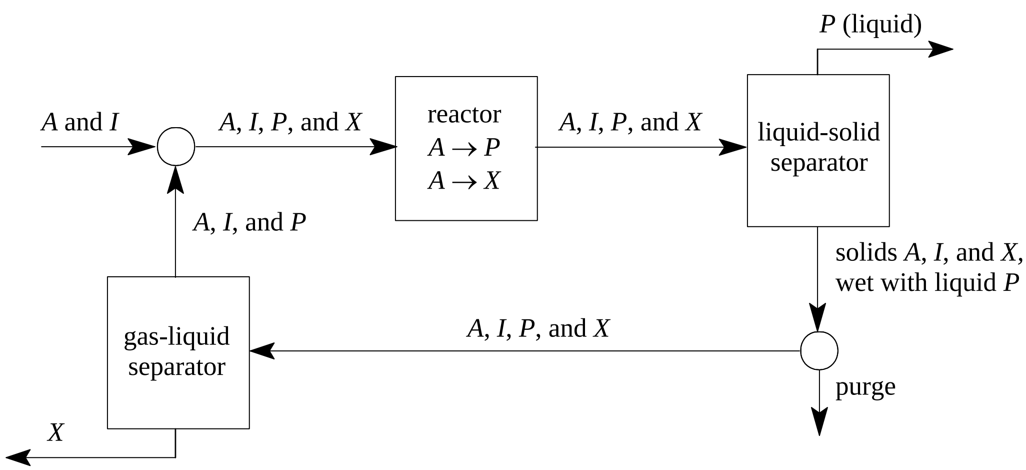
The simplest design is a reactor and a separator.



You may decide to recycle unreacted A, with a purge to remove impurity I and by-product X.



Or you may install a gas-liquid separator to purify by-product X, which can also be sold.



Design Competition - 2012

You have two choices for the reactant purity:

Grade 1: High purity (at least 95 mol% *A*) and high price.
Grade 2: Modest purity (at least 80 mol% *A*) and modest price.

You have two choices for the reactor:

Type 1: High conversion and modest selectivity of *P* over *X*.
Type 2: Low conversion and good selectivity of *P* over *X*.

You have two choices for the liquid-solid separator:

Type 1: High recovery of *P*; low mol% *P* in the solids stream.
Type 2: Good recovery of *P*; modest mol% *P* in the solids stream.

In general, equipment with better specifications costs more to purchase and costs more to operate. The equipment has economy of scale; the equipment price is proportional to $(\text{capacity})^{0.6}$

For the first year, you must decide what grade of reactant to use, what types of equipment to purchase, what size equipment to purchase, and your production rates. Economic data are provided in a separate file.

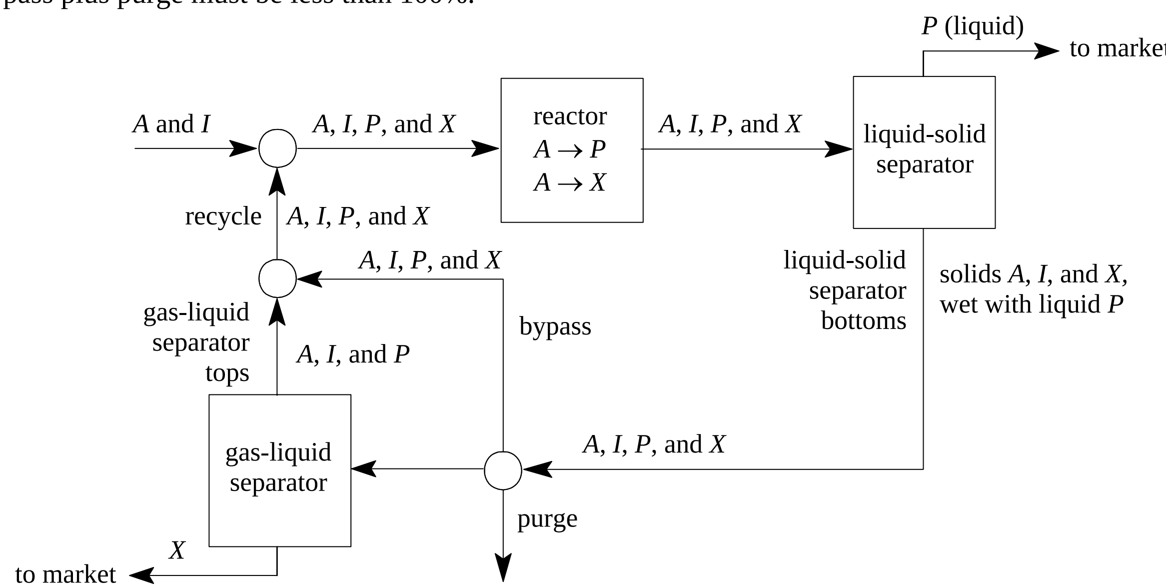
Your fiducial goal is to achieve an ROI greater than zero. Additional rewards are earned for an ROI greater than 0.20 and for the highest ROI in your Division.

