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CALIFORNIA POLYTECHNIC STATE UNIVERSITY
Mechanical Engineering Department

ME 234 **Midterm Project: QWERTY Machine©** **Fall 2012**

Due: Oct 25, 2012

For the lack of any better name, this project is called QWERTY, which also stands for "*Qan We Ever Really Top Yt*?" You are to design and build a machine that receives a starting trigger from you, "performs" for at least 15 seconds but not more than 60 seconds to accomplish a task of your choice, and completely stops. The following are the pertinent rules that apply:

1. You will be working in groups of three or four, preferably your E-Teams, and will make one machine per group.
2. Your machine should have a purpose or a task. The task does not have to be serious at all. It is intended to be a "Rube Goldberg" type machine.
3. The machine should be very creative and fun. Creativity is the main goal.
4. The design should have at least 10 separate and distinct motions that can individually be defined. There can be as many additional motions as necessary to do the job or to make the project work or to make it fun. Similar motions count as one motion.
5. A set of cause-effect will constitute one motion. An effect alone is not a motion.
6. No single motion may take more than 5 seconds.
7. No explosives or rocket projectiles are allowed.
8. You MUST be able to reset the machine and be ready to run again within max 2 minutes. The first run is to surprise us, the second run is for us to follow the details after you describe it to us and to grade it.
9. You may procure parts from any available resource. You may use the facilities at the Craft Center or even the student shop for manufacturing your machine.
10. You will have to clean up whatever mess you make.
11. The testing will be in Bonderson building room 107. This is an open room with limited space. There may be some tables there, but not for certain. Be mindful of the size of your machine. Transportation and parking is YOUR responsibility. You may drop off the machine at the building (across from the Library, but may not park there).

You have the option of dressing appropriately for the occasion!

Do ask if you have any questions regarding any rules.

Grading

The project is worth 100 points. We must test, grade and clean the area within the lecture time, so make sure you get there early to set up. Let me know if all members of your group have a class before our class that would prevent you from setting the machine up beforehand. Otherwise, I expect to be able to test any machine at 8:15 or 9:45 a.m.

Grading Breakdown

Total = (G1 + G2 + G3 + G4 - G5 - G6) * (NF)

G1: Creativity, a maximum of 50 points. (Be creative!!)
G2: Workmanship, for how the structure is put together, a maximum of 10 points.
G3: Performance, a maximum of 30 points (about 3 points per motion). Any part that fails to perform will lose its points.
G4: Timing, 10 points. No points if time is not 15 to 60 seconds.
G5: -5 points if not reset within 2 minutes.
G6: 20 points if you are not ready at 8:15 or 9:45 a.m.
NF: Niku factor, 1 to 1.15, at my discretion, if at all given, to award excessively creative and interesting designs, not to make the maximum grade more than 110 points.

Have fun!

Stop-Shoot Vehicle

Submitted by: Kirk Hagen
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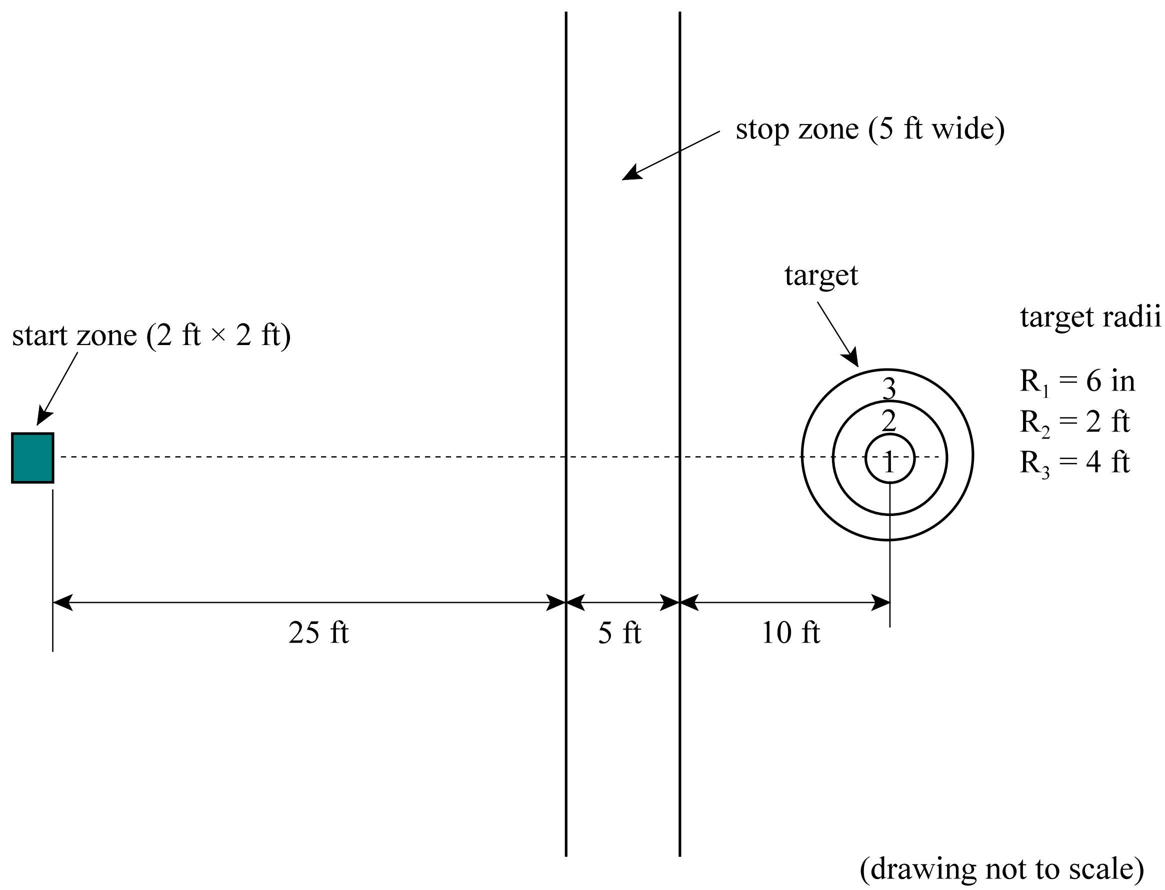
Weber State University
ENGR 1000
Introduction to Engineering

Design Project & Competition

Stop-Shoot Vehicle (SSV)

Objective

The objective of the project is to design and build a vehicle that travels along the floor from the start zone to the stop zone, stops inside the stop zone, and fires a projectile that strikes the center of the target within a time period of 20 seconds. (Refer to the drawing below). The start and stop zones will be marked out on the floor with masking tape, and the target will be marked out on the floor with chalk.



Vehicle specifications & competition rules

1. The vehicle must touch the floor along its entire travel path, i.e., no flying vehicles are permitted. The floor will be a standard hardwood floor.

2. The vehicle must fit within the 2 ft × 2 ft start zone. No part of the vehicle is permitted to extend beyond the start zone perimeter while the vehicle is in the start zone. Also, no part of the vehicle is permitted to deploy or articulate beyond a 2 ft × 2 ft perimeter at any time after the vehicle leaves the start zone.

3. The vehicle must be self-starting, i.e., it must propel itself out of the start zone without the aid of any external forces or influences. You may turn on a switch or similar actuating device, but you may not propel the vehicle in any way.

4. The projectile must be a *single*, *freely flying*, *rigid* object launched from the vehicle.

5. All means of propulsion and guidance must reside on the vehicle. Once the vehicle begins to move out of the start zone, the vehicle cannot be touched by anyone or anything and cannot be remotely controlled. While in the start zone, the vehicle may be aligned with the target.

6. The vehicle may not utilize any dangerous processes, materials or substances. These include, but may not be limited to, pyrotechnics, explosives, toxic chemicals, and compressed gases. The instructor reserves the right to determine whether any vehicle poses a safety hazard. All vehicles must pass a safety inspection prior to the start of the competition.

7. The vehicle and the projectile may not be tethered to each other or to the surroundings.

8. There is no weight limit for the vehicle or the projectile, but the projectile must completely fit *inside* a standard toilet tissue cardboard tube (length = 4.50 in, diameter = 1.63 in).

9. Each team will be given three runs. Points from the best run will be used for grading. Points for each run will be awarded as follows:

task	points
a) Showing up at the competition with a completed SSV:	40*
b) SSV leaves the start zone under its own power:	10*
c) The SSV comes to a **full** stop **completely** inside the stop zone:	15*
d) Task (c) **and** SSV fires a projectile:	15*
e) Task (c) **and** projectile hits inside ring 3:	5
f) Task (c) **and** projectile hits inside ring 2:	10
g) Task (c) **and** projectile hits inside ring 1:	20*
*Maximum points =	100

Note: *No points* will be awarded for firing a projectile while any part of the SSV is *outside* the stop zone, or while the SSV is still moving inside the stop zone, whether the projectile strikes the target or not.

Penalties for not completing tasks e, f and g within 20 s:

time excess	point deduction
0 - 5 s	10
5 - 10 s	15
> 10 s	20

Each student **team** will submit the following items to the instructor for **grading**:

1. *Photograph* (paper or electronic) of the SSV. Email: khagen@weber.edu.

2. *Drawing* of the SSV. This drawing can be prepared using a computer CAD package if the student team has the appropriate skills. If not, the drawing *must* be prepared using manual drafting tools such as a straight edge, compass, etc. The drawing must show a *side*, *front* and *top* view. All major components must be clearly dimensioned. You may use either SI or English units.

3. *Report* (2 pages minimum, double spaced, 12 point font or smaller) that addresses the following:

   a) design strategies
   b) challenges and strategies during the build phase of the project
   c) testing

The above items are due: ___________

As stated in the course outline, the design project is worth 20% of your course grade. The *project* grade will be broken down as follows:

competition:	50%
report:	20%
drawing:	20%
photograph:	10%
total:	100%

Lego Mindstorm “Search and Destroy” Vehicle

Submitted by: George Coppens
Saginaw Valley State University
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ECE/ME 101
Engineering Careers and Concepts
Fall 2012 - Saginaw Valley State University

TEAM DESIGN PROJECT
"Search & Destroy"

Background

You will be assigned to teams to complete an engineering design project. Each team will “invent” its own name. Your team is required to complete each step of the design process as presented in class. Your instructors recognize that your background is not sufficient to complete each step of the process as would a graduate engineer yet we expect you to do your best. You are born as creative as the next person so we expect a rather complete consideration of possible alternatives.

We expect your team to carry this project through to conclusion. That is, you will have completed the design process steps listed below and discussed in class.

1. Problem Identification - understanding what is needed.
2. Invention.
   a. Generation of Alternatives - research and ideation.
   b. Selection of Your Single Alternative - defining criteria for your choice.
   c. Refinement of Chosen Alternative - working out details.
3. Analysis and Testing - assuring design will be successful.
4. Decision on Final Version - refining final version.
5. Implementation - prototype construction and testing.

NOTE: The design competition will be conducted in the presence of classmates, family and friends, instructors, as well as other engineering faculty. The final report will consist of two parts: a written report and an oral report. THE FORMAT TO BE USED CAN BE FOUND IN THE DOCUMENT TITLED *Report Format for ECE/ME 101*.

Problem Statement

The goal is to design and construct a vehicle using the Lego Mindstorm kit that can navigate a simple course on the floor defined by black tape and yellow tape. The vehicle must then climb a ramp to a "fighting circle" and do battle with another vehicle. There will be two identical, non-intersecting floor courses leading to separate ramps. So two vehicles will start simultaneously and compete against one-another but the only contact between robots will occur at the top of the ramps in the fighting circle. The winner will be the surviving vehicle or the vehicle closest to the circle's center at the end of the heat. The floor-course is in the lobby outside the P118 lab and the ramp will be placed in that location about 30 days before the competition.

Competition Rules

1. The vehicle must be autonomous and controlled by the Mindstorm on-board computer. No remote power, control wires, or remote control links are allowed.

2. The vehicle's exterior dimensions at the start of each run must not exceed 30 cm x 30 cm x 30 cm. An offensive or defensive device may extend beyond this limit once activated, but cannot be activated before the start of the run.

3. The vehicle must be placed within the start area on the floor and activated by an on-board device (e.g. switch, mechanical release, etc.) on the vehicle. Team members may not activate any other device before the start or after the starting signal. Vehicles cannot be running and dropped to start. All cell phones must be turned off before the competition.

4. The vehicle and auxiliary devices must be powered by one or more of the three provided electric servo motors. No additional Lego parts may be used other than those provided in the kit.

5. When on the ramp the vehicle must run within the 30-cm wide, carpet-covered track. It may not run on top of the side rails.

6. At the end of each heat, the vehicle whose center, as determined by said vehicles length width, and height, is closest to the center of the fighting circle will be declared the winner. Alternatively, if one vehicle pushes the other off the circle or otherwise disables it, the surviving vehicle will be declared the winner. If neither vehicle attains the top of the hill during the heat or if both vehicles depart the circle, no winner will be declared for that race.

7. The competition will be based upon a double elimination format. A tournament grid will be set up and there will be a winner's and loser's bracket. Once a vehicle loses, it will immediately move to the loser's bracket and continue racing until it loses for a second time. This will allow teams who lose once to fight their way back to the final heat by winning the remainder of their races. The last race will involve the top car in the winner's bracket and the top car in the loser's bracket. If the winner's bracket car wins the race, the competition is over and that car is declared the overall winner. If the loser's bracket car comes out the winner, another race will be run because the winner's bracket car will have then lost only once. Modifications to the vehicle are permitted between (but not during) runs.

8. No pre-built chassis are allowed. The battery charger may not be on board the vehicle.

9. No alteration of supplied components is allowed.

10. A 30 cm x 30 cm square "virtual no-entry-by-opponent" zone will exist at the top of each ramp on the fighting circle. This is to prevent the first-vehicle-up from blocking the other's ascent to the circle. Once both vehicles are completely in the circle and off of the ramps, the "no-entry" zone will no longer exist.

NOTE: (Some specifications may be changed during the semester but you will receive the earliest possible notification.)

Design Project Evaluation*

You have noted that 50 percent of your course grade is associated with this project and other group activities. The design project requirements are:

Task	Deadline:
Rolling Chassis Completed	**September 20, 2012**
Powered Chassis	**October 11, 2012**
Preliminary Design Report Due:	**October 25, 2012**
Off./Def. Mechanism & Controls	**October 25, 2012**
Complete Vehicle Inspection:	**November 8, 2012**
Design Competition:	**November 29, 2012**
Oral Presentations:	**December 6, 2012**
Final Design Report Due:	**December 6, 2012**

***All design team members may not receive the same number of points. Your individual participation in your team will be reflected in the score you receive. You will be completing peer evaluations and up to 50% may be lost due to non-participation or debilitating and willful team conflict.**

From Your Instructors

We expect a number of events to occur in this project. Some of you will be remarkably successful... and some of you will experience failures along the way. This is not unusual. One common occurrence will be related to the iterative nature of design. Your team will probably go "back to the drawing board" more than once and this is normal. In addition, you will probably struggle to meet deadlines. This is also normal. But there are two concepts that will keep you on track and on schedule:

1. **Effective Project Management.** Develop a project schedule of events along with team member responsibilities. Leave enough time for testing. Use realistic test conditions.

2. **Teamwork.** While a leader may emerge from your group, you must all pull together to accomplish this project. Every team member has skills to bring to the project and an appropriate division of effort will be critical to your success.

As instructors we believe that enthusiastic participation by your team will lead to the ultimate success of your final design. We wish you the very best of luck. Remember skill, ingenuity and honest effort are your best allies!

Submitted by: Mark Eshani
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ehsani@ece.tamu.edu

Project 1

Engineering 111B

Foundations of Engineering I - Introduction to Electrical and Computer Engineering

Fall 2012

Due 5AM October 05, 2012

Write and submit the following take home project in pdf format through eLearning on or before the deadline a report of up to three pages on the following question(s). The report can be shorter than three pages but not longer.

1- What is the typical power consumption, in Megawatts, of a large server farm in the US?
2- What is the estimate of the total power consumption of the aggregate of all server farms in the US, in MW?

The report should have an introduction on what is a server farm and what power consumption by a server farm means.

The report should have a body discussing the power information of server farms, how many they are estimated to be where they are typically located, and the specific answers to the above two questions.

The report should have a section on where they got the information they used in their report. This can be in the form of a reference section or a description. It has to be complete and truthful.

You may use the internet to become familiar with server farms, their power demands, their estimate of aggregate power, etc; typical sites may be Google, Wikipedia, etc. You are free to use any other resource you wish and recite it in you report.

Lego Mindstorm Robot for Coup de Bot Tournament

Submitted by: Carlotta Berry
Rose –Hulman Institute of Technology
berry123@rose-hulman.edu

ECE 160

Design Project Overview

Winter – 2011-12

Project Description:

Berry, Ltd., a division of Voltmooreguson Enterprises, has oversight of the NXT Coup de Bot Tournament. Berry, Ltd., is soliciting your team's professional expertise in the design and construction of a *system* for entry into the Tournament.

Your team is required to design and construct a robot that will execute the requirements for the **Coup de Bot Tournament** in a superior manner. The tournament playing field consists of a planar surface on which 42 blocks are located. Your *system* must be designed to collect the blocks and form them in a "free form" scrabble-type layout.

The project specifications and contest rules have been sent out to many well-qualified and motivated teams. Will your team show its superiority in the competition by capturing one of the coveted awards?

Project Competition:
A project competition, "**Coup de Bot Tournament**", will be held starting at 17:30 on Wednesday, 8 February in the Kahn Arena (aka, the Kahn Rooms of the Hulman Memorial Union). Each team will show off their design to the amazement of their peers. Competition results do not impact your course grade, attendance at the competition is mandatory. Any conflicts, other than illness, must be discussed with, and approved by, your instructors before the dry run scheduled for 31 January. The class period following the competition (Thursday, 9 February) will be canceled to account for attendance at the competition.

Project Award Categories:

1. "**Bot Supérieure**" Award - Overall Tournament Winner;
2. "**Designer**" Award - Most creative/elegant successful solution (chosen by students and officials);
3. "**Stormy**" Award - Most theatrical solution (chosen by audience)
4. "**Team Spirit**" Award – Most "spirited" team

Product Design Specification – Version 1.0 – 8 December 2011
Product Design Specification – Version 2.0 – 15 December 2011

The requirements placed upon the *system* are as follows:

General Requirements:

1. The *system* shall be designed to perform on the competition surface as is shown in Figure 1 under the Competition Surface section.
2. The *system* shall be constructed only from Lego pieces included in the provided kit as listed in the kit inventory; one additional light sensor may be requested by each team; two (2) meters of orange string may be requested at the ECE stockroom by each team. A laptop of one team member will be allowed to be used as control devices for the *system* but are not considered a part of the *system*.
3. The *system* shall be designed to operate for the entire match without any reconstruction/reconfiguration by physical contact with the *system* by any team member.
4. The *system* shall not damage the competition surface or any block.
5. The *system* shall be designed to operate without any physical contact (this includes wired connections) during each match of the tournament. The laptop of one team member may be used to control the *system* as long as there is no physical contact during the match. All controlling devices must be operated by the same team member during the entire match.

C*ommunic*ation/Programming requirements:

6. The *system* shall be programmed in NXT-G (the drag and drop language supplied by Lego) or other appropriate programming language selected by each team. Any programming language/operating system software used must be available to all students at no cost, freeware, or available through existing Rose-Hulman licenses. All teams using any software other than NXT-G must provide information for acquiring the software to the instructor (who will publicize this to all teams.)
7. The laptop may be used to communicate with/control only your team's NXT within the wireless capabilities of the control devices. Laptop communication with another team's system is explicitly prohibited; disqualification for the round in question will be imposed upon any team that violates this prohibition. The control devices may not be positioned within, over, or under the competition surface during the match. The laptop may be placed on the surface adjacent to the competition surface during the team's competition.
8. The *system* may communicate with the control devices via wireless or wired connection during the set up period before each match, but only via wireless communication channels during the match.

Competition Rules

9. The *system* shall be defined to be that device constructed by the team to perform the designated tasks.
    a. The *system* shall not include a computer, infrared port or external wires, or any part of the competition surface.
    b. The *system* shall include the constructed device and any software loaded into the NXT.

c. All components of the system must remain connected to all other parts of the system during the match by parts supplied in the Lego kits.

10. The competition will consist of a paired match tournament. Each match will consist of a 1 minute setup period followed by a match lasting up to 3 minutes. The match will end 3 minutes after the setup period, when all EPs have been placed, or when both *systems* have stopped responding, whichever occurs first.
11. The seeding for the first round of the tournament will be based upon the **dry run** (conducted on class day 15, 31 January).
12. Forty two (42) lettered blocks will be placed by the officials during the setup time in the pre-defined locations on the competition board. The blocks will be located as shown in Figure 1. All blocks are 1 ¾" cubes with a mass of 35 g. Any block that drops from the competition surface during a match cannot be returned to the competition surface until the conclusion of the match and will not be scored.
13. During the 1 minute setup period the *system* may be programmed/reprogrammed.
14. The *system* may be started from any point on the assigned side of the competition surface. No part of the *system* may extend across the center divider onto or above the other team's competition surface. Additionally, no part of the *system* may contact any of the blocks prior to the competition during the setup time.
15. No parts may be added to or removed from the *system* during the match.
16. If parts become detached from the *system* during the match they may not be removed from the competition surface until the conclusion of the match. Detached part(s) may be reattached during subsequent setup periods or between matches.

Scoring Rules

17. The letter blocks will be placed along all 4 sides of the competition surface prior to each match in the locations shown in Figure 1. The colored capital letter side of each block will be facing upward with the top of the letter against the wall. The inventory of blocks showing color and number of each letter block is shown in Table 1 below.

Table 1 – Inventory of Letter Blocks

A	2	E	2	I	2	M	2	Q	1	U	2	Y	1
B	2	F	1	J	1	N	2	R	2	V	1	Z	1
C	2	G	1	K	1	O	3	S	2	W	1		
D	2	H	1	L	2	P	2	T	2	X	1		

18. The *system* may place the letter blocks anywhere within the competition surface to spell words in a scrabble-like fashion. The words may be arranged with any x-y orientation; perpendicular words will share common letter blocks. All letter-faces must face upwards and be properly oriented for words to score. Only capital letters can be used for words to score.
19. Blocks must be placed contiguously with previously placed blocks in order for words to score points. Blocks can form words that score if they are determined by an official in consultation with one member of the team to satisfy the following conditions:
    a. no more than 30^{o} from orientation of adjacent letters,
    b. no more than ½" from alignment with adjacent letters, and
    c. no more than ½" gap from adjacent letters.