EngrI 1120 - Introduction to Chemical Engineering
Design Competition - Fall 2012 - Part 1.

Your company has decided to produce P by the reaction $A \rightarrow P$. Unfortunately, there is a parallel reaction, $A \rightarrow X$. Both reactions are irreversible and both reactions are incomplete. Reactant A is available only as a mixture with inert impurity I.

A, I, and P have identical boiling points; we obtain pure P with a liquid-solid separator. But the solids A, I, and X retain some liquid P.

A generic process is shown below. To produce and sell product P, you need only a reactor and a liquid-solid separator. You have three options for the A+I+P+X mixture in the liquid-solid separator bottoms stream: (1) you may discard the mixture by sending 100% of the stream to the purge, or (2) you may recycle some of the mixture, for example, by purging 50% and sending 50% through the recycle, or (3) you may purchase a second separator to separate and sell by-product X. If you wish to produce X, the bypass plus purge must be less than 100%.



There are two options for reactant purity. Grade 1 mixture is high purity A and is expensive. Grade 2 mixture is modest purity A and is less expensive.

There are two options for the reactor. Reactor Type 1 has a high conversion of A but has modest selectivity for P over X. Reactor Type 2 has a lower conversion of A, but better selectivity for P over X.

There are two options for the liquid-solid separator. Both options produce pure P, but differ by the amount of P retained by the solids. Liquid-solid separator Type 1 recovers more P. Liquid-solid separator Type 2 retains more P in the solids stream, but is less expensive to operate.

Disposal of the purged stream requires special treatment and is expensive.

Engineering and Economic Data for Manufacturing *P* (and *X*) from *A*.

Equipment specifications, equipment costs, operating costs, chemical costs, and disposal costs vary with Design League and Division. Identify your team's League and Division and then download the data from the EngrI 1120 homepage - see "Design Competition."

Wednesday Design League:	Keynes Division: Teams W1 - W7
	Smith Division: Teams W8 - W13
Thursday Design League:	Friedman Division: Teams R1 - R6
	Galbraith Division: Teams R7 - R13

Reactor and separator prices are given by the formula $price = k \times (F_T)^{0.6}$, where k is a constant conversion factor, F_T is the flow through the unit, in mol/day, and *price* is in \$. For example, a reactor with double the capacity costs only 1.5 times as much. Operating costs for reactors and separators are given by the formula $operating\ cost = c \times F_T$; the units of *operating cost* are \$/year.

All economic parameters - equipment prices, operating costs, chemical prices, and disposal cost - are constant. Equipment depreciation is calculated with straight-line formula, with a lifetime of 10 years. The process operates 365 days/year.

Equipment purchase costs are paid at the beginning of the year. Operating costs are paid during the year. Revenue from sale of *P* (and perhaps, *X*) is received at the end of the year.

Goal: Start with $10,000,000 and maximize the ROI for your process in the first year.

You must decide what grade of reactant purity and what type of reactor and liquid-solid separator to purchase, and the capacity of each. You must decide if you wish to purchase a gas-liquid separator to purify and sell by-product *X*.

You must specify the fraction of liquid-solid separator bottoms to be purged and the fraction to be recycled. You also must decide how much reactant to purchase.

Annual Plans are due by 2:30 p.m. on the day of your Calculation Session, either October 17 or October 18. You will receive an Annual Report of your team's results by Friday, October 19.

If your team achieves a positive Return On Investment, your team will earn 25 homework points. If your ROI is greater than 0.2, your team will earn an additional 10 points. If your team has the highest Return On Investment in your Division, your team will be bestowed an additional 10 points.