20. Valid English words must be in the [Merriam-Webster Online Dictionary] and two (2) or more letters in length. Proper names are not valid. No points will be awarded for the letters within incomplete or invalid words. Prefixes, suffixes, or words using hyphens will not be scored as valid words. Profanity, obscenity, or vulgarity will not be scored as valid word. Words formed during the match but later contained within longer words or inadvertently moved during the match are not valid; words are determined at the close of each match.
21. Points will be awarded based upon the length of words and colors of letters. Bonus points will be awarded for words formed using only a single color of letters.
22. The score will be determined at the end of each match as follows:
    a. Letter scores are awarded based upon the ~~number~~ sum of the Scrabble™ value for each of the letters on the table used in valid words as follows: $\boldsymbol{LetterScoreTotal} = \sum \boldsymbol{LetterScore}$. The Scrabble™ letter values are as shown in Table 2 below.

Table 2 - Inventory of Scrabble™ Letter Scores

A	1	E	1	I	1	M	3	Q	10	U	1	Y	4
B	3	F	4	J	8	N	1	R	1	V	4	Z	10
C	3	G	2	K	5	O	1	S	1	W	4		
D	2	H	4	L	1	P	3	T	1	X	8		

    b. Word scores are awarded based upon the number of letters in each valid word according to $\boldsymbol{WordScore} = \boldsymbol{2^N - 1}$ where N is the number of letters in the word; the total word score is the sum of scores for all valid words.
    c. A bonus of 25 points will be awarded for each valid word that is composed only of letters of the same color.
23. The total team score for a match will be the sum of points scored by methods # 22 a-c.
24. ~~All~~ At least two words used in round 1 must begin with letters A, E, I, O, U, or Y; ~~all~~ at least two words used in round 2 must begin with letters N, L, P, R, S, or T; ~~all~~ at least two words used in round 3 must begin with letters B, C, D, F, K, or M; ~~all~~ at least two words used in round 4 must begin with letters G, H, J, Q, V, W, X, or Z; all words used in round 5 and the tie-breaker may begin with any letter, but no word used by the team in any earlier rounds may be re-used in any subsequent round. No word beginning with free-choice letters will be scored unless two valid words beginning with specified letters for that round are scored.
25. The first round of competition will take place during the class preceding the competition on Tuesday, 7 February. The second round will take place during the competition beginning at 5:30 PM on Wednesday, 8 February.
26. The seeding for the round 2 of the competition will be based on the points scored in the round 1 with the highest two teams competing on the same table, the 3^{rd} and 4^{th} highest on the same table, etc.
27. All teams will compete in round 3 (quarterfinals) with the same seeding process as described in # 26.
28. The four teams with the highest cumulative score through round 3 will move on to round 4 (semifinals) with the same seeding process as described in # 26.
29. Cumulative scores for all teams entering the round 4 will be reset to zero.

30. The two teams with the highest score from round 4 will move on to round 5 (finals) with the same seeding process as described in # 26.
31. Cumulative scores for the two teams entering the round 5 will be reset to zero. The winner of round 5 is the champion.
32. If both teams have identical scores at the end of that round 5, a 1 minute tie breaker will be held immediately after that round to determine the champion. The team with the highest score after 1 minute is the champion.
33. If the scores are equal at the end of the 1 minute tie breaker the cumulative score for rounds 3, 4, and 5 will be used to determine the champion.
34. If the cumulative scores of rounds 3, 4, 5, and the tie-breaker are equal, a sudden death round will be held. The first team to score a valid three-letter word in the sudden death round will be the champion.

Competition Surface

The competition will be held on a fixed operating surface. The competition surface is shown in Figure 1. The competition surface will be provided for practice during the project design and construction phase. The competition surface will be flat black.

Materials

1. Student teams shall use only the parts provided by the ECE Stockroom (Lego pieces included in the provided kit as listed in the kit inventory and one additional light sensor) in constructing their *system*. One Wiimote and a team member laptop will be allowed to be used as control devices for the *system* but are not considered a part of the *system.*
2. No additional parts shall be added to the inventory received from the ECE Stockroom without prior written approval by the ECE160 faculty.
3. Parts shall not be traded between teams.
4. Students shall not modify the kit or parts provided.
5. Students shall return the Lego NXT kit as listed in the kit inventory and all additional parts supplied with all items accounted for one day before the final presentation session held during Finals Week.

Other Requirements

1. All students shall participate with their team in the competition.
2. All students shall participate with their team in the design process for this project.
3. All team members shall participate equally in the project work.
4. All team members shall receive a grade on the project based upon the entire team's work as well as their individual work.
5. Students shall respect the creativity of others.
6. Students shall in no way interfere with another team's project work or interfere with another team during the competition.

Judging

1. Teams shall ask instructors for rule interpretations in a timely fashion. Requests for rule interpretations made after 17:10, 31 January may be rejected.
2. Officials shall be provided by Berry, Ltd., and the ECE Department.
3. The decision of the officials shall be final. Decisions may be challenged for factual or interpretive errors; but, the officials have the final decision on the validity of challenges.

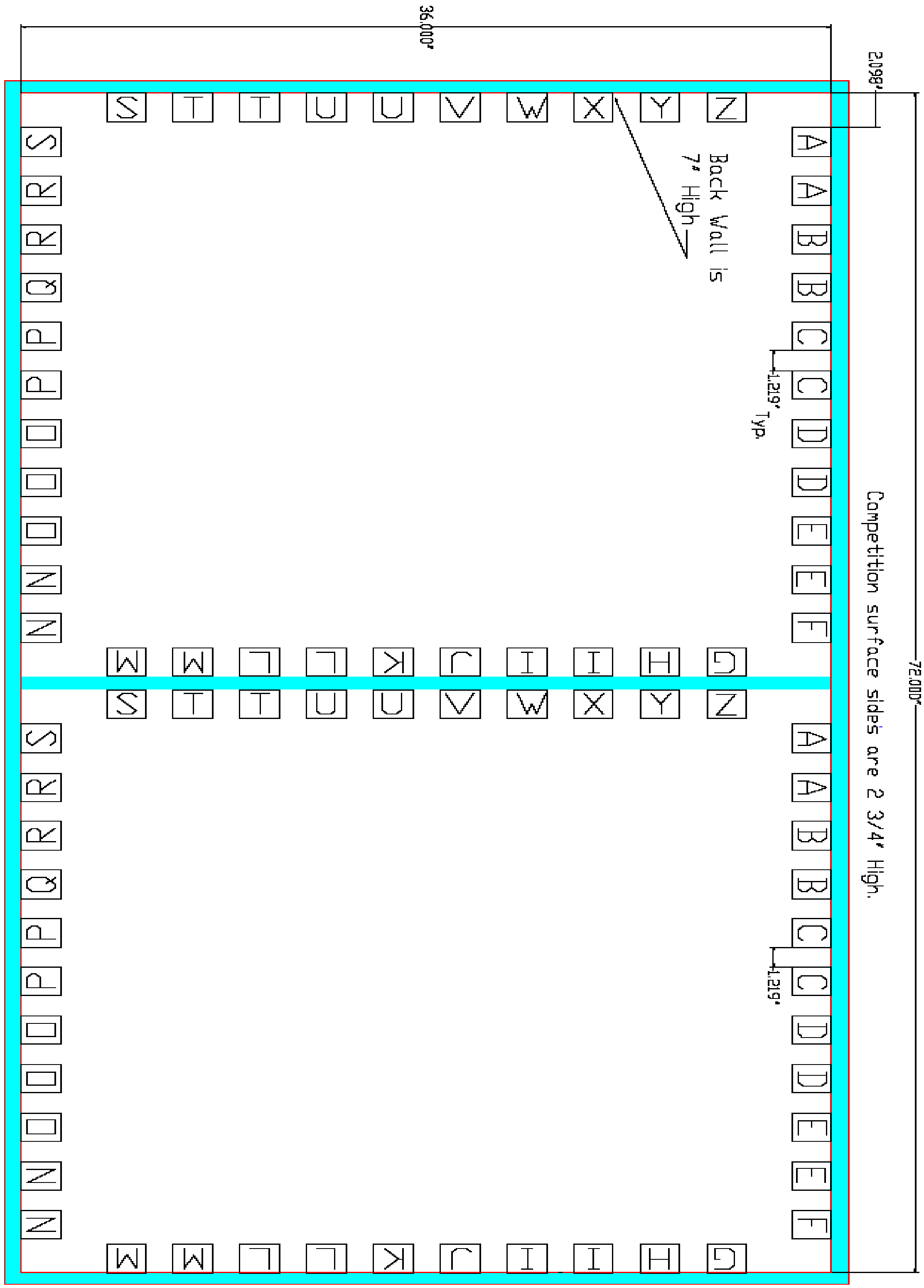

Figure 1 – Coup de Bot Tournament Competition Surface

Lego Mindstorm Robot for Robowl-a-Rama Tournament

Submitted by: Carlotta Berry
Rose –Hulman Institute of Technology
berry123@rose-hulman.edu

ECE 160

Product Design Specification (PDS)

Fall 2012- 2013

Version 2.0*

***changes from version 1.0 are in red**

Design Project Overview:

Berry, Ltd., a division of Rose Enterprises, has oversight of the ROBOWL-A-RAMA Tournament. Berry, Ltd., would like to solicit your team's professional expertise to design and construct a *system* for entry into the Tournament.

Your team is required to design and construct a *system*, also referred to as *robot*, that will execute the requirements for the **ROBOWL-A-RAMA Tournament** in a superior manner. The tournament playing field consists of a planar surface with 4 miniature bowling balls and 20 miniature bowling pins. Your *system* must be designed to collect the balls and use them to knock down the pins.

The product design specifications and contest rules have been sent out to many well-qualified and motivated teams. Therefore, your team must be deliberative and diligent in order to work hard to come up with the most creative and effective solution.

Project Competition:

A project competition, **ROBOWL-A-RAMA Tournament**, will be held at 17:30 on Thursday, November 1, 2012 in the Kahn Arena (aka, the Kahn Rooms of the Hulman Memorial Union). Each team will show off their design to the amazement of their peers. Competition results do not impact your course grade; however attendance at the competition is mandatory. Any conflicts must be discussed with, and approved by, your instructor before the dry run. Due to the competition, the 18th day of class (9-2), 11/1-11/2/12, will be cancelled.

Project Award Categories:

- "Gutter Ball Supreme" - Overall Tournament Winner;
- "Frame King Extraordinaire" - Overall Tournament Runner Up;
- "Top Alley Designer" - Most creative, unique and elegant solution;
- "Team Spirit"– Most "spirited" team with an identifiable non-offensive theme;

Product Design Specification

The requirements placed upon the *system* are as follows:

General Requirements:

1. The *system* shall be designed to perform on the competition surface shown in Figure 1. The lane (or alley) is 34" from the foul line to the head pin and it is 14.45" wide. The approach lane is 24" long and ends at the foul line. There are two alleys on the competition surface and they are separated by approximately 0.25 inches.

2. Each frame is made of ten pins. The ten pins are arranged in four rows with one pin, the head pin, in the first row, two in the second row, three in the third row and four in the fourth row. There are two balls available for each frame and they are placed in

the two pits at the end of the approach lane. The pins are 1-1/2" in diameter and 3-15/16" tall. The painted red ball has a diameter of 1-3/4". The bowling ball and pins are shown in Figure 2.

3. The *system* shall be constructed only from LEGO® pieces included in the provided kit as listed in the kit inventory; one additional light sensor may be requested by each team; two (2) meters of orange string may be requested at the ECE stockroom by each team. A laptop of one team member will be allowed to be used as control devices for the *system* but are not considered a part of the *system*.

4. The *system* shall operate without damaging the competition surface or any of the game pieces.

5. The *system* shall be designed to operate for the entire match without any reconstruction or reconfiguration.

6. The *system* shall be designed to operate without any physical contact (this includes wired connections) during each match of the tournament. During the remote control period, the laptop of one team member may be used to control the *system* as long as there is no physical contact during the match. All controlling devices must be operated by the same team member during the entire match; teams can only change drivers between rounds.

Materials:

1. Student teams shall use only the parts provided in their LEGO® kit as listed on their kit inventory, parts provided by the ECE Parts Room to complete their kit inventory or as listed in this document including string and one additional light sensor, if required. One team member laptop will be allowed to be used as control device for the *system* but it is not considered a part of the *system.*

2. No additional parts shall be added to the inventory received from the ECE Stockroom without prior written approval by the ECE160 faculty.

3. Parts shall not be traded between teams.

4. Students shall not modify the kit or parts provided.

Students shall return the LEGO® NXT kit as listed in the kit inventory and all additional parts supplied with all items accounted for one day before the final presentation session held during Finals Week.

Communication/Programming requirements:

1. The *system* shall be programmed in NXT-G (the drag and drop language supplied by LEGO®) or other appropriate programming language selected by each team. Any programming language/operating system software used must be available to all students at no cost, freeware, or available through existing Rose-Hulman licenses. All teams using any software other than NXT-G must provide information for acquiring the software to the instructor (who will publicize this to all teams).

2. During the autonomous period, the system must acquire balls, move to the foul line and release balls with no human intervention or communication with the laptop.

3. During the teleoperation (remote control) period, the laptop may be used to communicate with/control only your team's NXT within the wireless capabilities of the control devices. The control devices may not be positioned within, over, or under the competition surface during the match. The laptop may be placed on the surface adjacent to the competition surface during the team's competition.

4. The *system* may communicate with the control devices via wireless or wired connection during the set up period before each match, but only via wireless communication channels during the match.

Competition Surface:

The competition will be held on a fixed operating surface. The competition surface will be flat black and is shown in Figure 1. The competition surface, balls and pins will be provided for practice during the project design and construction phase.

Competition Rules:

1. The *system* shall be defined to be that device constructed by the team to perform the designated tasks.
   a. The *system* shall not include a computer, infrared port or external wires, or any part of the competition surface.
   b. The *system* shall include the constructed device and any software loaded into the NXT.
   c. All components of the system must remain connected to all other parts of the system during the match by parts supplied in the LEGO® kits.

2. The tournament is comprised of a seeding round and several elimination rounds. Round 1 is used to determine seeding for the second round of the tournament and it will be based upon the **dry run** conducted on day 17 (9-1), 10/29-10/30/12, of class.

3. During the second day of the competition, there will be paired matches or heats. The paired match will consist of two competition tables with one team per table for each elimination round.

4. Each match will consist of a 2 minute setup period followed by a bowling period lasting up to 3 minutes. The bowling period will consist of a 1 minute autonomous period and a 2 minute teleoperation period. The match will end 3 minutes after the setup period ends, or when both systems have stopped moving, whichever comes first.

5. During the 2 minute setup period, the *system* may be programmed or reprogrammed.

6. A match is made of 2 frames where a frame has 10 pins. For each frame, the system is allowed to roll two balls. If the system knocks down all of the pins on the first roll then it is a "strike" indicated with an "X". If not, then a second roll at the pins still standing is attempted. If all of the remaining pins are knocked down then it is called a "spare" indicated with a "/". If there are no pins knocked down on a roll then this is called a "miss" indicated with a "–". If any pins are left standing then it is referred to as an "open frame".

7. Once a ball is acquired by the system, if any part of the system crosses over the foul line before releasing the ball, this is called a foul and indicated with an "F". After the system stops moving, it is also a foul if the ball release mechanism extends more than 12 inches past the foul line. Also, balls must be rolled one at a time, if the second ball is rolled before the first ball clears the pins or drops in the pocket then the second roll is a foul. Any pins knocked down when the system commits a foul will not count in the score. If the foul occurs on the first roll then the pins will be reset by the judges. Line paths on the board will be delineated with white tape and the foul line will be delineated with red tape.

8. Two alleys will be set up with 10 pins in each. There will be two balls available in each pair of pits for each alley which yields a total of 4 balls for game play. At the beginning of the autonomous period, the *system* can be loaded with one ball or both balls can be in the pits. Bonus points will be earned for a system that starts the autonomous period with the balls in the pit. The pit location is shown on the competition field in Figure 1.

9. Any ball that drops during the match onto the competition surface can be reacquired by the system. Any ball that drops from the competition surface during a match can be returned to the competition surface but there will be a 5 point penalty. If a ball from one approach lane drops and hits the pins in the opposite alley then it will not count in the score.

10. The *system* may be started from any point on the assigned side of the competition surface.

11. No parts may be added to or removed from the *system* during the match.

12. If parts become detached from the *system* during the match they may be reattached for a 5 point penalty. In addition, detached part(s) may be reattached during subsequent setup periods or between matches.

Scoring Rules:

1. In an open frame during the teleoperation period, a bowler gets credit for the number of pins knocked down. A strike is worth 40 points and a spare is worth 30 points.

2. During the autonomous period, all points are doubled. Therefore, a pin is worth 2 points, a strike is worth 80 points and a spare is worth 60 points. In order to earn the 60 points for the spare all ten pins must be knocked down in the autonomous mode otherwise the spare is worth 30 points.

3. If a system bowls a perfect game with 2 strikes in a row then there will be a 20 point bonus.

4. Table 1 shows the score card for several sample matches:

1		2	
Auton		Tele	
8	10	7	1
18		26	

1		2	
Auton		Auton/Tele	
	X	6	4
80		90	

1		2	
Auton		Tele	
4	/	7	/
60		90	

1		2	
Auton/Tele		Tele	
5	/		X
30		70	

1		2	
Auton/Tele		Tele	
12	2	7	/
14		44	

1		2	
Auton/Tele		Tele	
	X		X
40		40 + 20	

Table 1: Sample Score Cards

5. During the autonomous period, if the balls are preloaded there will be a 5 point deduction.

6. Round 1 is the dry run and seeding round. Teams will be placed in heats for round 2 based upon the scores earned in round 1. After round 1, the scores from each round will be ranked and the top half of the teams will progress to the next round. If there is a tie that will affect the ability of a team to progress to the next round then a tie breaking round will take place to determine the winner of the bout. There will be a 30 second sudden death match. Each team is allowed one ball and the team to knock down the most pins will be declared the winner of the bout. This bout is a remote control round.

Judging:

1. Judges shall be provided by Berry, Ltd., and the ECE Department.

2. Judges will serve as officials and scorekeepers. Therefore, judges will be responsible for insuring that the teams abide by the rules of competition, scoring each round and giving the score sheet to the official scorekeeper. Judges will also be responsible for removing any balls or fallen pins during the match as long as it will not disturb the pins left standing. Judges will stand the pins back up in their original position if there is a foul on the first roll. Judges will also clear knocked over pins from the lane that may inter with subsequent rolls.

3. The decision of the officials shall be final. Decisions may be challenged for factual or interpretive errors; but, the officials have the final decision on the validity of challenges.

4. Teams shall ask the instructor for rule interpretations in a timely fashion. Requests for rule interpretations made after 5:00 p.m. on November 1, 2012 will be rejected.

Other Requirements:

1. All students shall participate with their team in the competition.
2. All students shall participate with their team in the design process for this project.
3. All team members shall participate equally in the project work.
4. All team members shall receive a grade on the project based upon the entire team's work as well as their individual work.
5. Students shall respect the creativity of others.
6. Students shall in no way interfere with another team's project work or interfere with another team during the competition.
7. Teams caught exhibiting un-sportsman like behavior will receive a warning. The second infraction conduct will earn a 50 point penalty for the current match or if they are in between matches for their subsequent match. If the behavior continues, the third infraction will have a detrimental effect on the team's project grade.

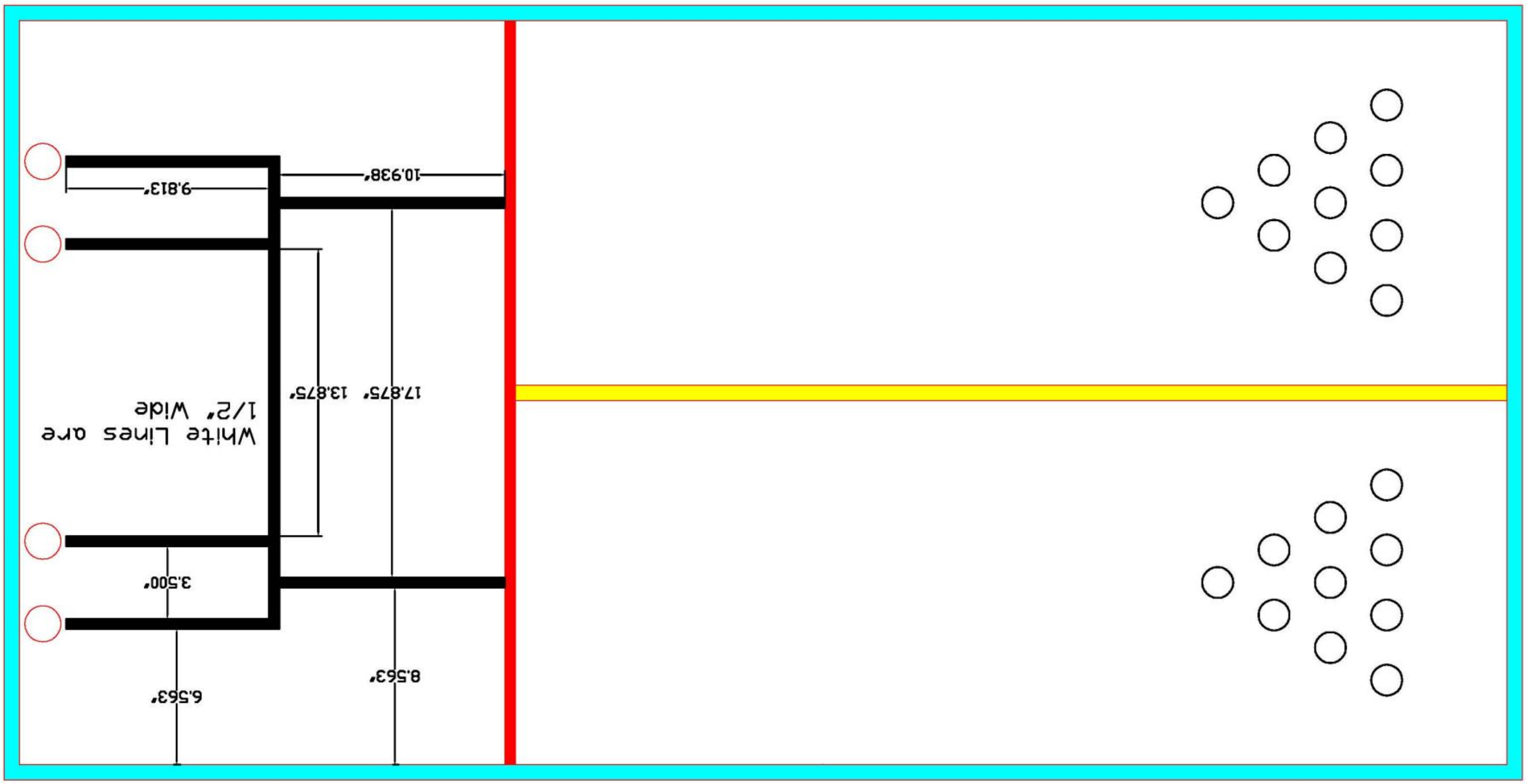

Figure 1: Competition Surface

Figure 2: Bowling Pins and Balls

Edible Car Project, Youngstown State University

See YouTube video:

https://youtu.be/k2zgJdsHlwE

Design, Build, Test, and Demonstrate a Mini-Golf Hole

Submitted by: Kerry Meyers
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ENGR 1550 – Fall 2012
Mini-Golf Project

Students will design, build, test, and demonstrate their design for a mini-golf hole in accordance with the project timeline shown in Table 1.