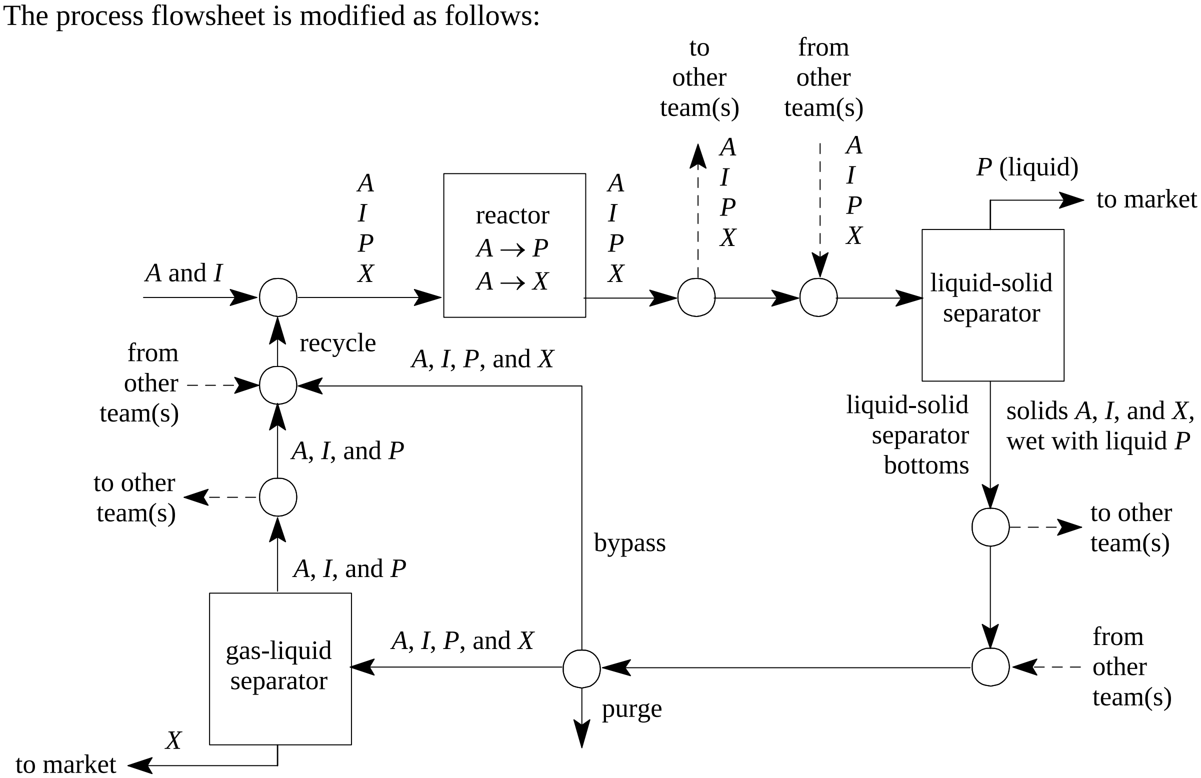
Hint: There are eight combinations of reactant grade, reactor type, and liquid-solid separator type. *Every* combination can be operated to produce a positive ROI. Half of the combinations can be operated to produce an ROI greater than 0.2.

EngrI 1120 - Introduction to Chemical Engineering
Design Competition - Fall 2012 - Part 2.

In addition to buying reactant mixture *A*+*I* and selling product *P* (and perhaps, *X*), you may buy and sell intermediate compositions by trading with other companies. For example, you may decide to buy only a reactor – no separators. Because the reactor price scales non-linearly, your reactor will produce reactor effluent cheaper than smaller reactors. You could supply other companies with reactor effluent at a price below their cost to manufacture it. Both companies may benefit.

Or perhaps your company may decide to invest in a large gas-liquid separator to purify *X*. Perhaps your company can charge less than the disposal cost for purged waste. So other companies will give you liquid-solid separator bottoms *and* pay you a fee less than the disposal cost. You can sell by-product *X*. All companies may benefit.

The process flowsheet is modified as follows:



What price to charge for reactor effluent? What price to pay for reactor effluent? What fee to charge for disposing purged mixtures? Prices and fees must be negotiated between companies.

Trading with other companies is optional; you may eschew intercompany entanglements and operate independently.

Rules:

This is a new competition. Every team is starting with $10,000,000 and no equipment. The costs and equipment specifications are unchanged from the previous competition.

Annual Plans and (optional) Contracts are due by 3:00 p.m. on the day of your Calculation Session, either October 24 or October 25. You will receive an Annual Report of your team's results by Friday, October 26.

continued on the back ...

More Rules.