Learning Objectives:

1. To engage in an open, ended design project that allows creativity
2. To collaborate with peers in a meaningful way (which is inclusive of all members and their ideas) so as to develop a design that meets all constraints.
3. To expand experience with technical communication (both oral and written), and additionally to apply knowledge of drawing and visualization to communicate design to instructors and peers.
4. To apply the skills developed using Excel as an engineering tool over the course of the semester including: data entry, mathematical computations, plotting, statistics, conditionals, filtering, and curve fitting in a way that is "automated" using Macros (which can repeat a process for a given data set).
5. To apply knowledge of uncertainty, accuracy, and precision in the analysis of the results of collected data

Table 1. Timeline for Project

Date	Activity / Requirement
Week of 10/29	Lab work on drawing and visualization. Introduce the Project and begin individual brainstorming of concepts.
Week of 11/5	Lab work using Google Sketch-up. Form Project teams and share concepts.
Week of 11/12	Lab work on accuracy, precision, and reliability. Open time to work with Project Team.
Week of 11/19	Thanksgiving Week – work with your project teams outside of class
Week of 11/26	Demonstrate your project to the class (basement of Moser Hall on your lab day 2-4:50 pm). Sign in to Peer Evaluation System, try demo.
Week of 12/3	Oral presentation of project to the class & turn in final written report.
Week of 12/10	Finals Week – only assignment is to complete on-line Peer Evaluation

Design Constraints:

- Project groups will be teams of 3-5 students (typically 4 in a group).
- You will be provided:
  - A golf ball
  - Astroturf area of 6'x25'
  - Bricks to define the edges of your design
- You are welcome to use any materials that you have lying around at home, but they must be included in the parts list / budget in the final report (you can use Garage Sale price estimation)
- Each team member may spend up to $5 of their own money to purchase supplies for the project (team total cannot exceed $20 in new material costs) – THIS WILL NOT BE REIMBURSED, so spend only if absolutely necessary!
- Your design must have the following:
  - A bend in the course (cannot be completely straight)
  - Some forms of obstruction(s)
  - Creativity, originality… maybe even a theme?
  - Either an elevation change or an additional bend in the course

Submitted by: Saeed Niku
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Development of a Commercial for a Phony Product

You are to consider a phony, nonexistent, even a ridiculous product or service that makes no sense, and make a 45-60-second commercial for it. The purpose is to think creatively, without boundaries of practicality, and imagine what might be possible.

The length of the commercial must be between 45 and 60 seconds. You or anyone else you choose may act in it. Commercials with scripts and acting are much preferred to announcements with written material only.

You may borrow equipment from the institution or use the editing room available on campus. You may edit, mix, add music and special effects, etc., to your recording at the editing room. Check the final quality of your recording. Beware of wind noise if you record outdoors and of lighting if you record indoors.

You will be working in groups of 4, with one commercial per group.

This is your chance to be creative without bounds. Take advantage of it.

Grading: You will be graded on:

Creativity (both the product and commercial)
Sound and picture quality
Timing (45 to 60 seconds)

You must indicate the names of the group members as well as give credit to your actors and other involved individuals.

Submitted by: Maryam Grami
Winona State University
MGrami@winona.edu

Group Design Project and Presentation

WINONA STATE UNIVERSITY
Composite Materials Engineering
CME 182: ENGINEERING GRAPHICS AND DESIGN
Spring or Fall 2XXX

Group Design Project

15% of your course grade - Due XX /XX/ XXXX

Design, Construction, and Report on a Prototype Model for a Project Titled:

Electricity Generation from Renewable Sources

Statement on Project 1:

The use of renewable energy is not new, as wood has been the main source of our energy needs. The convenience and low prices of fossil fuels resulted in lower consumption of wood in the world. Presently, the consumption from renewable sources in the United States is about eight percent of all energy used. Renewable energy sources can be replenished in a short period of time. The five renewable sources used most often are:

1. Biomass, including wood and wood waste, biogas, and ethanol
2. Geothermal
3. Solar
4. Water - as hydropower
5. Wind

Unlike fossil fuels, non-biomass renewable sources of energy (hydropower, geothermal, wind, and solar) do not directly emit greenhouse gasses.

Your project:

Design, describe, and construct a functional prototype (small-size about two feet in length or height) model to demonstrate production of electricity from renewable energy sources of wind, solar, or hydroelectric systems.
For solar powered system, in addition to the electricity generation, the model should demonstrate other functions such as moving, driving, or lifting parts.

Construction of Prototype Model:

- Follow the design process steps and make a **prototype working model** (small-size) to demonstrate the dimensions, appearance, components relationships, and operation of the final electricity generator.
- For wind or hydro energy conversion you need to **build an electric motor from magnets and wire**.
- Depending on your design, for conversion of wind or hydro energy you may need to **build a gear box** too.
- The model will be used for **function analysis** an**d testing operation**. The system should produce a measurable current of electricity and be able to **turn on a small light bulb or an LED**.

- Use plastic sheets (clear or opaque), plywood, or metal sheets or parts to build your model. Cardboard and paper-type materials are unacceptable.
- **Note:** Cutting and shaping the materials in the machine shop and the wood shop has to be done by the CME department Senior Technician (Xxxxx Xxxxxxx) or under his supervision during his office hours of weekdays at 8:00 am to 4:00 pm. Xxxxx Xxxxxxx contact information:
    - **Office: Stark xxxx**
    - **Phone: xxx-xxxx**
    - **Email: xxxxxxxxxxxx**
- **Use of any ready parts from a manufactured, purchased, or existing system is not acceptable.**

Report:

Must include:

1. A cover sheet with student names, group number, date, project title, and project picture.

Part 1: for a real renewable energy generator serving an average family in Minnesota

I. Problem Statement.
II. Requirements and limitations (at least 15 requirements and 10 limitations)
III. Needed information.
IV. Market Considerations for the state of Minnesota and nationwide.
V. Description of parts and **mechanism of electricity generation**.

Part 2: For the Prototype Model

2. **Preliminary design concepts**: freehand drawings - two design ideas per person in the team. Design ideas should be clear and neat.
3. **Refinement**: detailed and to scale hand drawing of the three best designs.
4. **Analysis**: Write down list of criteria that have to be analyzed for a real size system
5. **Decision table:** prepare decision table based on the design criteria and select the best design.
6. Detailed and to scale **computer solid model for the final assembled model**, **include working drawing for the major parts. The drawing of at least one part should show GD&T in addition to its dimensions.**
7. Prints for isometric, side views, and working drawings for CAD model.

Evaluation:

Your grade will be determined based on originality and function of design, as well as your <u>overall effort devoted to the project</u>.

- Break down of the points:

Design **40%**

Free hand and CAD drawings	**20%**
Prototype Model	**40%**

NOTE: At the end of the semester, each student's grade will be adjusted according to performance and team cooperation (fellow team members will anonymously grade each other).

Group Presentation

5% of your grade - Date: XX /XX/ XXXX

Renewable Electricity Generation Technologies

Prepare and deliver a PowerPoint presentation with about 25 slides for the **Real size renewable energy system related to your prototype model** (Design project), **Include:**

- An introduction on the overview and significance of your selected system
- Explain **design features /or requirements, specifications, and limitations**
- Explain **materials selection**
- Explain **mechanism of energy production, conversion, or recovery** (which ever applicable).
- Explain **advantages and disadvantages of the system**
- Use information from Internet and other resources.
- Add photos
- Give a list of your references.
- Add students name and group number on the first page.
- Save a copy of the presentation (include group number on the file name) in your "Group folder" inside the Shard folder of the T-drive.

❖ **Evaluation:** **Grades will be based on completeness and depth of coverage of the topic.**

Submitted by: Rich Bankhead
Highline Community College
rbankhead@highline.edu

Build a Cantilever from Straws and Masking Tape

Challenge: Build a structure using straws and 36 inches of masking tape that cantilevers or extends a maximum distance beyond the edge of a table top without going below the top of the table.

Teams: Teams may consist of up to 3 students.

Materials: You may use as many straws as you like, but you will only be given 36 inches of masking tape.

Tools: Each team will be allowed to use a pair of scissors to cut their tape and straws.

Time Allocation: You will be given 30 minutes to complete this task. At the end of the time allocation judges will measure your team's cantilever distance.Your structure must be free standing at the end of 30 minutes.

Structures: Structures must be free standing. During the judging you will not be allowed to support your structure with your hands. Your structure may not touch the ground our anything other than the table top to which it is attached.

Measurement: Structures will be measured perpendicular from the edge of the table.

Tips:

- You may use masking tape to attach your structure to the table top.
- Building vertically will help you build horizontally out over the edge of the table.
- Your time will be limited. Arrive at the competition with a plan for building your structure. You can practice before you arrive.
- Straws are much stronger in tension than compression. You can demonstrate this by pulling on the ends of a straw (tension) in comparison to pushing on the ends

of a straw (compression). When a long length of a straw is compressed it fails under column buckling. Be sure to support straws which are under compression.

- Have fun and enjoy the challenge.

Programming a Simple Music Synthesizer and Transcriber in MATLAB

Submitted by: Jeff Fessler
University of Michigan
fessler@umich.edu

Eng. 100: Music Signal Processing F12 J. Fessler

Project 3: Music synthesizer and transcriber

1 Abstract

This is the main project for the course. It has two parts: (1) Programming a simple music synthesizer entirely in MATLAB using a MATLAB musical GUI similar to the one you developed in Project 1, now using snippets of real instrument sounds; (2) Programming and evaluating a simple music transcriber entirely in MATLAB using the MATLAB stem-based staff-like notation in Project 1, but now including note duration information.

2 Background

Music synthesizers use a variety of techniques. A simple approach to music synthesis is to record the sounds of actual musical instruments and play them back at variable speeds to produce the desired pitches, called *wavetable synthesis*. Another simple approach is to filter basic signals like square waves or sawtooth waves to achieve a desired effect, called *subtractive synthesis*. Another approach (that requires more circuitry if implemented with analog electronics) is to produce each harmonic of a note separately and add these sinusoids together, called *additive synthesis*.

Musical transcription, which generates sheet music (or the equivalent) directly from a musical recording, is much more challenging, particularly for polyphonic music. It is not a completely solved problem, and modern techniques involve signal processing concepts such as hidden Markov models that are graduate-level material, because real music is more complicated than the periodic signals whose periods change abruptly that we have considered in this course.

Nonetheless, transcription of simple music can be accomplished using the techniques you have learned in this course. You saw in Lab 3 that the spectrogram could itself function as a type of musical notation. The correlation approach from Project 2 is another option, as is the harmonic power spectrum that will be described in lecture. Your team should consider more than one approach and select the one that you think is the best for this project.

The results of this project will be two MATLAB.m files. One file implements a music synthesizer that accepts on-screen keys clicked with a mouse and outputs a melody using any of several musical instruments (guitars, clarinets, and others) selected from an on-screen menu. Of course, these can be added together ("mixed") to achieve the effect of several instruments played together.