Teams may write contracts with other teams in their League and Division only.

Because a company will depend on another company fulfilling the contract, the contracts have a provision for penalties. For example, if a company agrees to supply Reactor Type-1 effluent at 50.0 mol/day, but fails to do so, that company must pay the penalty stated on the contract.

Contracts are valid for one year only. If you want a perpetuity arrangement, you must write contracts for years one (1) and two (2).

Services and cash from contracts (see below) exchange during the year.

Company X may not give its money to company Y, even if company X has a contract to be repaid by company Y, with interest or a share of the profits. This contract is essentially a merger of two companies into a single company with twice the assets. The competition is intended to exercise engineering design and negotiation skills, so all companies should start with the same resources.

For subsequent years, each company may spend the amount listed on the line "cash at end of year" plus money received by contract(s). If your company does nothing in year 1, your company has $10,000,000 (plus or minus money by contract(s)) in year 2.

Every contract must be a reasonable exchange of process streams and/or cash. Every contract must be explicit. Cash amounts must be specific numbers. For example, contracts with payments described as "half the profits" will not be accepted.

Equipment may not be exchanged between companies. If your company needs additional processing capacity and another company has excess processing capacity, your companies should arrange to exchange process streams, such as reactor effluent, or liquid-solid separator bottoms, for example.

In the second year, new equipment may be purchased to increase the size of an existing process, and/or new equipment may be purchased to create a new process.

In summary, Annual Plans and InterCompany Contracts must be unambiguous. Add comments to indicate precisely how each equipment purchase is to be used. If you have questions, please ask. I will try to respond promptly to e-mail by the next business day and I am available during office hours, 1:30-3:30 p.m. Mondays.

Goal: Start with $10,000,000 and maximize the net value of your process after two years. The net value of a company is cash plus depreciated value of equipment.

For each week that your team achieves a positive Return On Investment, your team will earn 25 homework points. If your ROI is greater than 0.2, your team will earn an additional 10 points. For each week that your team has the highest Return On Investment in your Division, your team will be bestowed an additional 10 points.

Equipment Specifications and Economic Data for Manufacturing *P* (and *X*) from *A*.

Reactor and separator prices are given by the formula *price* = $k \times (F_T)^{0.6}$, where *k* is a constant and F_T is the flow through the unit, in mol/day.

Operating costs for reactors and separators are given by the formula *operating cost* = $c \times F_T$. The units are $/year. So if *c* = 2500 and you have a unit operating with a flow rate of F_T = 300 mol/day, the annual operating cost is 2500 * 300 = $750,000 / year.

Tables of constants *k* and *c* appear below. Be careful to select the data for your League and Division.

All economic parameters - equipment prices, operating costs, chemical prices, and disposal cost - are constant. Equipment depreciation is calculated with straight-line formula, with a lifetime of 10 years. Your process operates 365 days/year.

Wednesday Design League - John Maynard Keynes Division 2012 - Teams W1 - W7.

		k	*c*
reactant mixture grade 1 (98 mol% *A*)	$31/mol		
reactant mixture grade 2 (94.5 mol% *A*)	$22/mol		
reactor, type 1 (57% conversion of *A*, *P*:*X* = 4:1)		$75,000	$2,700
reactor, type 2 (38% conversion of *A*, *P*:*X* = 10:1)		$52,000	$2,100
liquid-solid separator type 1 (*P* retained by solids = 3 mol% of solids)		$65,000	$2,200
liquid-solid separator type 2 (*P* retained by solids = 8 mol% of solids)		$47,000	$1,700
gas-liquid separator		$30,000	$3,800

Product *P* sells for $111/mol. By-product *X* sells for $37/mol.

Disposal of purged waste costs $6/mol.

Wednesday Design League - Adam Smith Division 2012 - Teams W8 - W14.

		k	*c*
reactant mixture grade 1 (93 mol% *A*)	$35/mol		
reactant mixture grade 2 (81 mol% *A*)	$18/mol		
reactor, type 1 (85% conversion of *A*, *P*:*X* = 2:1)		$78,000	$2,300
reactor, type 2 (55% conversion of *A*, *P*:*X* = 8:1)		$49,000	$2,100
liquid-solid separator type 1 (*P* retained by solids = 5 mol% of solids)		$62,000	$1,800
liquid-solid separator type 2 (*P* retained by solids = 18 mol% of solids)		$34,000	$1,400
gas-liquid separator		$35,000	$3,400

Product *P* sells for $106/mol. By-product *X* sells for $33/mol.