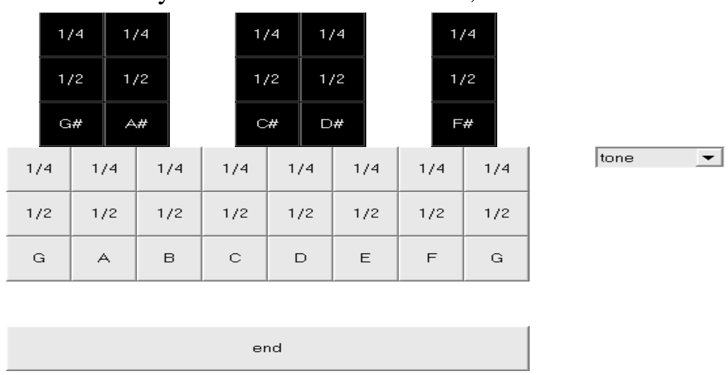
The other .m file implements a music transcriber that accepts a .wav file of music from your synthesizer and generates a musical-staff-like transcription using MATLAB's `stem` command. Details are specified below. Some suggested approaches for the transcriber will be discussed in lecture and it may be helpful to refer to those slides.

3 Project 3: What you have to do

- Download the file `proj3.wav` from the course web site. This file contains snippets of length 32768 samples each from an electric guitar, a clarinet, a trumpet, and a single tone, all sampled at $44100\frac{\text{Sample}}{\text{Second}}$. Each instrument played the 13 notes of an octave (including the note at both ends twice) in succession. Your synthesizer will include these four instruments played back using these samples, which is called "sample-based synthesis."
- Design at least one additional instrument of your own using additive synthesis (adding together harmonics with amplitudes selected by you) and label it with your team name.
- Also create a marching band sound by reverberating each trumpet note. Do this by adding copies of trumpet to itself, with each copy delayed slightly from the previous copy.

3.1 Synthesizer specifications

- Your synthesizer should have a keyboard with note durations, like those shown below.



- Use the following note durations.

Note	Whole	Half	Quarter	1 second
Length	$32668 + 100$	$16284 + 100$	$8092 + 100$	$S = 44100$

  The final 100 samples of each note should be zeros, to provide duration information.
- The pull-down menu should offer the user a choice of instruments, selected prior to use of the keyboard.

```
h = uicontrol('style', 'popup', 'position', [500 250 100 50], ...
'string', 'guitar|clarinet|trumpet|tone|TeamSound1|band');
```

- To determine which instrument the user selects use: `pause; v=get(h, 'value');`
  This generates v=1,2,3,4,5 or 6 depending on the user's selection.
  Alternatively the `v = get(h, 'value')` command can be defined as the `'callback'` option of the `uicontrol` command.
- We encourage you to be creative and add desirable features to the basic GUI shown above. You may modify the layout as long as your approach can generate (at least) all 13 notes and all 3 durations, and is at least as "easy to use" as the layout above.

3.2 Transcriber specifications

- The transcriber should output a musical scale and notes like in Project 1, except that here the separation between transcribed notes should indicate the length of each note:
  a whole note is followed by 3 extra spaces; a half note by 1 extra space; a quarter note by none.
  Hints:
  - Use `reshape` and look for columns ending in zeros.
  - Let `t` be the indices of those columns.
  - Then you can use `stem(t,x)` where `x` is something like `12*log2(frequency/440)+6`
- The transcriber need not be able to handle the electric guitar (lower bass scale).
- The transcriber must be able to handle your additive synthesis instrument (or the first such instrument if you make more than one).
- If you add extra features to your synthesizer such as polyphonic music or additional instruments, your transcriber is not required to handle those.
- Perform *noise investigations*, like in Project 2.
  - Show the error rate versus SNR for at least 5 instruments on one plot (with 5 curves).
  - Vary the SNR enough that the error rates range from 0 to at least 50% for every instrument.

3.3 Presentation and report

You will present your results in both written form (a technical report) and orally to the class and instructors, who will function here as your co-workers and bosses. Your presentation must include a screen shot of your synthesizer GUI, a brief audio example from your synthesizer, a screen shot of your transcriber output corresponding to that audio example, a description of your transcription method, and your error rate plot. Your report must include these same elements, except that the audio example is optional. (Additional aspects of the presentation and report will be specified in your discussion section.) You will be graded on both the presentation and the results. This is very realistic–great inventions will flourish only if you can explain to bosses and customers what it does and why it is valuable.
Because this is the main design project in the course, there will be several deliverables along the way.
See the class schedule on ctools for some of the deadlines; others will be announced in recitation and lab.
Your team report will be graded by both your DSP professor and your TC instructor.
It is due by 5PM on Fri. Dec 14 and must be uploaded to ctools by then.

Submitted by: Will Durfee
University of Minnesota
wkdurfee@umn.edu

Identify and Solve a Significant Technical Problem

Introduction

The objective of this project is for your team to find a significant technical problem and to propose a realistic solution to the problem based on your emerging skills as a scientist or engineer. Scientists and engineers are problem solvers so this semester-long activity will give you a chance to think like a professional when approaching a novel challenge.

Good scientists and engineers are innovative and you should strive to be innovative in your approach to solving the problem. "Innovation" is an idea translated into a useful product or service that adds value to society. Being innovative is more than being creative. Innovation adds the concepts of translating the idea into practice and having ideas that others see as a viable and valuable solution.

The project launches during the second block of CSE 1001 and is due just after Thanksgiving. The final deliverable is a five minute presentation that describes the problem and your proposed solution.

A prize will be awarded to the team in the section that has the best innovation as judged by your peers.

The Problem

Choose one from the following:

1. Find a problem related to any aspect of the Central Corridor light rail transit(CCLRT) line construction and propose a solution. Some web sites for the CCLRT are http://www.metrocouncil.org/transportation/ccorridor/centralcorridor.asp and http://lightrail.umn.edu/ . There is lots of CCLRT construction activity on the UMN campus.
2. Pick one of the 14 Engineering Grand Challenges (http://www.engineeringchallenges.org/) identified by the National Academy of Engineering. Find and solve a problem related to the challenge.
3. Find a product, structure or service at the University of Minnesota that does not work and propose a solution
4. Find a problem related to a community in the Twin Cities metro area that does not involve the University of Minnesota, and propose a solution.
5. Design, prototype, evaluate and demonstrate a new human powered machine that does something useful.

6. Determine the temperature on the Twin Cities campus of the University of Minnesota. Some of the issues in solving this problem are how to measure, where to measure, when to measure, how many samples, how to analyze the data, how to present the results and how to interpret the results.

The Process

Your team will tackle this project using a four-step process that is suitable for tackling any problem. The four steps are: define the problem, develop a solution, evaluate the solution, and report the project. The following paragraphs detail each step.

1. Define the Problem

The problem areas that you chose among are broad so your first step after choosing the area is to define the specific problem you will work on. For example, if you choose to work on a problem related to CCLRT construction, you need to determine what problem you will work on. But, right now you don't even know enough to figure out what, if any, problems are associated with the construction.

Your initial task is to undertake what some call the "discovery" phase of a project. This is where you gather information to rapidly come up to speed in knowledge about the problem area. Read (reliable) web sites, trade journals, academic articles, text books, newspaper articles, talk to experts, talk to users. For example, on the Engineering Grand Challenges, after you pick the challenge, you might want to talk with a faculty expert in the area. For the CCLRT problem, you might want to talk with one of the construction workers, or with a pedestrian crossing Washington Avenue or with the research principle investigator who's imaging magnets are moving from Hasselmo Hall to Mayo Garage. Efficient and effective information gathering will tax your team's ability to plan. Determine a process where every member of the team is gathering information but with little or no overlap. That way you will have a 5-person research team on the job.

In the discovery phase, please avoid random googling and please do stick to reliable sources of information. For example, Wikipedia can be reliable (but limited) in some areas, but a crank's blog is generally not. The appendix to this document contains tips on finding reliable information.

In addition, make sure that you talk to appropriate experts and users because the "voice of the customer" is always enlightening. Generally talking to one person is not enough; you want to talk with several to get reach a consensus view of what people are saying. For example, if you were to tackle understanding climate change and spoke to one expert, you might get a skewed view of consensus opinion.

Once you have sufficient information to understand the problem, you must develop a problem statement for what your team will work on. The problem statement (typically 100-250 words) contains a clear description of the specific problem your team will attempt to solve. "Our team will solve a problem related to CCLRT construction" says little. What problem related to construction will the team solve? The problem statement does not hint at or describe the solution but rather describes the objective of the project. Note that in most of your high school courses and in many of your college courses, the problem statement is given: "solve this problem." This project is real-world because the team comes up with the problem statement.

2. Develop a Solution

Solution ideas flow once there is a crisp problem statement. Developing the solution has three stages: concept generation, concept selection, concept implementation.

Concept generation is where you develop *all* of the different ways to solve the problem. Along with getting ideas from experts and from the material you read, this is where brainstorming, individual and group, helps. Or, sometimes the idea will come to you while bicycling home or just before you fall asleep. This is why you need your design notebook with you at all times.

The team must develop many ideas for solutions. A common trap of inexperienced problem solvers is to go with the first solution that comes to mind. Maybe that worked in high school when the assignment was due the next morning, but it does not work in the professional world. For a team of 5, it would be reasonable to have at least 20 ideas (not all complete and not all feasible) for solving the problem. As a reality check, a professional consulting firm might generate 200 ideas before they halted the concept generation process. A good way to manage the ideas is to jot them on index cards, one idea per card, as they come. This makes it easy to view, sort and combine ideas. If possible, record the idea on the card with a quick sketch and a few words because it is faster to comprehend a concept through a sketch and through a written description. And as always, use your notebook to record and work out ideas.

With a sufficient number of ideas, the next task is to select the concepts that rise to the top and are worthy of implementation. Selection has two steps. Step one is to determine the criteria by which the ideas will be rated. Having specific criteria avoids decisions degenerating to, "Let's do this idea because I like it." Criteria for some of the CSE 1001 innovation projects might include: cost to implement the solution, resources and time required to build a prototype (for problem statements where the team is building something), ease of use and impact on the user community. Develop criteria that make sense for your project.

Step two of the selection process is to rank each concept on each criterion. During this process, some ideas will naturally rise to the top. If two ideas are good, but not on all criterion, think of how they can be combined into a new, stronger idea. In deciding which ideas deserve to move ahead, use your team decision making process.

The team may decide to pursue one idea or may decide that two ideas should be pursued because more work is required on each before a final selection is made. Both paths are common in the professional world; however, at the end you will be presenting a single solution.

Now comes the fun part: implementing your solution. Depending on your problem, it may involve collecting data or it may involve building a working prototype or it may involve a computer based rendering or it may involve some mathematical analysis. Every problem will be different. The goal is to develop the solution in sufficient detail that it can be evaluated.

3. Evaluate the Solution

Having a solution to the problem is not enough. The team is obligated to evaluate whether the solution is a good one. For this, the team should create and implement an evaluation test plan. The best way of thinking about an evaluation plan is to evaluate the implemented solution against the same criteria the team used to select the concept. For solutions that involve constructing a prototype, the evaluation plan could include performance tests. For all solutions, evaluation should include getting feedback from intended users on the implemented idea. This is important because in the professional world, you are never solving problems for you but rather are solving problems for a wider audience.

4. Report the Project

Good work that goes unreported may as well never have happened. Developing the ability to efficiently and effectively describe your work is a trait of high-performing scientists and engineers. For the CSE 1001 innovation project, you will be reporting on your project through an oral presentation using the "3-in-5" format, which means three PowerPoint slides in five minutes. Instructions for your presentation are in the appendix to this document. Pay attention to this presentation because it will be the sole means by which others can judge the quality of your work. This is common in the professional world where you are continually called upon to describe and justify your work in a very brief time.

Project Planning

There is no question that the team does not have enough time for this project. With that out of the way, the important question is, "How can the team take advantage of its skills and talents and available time to do the best possible job on the project?" For that, the team must use good project planning.

Basic project planning takes the big project and breaks it down into manageable tasks, the to-do list for the project. Every task has a what (task definition), when (due date) and deliverable (the document or artifact or demonstration that will be delivered at the end of the task).

Here is a poorly worded task:

Team researchers the problem

Here is a well-worded task:

John will search the patent literature and deliver on October 7 a short PowerPoint deck describing the results of his patent search.

As soon as possible, the team should develop the task list and milestones. Working backwards from the project final deadline and using estimates of task durations should result in an appropriate set of due dates for the tasks.

Along with tasks, the team should set three or four key milestones for the project. For example, "On October 10 the team will have at least 100 ideas." Milestones are very concrete and a great way to see if the project is ahead or behind schedule.

The challenging part of project planning is determining the task list (with tasks neither too small nor too big) and estimating how long a task will take. Another challenging part of project planning is assigning tasks to that every team member has about an equal work load. A third challenging part of project planning is ensuring that everyone on the team, particularly the one assigned to a task, is absolutely clear on what is the task deliverable and when it will be delivered.

The team should designate one person to be the project manager whose job it is to project plan.

Required Project Deliverables

The project will have many deliverables internal to the team. There are only two deliverables required for submission to the course:

1. A 100-250 word problem statement as described in the Define the Problem section above. Upload to the Moodle site during Block 3 (see syllabus for due date). Grading is based on the detail and clarity of the problem description and on the quality of the writing.
2. 3-in-5 presentation in class during Block 6 (see syllabus for due date). Grading of the project based on the presentation is described below

Project Costs

There is no expense account for the project and any project-related costs are paid by the team. It is unlikely, however, that your project will entail any expenses. If you choose a project that involves prototyping, use your ingenuity (found parts, donated parts) to keep the project cost tiny, or even zero.

Grading

The project will be assessed using five criteria:

1. **Significance of the Problem:** Does the project address an important problem or a critical barrier to progress? Will stakeholders be affected positively if the problem is successfully solved?
2. **Innovation:** Is the solution to the problem new? Does the solution lead to new ways of thinking about the problem?
3. **Feasibility:** Is the solution practical, achievable and believable?
4. **Implementation:** How well was the solution implemented?
5. **Presentation:** How well did the team present the statement of the problem, the proposed solution and the evaluation of the solution?

All members of the team will receive the same grade for the project.

Prize for Best-in-Section

To motivate your team to do its best and to reward high-performing teams, a prize will be awarded to the top team in your section. Members of the winning team will receive a $20 gift certificate to the University of Minnesota Bookstore.

The winner will be selected based on how students rate the quality of the project based on the 3-in-5 presentation and using the same criteria that are used for grading the project.

Appendix: 3-in-5 Presentation

You will present your project in “3-in-5” oral presentation format, which means three clicks of the mouse and five minutes of presentation time. Three clicks of the mouse means a title slide plus three content slides.

Because of the small number of slides and the limited time, the team must think hard about how to present information clearly and succinctly. Clear an succinct information delivery is a characteristic of professional scientists and engineers.

Your 4-slide presentation must use this format:

Slide 1: Title slide with a descriptive project name as the title, the names of all team members and the date of the presentation. Consider having a title that describes, in just a few words, what the solution to the problem is because good presentations do not leave the audience in suspense. Consider adding an image on the slide that is a photograph or rendering or diagram of the problem and your solution. This slide, like all four slides, should be information rich.

Slide 2: This slide names and contains a description of the specific problem the team is solving. The slide is a compact version of your problem statement. Along with describing the problem, describe the significance of the problem. The use of images will help the audience to understand the problem you tackled.

Slide 3: This slide describes your solution to the problem. Describe just your final solution, not how you got there or how you selected the solution. This slide should be rich in technical detail. The goal is for your audience to understand exactly what your solution is and how it works.

Slide 4: The final slide evaluates the solution and describes in an objective way how well your solution solves the problem. For this slide use the results of your evaluation of the solution. This is not a marketing slide where you overstate the value of your idea. Stand back and be objective.

The finished PowerPoint file must be uploaded to Moodle by 11:30pm the night before you are due to present. It will be loaded onto the instructor's laptop and the TA will advance the slide when you say "next slide."

If your project involved constructing a prototype or a model, or you used equipment, bring it along for the presentation. Because the presentation is a tight 5 minutes, demonstrating the prototype or equipment is strongly discouraged.

While the entire team should work to develop the presentation, select one or at most two team members to deliver it. The presenters should practice, practice, practice in front of the rest of the team who can provide constructive feedback, including timing. Timing is critical because you will be cut off at 5 minutes, finished or not.

Dress for the presentation is whatever the team thinks is appropriate.

While this is a professional presentation and you have some serious content to deliver, please do let your creative juices flow when thinking of best ways for the audience to understand your project.

Appendix: Finding Reliable Information

Here are resources that can advise you on how to find reliable information that can be used during the discovery phase of your project. Every team member should go through every resource.

"Finding and Evaluating Information" from the UMN Library
http://www.lib.umn.edu/instruction/tutorials#finding

"Searching the World Wide Web: Overview" from the Purdue Online Writing Lab
http://owl.english.purdue.edu/owl/resource/558/01/

"What is Primary Research and How do I get Started" from the Purdue Online Writing Lab
http://owl.english.purdue.edu/owl/resource/559/1/

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ME 213 Introduction to Engineering Design

ME 213: Introduction to Engineering Design is an introductory class offered by the Department of Mechanical Engineering at UHM. The goal of the course is to learn the design process and associated skills (teamwork, communication, and computing), to recognize the role of fundamentals in design and problem solving, and to be exposed to different examples of engineering (projects, disciplines, and careers). Learning through hands on and open ended projects are emphasized.

Design Project: In an effort to help you understand the engineering design process, you will be required to work on a design term project and several in class projects assigned during the semester. The term project will require conceptualization, designing, fabrication, and testing as an engineering team. The term project should be done by actively communicating and collaborating with your team members. You will use the engineering design process to develop and complete the assigned project. No late work regarding the design project will be accepted. In addition, a short oral presentation and a poster will accompany each term project. Details will be given upon assignment of each project. Most of the projects are open ended.

Term Project: Rube Goldberg Machine Teams of 6 students design, construct, and test a series of simple machines which act in a chain reaction to accomplish a simple task. Machine should be creative and appealing.

Presentation: Your presentation should be 10 minutes for a project engineering team. Due to the limited class time you will be cutoff if you exceed the upper limit.

Report: A minimum of 16 pages report is required on final project. The instruction will be posted on course website. Overall 40% of the course grad is from reports.

Term Project: Rube Goldberg Machine

Inspired by cartoonist Rube Goldberg, students will compete to design a machine that uses the most complex process to complete a simple task - put a stamp on an envelope, screw in a light bulb, make a cup of coffee - in 8 or more steps.

Educational Goals for this project are:

- To show simple design is the key in good engineering design.
- To show a single system composed of several interacting parts that contribute to the basic function, and where the removal of any one of the parts causes the system to cease functioning.
- To demonstrate that design processes involve a multitude of skills and knowledge from many subject areas.
- To allow students to experience the interface between the design and build.

Guide Line:
Students will work in teams of 5 to 6 to design, construct, and test a series of simple machines which act in a chain reaction to accomplish a simple task of the student's choice.

REQUIRED: Minimum of eight steps (A student will start the sequence of events but that does not count as a step.) Machines to include lever, inclined plane, wedge, and pulley.
Generating electricity using a given gear motor. Running another motor with propeller using the generated electricity.

Procedure:

1. Chose a purpose for your machine. Use websites books or your own imagination to create a purpose for your machine.
2. Design and illustrate your design of a Rube Goldberg Machine on a full size poster. Title should be short and bold. Steps should be clearly labeled with numbers or letters
3. Write the steps on a separate sheet of paper and tape it to the back of the poster.
4. Describes machines that are required in the design. Different kinds of pulleys, levers, etc.
5. Using more than one form of energy will enhance the creative nature of the cartoon.
6. Final poster describing the design process and details of the design.

7. A presentation will be made to the class:
   Explain all steps.
   Identify all simple machines.
   Identify all forms of energy.
8. The grade will be based upon clarity, creativity, completeness of the project (20%), oral presentation (10%), poster (30%) and the result from the competition between groups (40%).

Judging criteria for Project

Number of steps and style (20 points)
Creative use of materials (10 points)
Energy conversion (chemical, electric, mechanical) (10 points)
Use of different mechanism and good timing (10 points)
Successful completion of task (30 points)
Machine setting and assembly (10 points)
Rube Goldberg spirit of the group (10 points)
Human Intervention (-2 for each)

Evaluation and Grade Sheet for ME 213 Presentation

	Good...................OK…...................Poor				
	4	3	2	1	0
Introduction	___	___	___	___	___
Clarity	___	___	___	___	___
Organization	___	___	___	___	___
Professionalism	___	___	___	___	___
Communication	___	___	___	___	___
Conclusion	___	___	___	___	___
Time limits	___	___	___	___	___
Completeness	___	___	___	___	___
Understanding	___	___	___	___	___
Questions	___	___	___	___	___

Duck Pond Project

Submitted by: Kerry Howe
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Civil Engineering 160
Duck Pond Project

Project Goals

In order to meet our class goals of introducing students to the design process and to the principles of sustainability, we will complete a design project to improve undesirable conditions at UNM's Duck Pond. The elements of the design process are repeated below as they apply to the Duck Pond Project.

Project Details

1. You can work in **teams of two** for the design component of the project. However, you must **complete your own** AutoCAD drawings. Self-organize your groups or work alone.
2. Your final drawings are due to Mr. Gonzales the **week of April 25th** at the time specified by him. As usual, you will complete an E-Submittal to Mr. Gonzales.
3. Final class presentations will be held on **Friday, April 29th**. You will complete one PowerPoint slide to summarize your final design. Presentations will be in your teams.
4. Your final written report is due to Dr. Stone on **Monday, May 2nd**. This will also be as a team.

The Duck Pond Design Process

1. Identify the Need

The Duck Pond is an important feature on the UNM campus. This oasis in our arid environment provides a place for students to study, read, and contemplate the meaning of life. As great of a place as the Duck Pond is, it is not without its problems. Contaminants enter the pond in many forms causing silt to accumulate on the bottom and algae to grow in the water. As a result, the university must drain and clean the pond on a regular basis. This process is expensive and sometimes has very undesirable consequences (see article below). Thus, it is desirable to modify the layout of the Duck Pond and the area surrounding it in order to reduce maintenance needs and to generally improve the local environment.

UNM Apologizes for Fish Kill at Pond (July 1, 2010 Albuquerque Journal)

The University of New Mexico has apologized for harming wildlife in the duck pond during a routine cleaning last Saturday.

"We regret this incident. It is never our intent to harm the wildlife at the duck pond," said Mary Vosevich, director of the UNM Physical Plant. "We apologize to those who were upset by this occurrence and pledge to improve our procedures going forward."

Dead koi and catfish floated on the surface of the pond after the water level dropped too low for them to survive. The scene angered several visitors.

UNM routinely lowers the water level in the duck pond for cleaning. This year, a larger than normal amount of sludge caused the water level to decline more rapidly than anticipated, killing many fish.