Disposal of purged waste costs $6/mol.

Thursday Design League - Milton Friedman Division 2012 - Teams R1 - R6.

reactant mixture grade 1 (97 mol% *A*)	$29/mol		
reactant mixture grade 2 (90 mol% *A*)	$15/mol		
		k	*c*
reactor, type 1 (33% conversion of *A*, *P*:*X* = 3:1)		$45,000	$2,500
reactor, type 2 (22% conversion of *A*, *P*:*X* = 8:1)		$22,000	$1,800
liquid-solid separator type 1 (*P* retained by solids = 5 mol% of solids)		$22,000	$1,800
liquid-solid separator type 2 (*P* retained by solids = 13 mol% of solids		$17,000	$1,600
gas-liquid separator		$12,000	$1,400

Product *P* sells for $127/mol. By-product *X* sells for $47/mol.

Disposal of purged waste costs $5/mol.

Thursday Design League - Kenneth Galbraith Division 2012 - Teams R7 - R13.

reactant mixture grade 1 (95 mol% *A*)	$23/mol		
reactant mixture grade 2 (88 mol% *A*)	$15/mol		
		k	*c*
reactor, type 1 (45% conversion of *A*, *P*:*X* = 1:1)		$55,000	$2,200
reactor, type 2 (30% conversion of *A*, *P*:*X* = 2:1)		$39,000	$1,700
liquid-solid separator type 1 (*P* retained by solids = 4 mol% of solids)		$44,000	$1,600
liquid-solid separator type 2 (*P* retained by solids = 13 mol% of solids)		$29,000	$1,200
gas-liquid separator		$28,000	$2,400

Product *P* sells for $155/mol. By-product *X* sells for $48/mol.

Disposal of purged wastes costs $4/mol.

EngrI 1120 - Introduction to Chemical Engineering

Design Competition - Annual Investment and Operation Plan - 2012

Company ___________

Year ___________

Equipment Purchases:

Reactor:	Type:	___________	(1 or 2)
	Size:	___________	(capacity in mol/day or cost in $)
Liquid-Solid Separator:	Type:	___________	(1 or 2)
	Size:	___________	(capacity in mol/day or cost in $)
(optional) Gas-Liquid Separator:			
	Size:	___________	(capacity in mol/day or cost in $)

Operating Parameters:

Reactant *A*+*I* Purity: Grade: ___________ (1 or 2)
Reactant *A*+*I* flow rate: ___________ (mol of *A*+*I* per day, or write MAXIMUM*)

Fraction of Liquid-Solid Separator bottoms to purge: ___________

Fraction of Liquid-Solid Separator bottoms to bypass Gas-Liquid Separator**: ___________

Company Representative: ________________________________

*You need not calculate the exact flow rate of *A*+*I*. If you write "MAXIMUM," we will process as much *A*+*I* as possible, limited by your equipment capacity or your cash remaining after buying equipment.

** The sum of fraction purged plus fraction bypassed must be less than or equal to 1. If you do not purchase a gas-liquid separator (and therefore sell no by-product *X*), you must set the sum of fraction purged plus fraction bypassed to exactly 1.

EngrI 1120 - Introduction to Chemical Engineering

Design Competition - InterCompany Contract - 2012

Year ______

Company _______ (hereafter known as company 1) **gives**

_______ mol/day of reactant grade _______ (1 or 2).

_______ mol/day of reactor effluent with at least _______ mol% *P*.

_______ mol/day of liquid-solid separator bottoms with at least _______ mol% *A*.

_______ mol/day of gas-liquid separator tops with at least _______ mol% *A*.

_______ $ cash.

and

Company _______ (hereafter known as company 2) **gives**

_______ mol/day of reactant grade _______ (1 or 2).

_______ mol/day of reactor effluent with at least _______ mol% *P*.

_______ mol/day of liquid-solid separator bottoms with at least _______ mol% *A*.

_______ mol/day of gas-liquid separator tops with at least _______ mol% *A*.

_______ $ cash.

Penalties:

If company 1 fails to deliver, a penalty of $ __________ will be paid to company 2.

If company 2 fails to deliver, a penalty of $ __________ will be paid to company 1.

Signatures:

Company 1 Representative: ________________________________

Company 2 Representative: ________________________________

EngrI 1120 - Introduction to Chemical Engineering

Generic Process Flowsheet for the Design Competition - 2012