"At no time do we ever completely drain the pond so that we can preserve the fish," Vosevich said in a written statement. "The lowering of the water level has always been a routine process to pump the sludge that accumulates and is necessary to provide a more sustainable environment for wildlife that is present." The pond was last cleaned in 2007.

UNM officials said they don't stock the pond with birds or fish.

Video of the fish kill and upset visitors: http://www.koat.com/news/23650889/detail.html

2. Problem definition

The major problem at the duck pond is that excess nutrients (phosphorus and nitrogen) enter the lake, and the nutrients result in the growth of nuisance algae. The primary sources of nutrients are runoff following rain and irrigation of the surrounding landscape, and bird feces. Bird feces is present in large concentrations because visitors feed the birds bread crumbs (amongst other things), and thus the lake supports an unnaturally high bird population. The deleterious effects of nutrients are partially offset by the presence of water fountains in the ponds. However, “dead zones” still exist where the water is not mixed and the fountains often malfunction due to excess solids in the water.

3. Constraints

The client, UNM, imposes the following constraints:

1. The area of the modified pond should be equal to, or greater than, the existing pond.
2. The overall project extent should not exceed the current extent of the Duck Pond area as constrained by the current concrete sidewalks surrounding the grassed area.
3. Although this project does not call for you to do detailed cost estimates, keep in mind that UNM is in a budget crisis and the project will need to be funded through donations. The fundraising goal is $200,000.
4. The modified Duck Pond must still provide space for students to gather and relax while also being able to accommodate special occasions such as weddings. Also, the Duck Pond Bridge must still be used in its current form (but can potentially be moved to a new location).
5. The university would like to use the modified Duck Pond as a centerpiece in its mission to promote sustainability. Thus reasonable efforts should be made to use innovative sustainable materials and to avoid or minimize the need for external electricity, while incorporating other aspects of sustainable engineering wherever feasible.

4. Criteria

Criteria are used to weigh the various alternatives that will be developed in the following steps. All alternatives will have strengths and weaknesses, and thus it is important to set standards for comparing them in advance. Often we assign a weight to our criteria and the criteria typically flow from the problem description and constraints. To the greatest extent possible, the criteria should be quantitative. We will develop the criteria through our Friday lectures.

Some examples include:

1. The design should reduce the amount of nutrients entering the pond by X% from current levels.
2. The cost of the project should be less than $Y.
3. Z% or more of the material should be directly recycled from the current project or should be from post-consumer products.
4. The new design should not require drainage and maintenance at a frequency greater than every # years.
5. Water use for the project should be reduced by at least A% and power use should be reduced by at least B%.

5. Search

One of your jobs is to search for solutions to the problems defined above. For example: (1) How can we keep excess nutrients out of the lake? (2) Once in the pond, what can we do to reduce the undesirable impacts of nutrients on the pond’s ecosystem? and (3) Is there anything that can be done to the pond’s design in order to more easily remove the nutrients? These are just examples. The point is to search for desirable features to include in a design to address the identified problem. Document where these techniques have been used before; how much they cost; potential negative consequences, etc.

6. Alternatives analysis

This is the point where you get creative. Combine your research with the constraints and criteria to solve the identified problem. Select the design features that give you the greatest benefits for the investment and that are most likely to address the identified problems.

7. Analysis

You won't have the time or details to perform this task in great detail, but this is where you will evaluate the project alternatives with respect to the criteria. For example, how much electricity and water will your design require? What will the project elements cost? Etc.

8. Decision

Assuming you had the necessary information, this is where you would compare the project criteria with the results of your analysis. For example, by what percentage will the nutrient delivery be reduced? For our class, this will be a qualitative process where you use judgment and creativity to specify the elements of your design.

9. Specification

As Mr. Gonzales has taught you, you need to document your project through engineering drawings. Follow the guidance from the AutoCAD portion of the class to produce drawings of your 50% and final design. The deliverables must include a plan drawing of the new design along with section drawings where needed and product specifications for any equipment or special materials.

10. Communication

The final, but perhaps most important, element of a design project is to communicate your design to the client and public. You will have the opportunity to present your final design through a brief presentation and a short (4 to 5 page) report. In addition to a title page, your final report should include: (1) Project Need and Problem Statement; (2) Design Constraints and Criteria; (3) Summary of Potential Techniques; (4) Alternative Selection; (5) Design Approach and Specifications; and (6) Summary.

Living Roof Design Project

Submitted by: Kerry Howe
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Civil Engineering 160
Centennial Engineering Center Living Roof

Project Goals

In order to meet our class goals of introducing students to the design process and to the principles of sustainability, we will complete a conceptual design project to increase the sustainability of the Centennial Engineering Center. The elements of the design process are repeated below as they apply to the project.

Project Details

1. You can work in **teams of two** for the design component of the project. However, you must **complete your own** AutoCAD drawings. Self-organize your groups or work alone.
2. Your final drawings are due to Mr. Gonzales as specified in the AutoCAD portion of your class. As usual, you will complete an E-Submittal to Mr. Gonzales.
3. Final class presentations will be held on **Friday, April 20th and Friday April 27nd**. You will complete one or two PowerPoint slides to summarize your final design. Presentations will be in your teams of two.
4. Your final written report is due to Dr. Stone on **Friday, April 27nd**. This will also be as a team. Your written reports should include **<u>all of the sections described below</u>**. Site your sources of information and **don't plagiarize**!

The Process

1. Identify the Need

As we have discussed in the first half of this class, a rapidly growing global population and dwindling natural resources have forced us to think differently about how we interact with our natural environment. Further, conservation of water and energy are critical needs for developing sustainable infrastructure. UNM has an opportunity to provide leadership to address these challenges.

2. Problem definition

Please develop a problem statement of your own to include in your final report. Remember, don't jump to a conclusion or to alternatives. Instead, clearly state the need in broad terms without proposing solutions. Here's an example to get you started:

> "Traditional design and construction practices have not managed water and energy use in a holistic fashion. Water, one of the most precious resources in our region, is routed directly into the stormwater system."

3. Constraints

The client, UNM, imposes the following constraints:

1. The project area should not exceed the area immediately around CEC, but can include the landscaped areas to the east and west of the building.
2. Although this project does not call for you to do detailed cost estimates, keep in mind that UNM is in a budget crisis and the project will need to be funded through donations. The fundraising goal is $200,000.
3. The building must remain in use throughout the design and construction phases.

4. Criteria

Criteria are used to weigh the various alternatives that will be developed in the following steps. All alternatives will have strengths and weaknesses, and thus it is important to set standards for comparing them in advance. Often we assign a weight to our criteria and the criteria typically flow from the problem description and constraints. To the greatest extent possible, the criteria should be quantitative. We will develop the criteria through our Friday lectures.

Some examples include:

1. Capture all rainwater for a moderate design storm.
2. Costs should be kept low, but long-term cost savings must also be considered.
3. To the greatest extent possible, material should be directly recycled from the current project or should be from post-consumer products.
4. Routine maintenance should be within the capabilities of current staff.
5. The project should be a centerpiece of sustainability for UNM!

5. Search

One of your jobs is to search for solutions to the problems defined above. We are starting with the Green Roofs Design Manual (posted on WebCT), but you should gather additional resources as necessary to support your design.

6. Alternatives analysis

This is the point where you get creative. Combine your research with the constraints and criteria to solve the identified problem. Select the design features that give you the greatest benefits for the investment and that are most likely to address the identified problems. Your final report must include a decision matrix.

7. Analysis

You won't have the time or details to perform this task in great detail, but this is where you will design your living roof. Provide basic specifications such as soil depth, membrane materials, vegetation, and drainage plans.

8. Decision

As we have discussed, there are always tradeoffs within the details of the design. For example, one membrane might be cheaper, but the reliability might be lower. In this part of your report, please highlight where tradeoffs must be considered.

9. Specification

As Mr. Gonzales has taught you, you need to document your project through high-quality engineering drawings. Follow the guidance from the AutoCAD portion of the class to produce drawings of your 50% and final designs. The deliverables must include a plan drawing of the new design along with section drawings where needed and product specifications for any equipment or special materials.

10. Communication

The final, but perhaps most important, element of a design project is to communicate your design to the client and the public. You will have the opportunity to present your final design through a brief presentation and a short (5 to 6 page) report. In addition to a title page, your final report should include: **(1) Project Need and Problem Statement; (2) Design Constraints and Criteria; (3) Summary of Design Alternatives; (4) Alternative Selection; (5) Design Approach and Specifications; and (6) Summary**. We will provide more details in the coming weeks.

LEGO Mindstorm Robotic Pet

Submitted by: Victoria Froude
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EG 10111 Introduction to Engineering Systems
Project Document for Lego Pet

This document describes the technical requirements for the Lego "Pet" project. It is envisioned that your Pet will be programmed using Lego Mindstorms/LabVIEW NXT and designed to "behave" like a pet animal. Your team will incorporate several different features such that your pet's behavior represents aspects that an actual pet of this type would display (i.e. motions like walking, sitting, picking something up, etc.), but can also incorporate aspects related to being an electronic toy (displaying text, talking). You are working towards a project that you will demonstrate in front of your learning center section during the 7th week of the semester (week of October 3rd).

You will have the opportunity to meet with elementary school kids as they will serve as your "customer" for this project to understand requirements and desires of your customers. The best projects from each section will then be invited to demonstrate their projects for the elementary school kids.

Your group will have certain "general requirements" that every group must adhere to, but there is considerable room for creativity. As a group, you get to determine what animal you will simulate as well as what states / behaviors you will incorporate.

General Requirements
Your Pet shall be built using only the equipment provided by EG10111 staff, including Lego parts, NXT assorted sensors and motors, and electronic equipment.

Additional items such as fur, eyes, etc. may be incorporated to make it look more like the type of Pet you designed as long as none of the Lego parts/equipment is permanently modified/damaged.

All computer programs that the Lego Pet executes shall be developed as a finite state machine and downloaded using the NXT and associated LabVIEW Software.

- Your Pet must be able to move without running into walls or other obstacles, but the type of locomotion is up to your group (walk, run, roll, hop, etc.).
- You must incorporate at least 2 different LEGO NXT sensor types (Light, Touch, Sound, Distance).
- *At least* one state or capability must make use of the NXT graphical display and/or sound capabilities.
- *At least* one state or capability must include the use of arithmetic or other mathematical functions *other than* simple comparisons (less than, equal to, etc.).

Additional Features / Capabilities
Each group must design in 5 different states for the pet. Each state should demonstrate different features making the behavior distinct. For example, your pet might transition from a state of sleeping (in which your pet is not moving, but is snoring) to an active state where your pet is interacting with people or surroundings. Below, are several other states that could be considered for your pet.

- Pick up an object (scoop, pinch, balance, etc.) or fetch an object
- "Heel" or walk up to or alongside someone or something
- An arm or paw that move as appropriate to that pet (ex: moving tentacles, a paw shaking hands, scratching, batting an object) that moves in response to customer input
- Position change (from standing to sitting or vice versa)
- Rolls over (returning to original position or responding to "belly rub")
- Bark or purr or make additional noise as appropriate to that pet

- A tail that "wags" or moves as appropriate to that pet
- Ears that "perk up" or move as appropriate to that pet
- Wings that "flap" or move as appropriate to that pet
- A nose that "wiggles" or move as appropriate to that pet
- "Pant" or breathe
- Eat food (physically hold it inside of its mouth, or virtually distinguish when it is "hungry")
- Simulated (numerical) "levels" of energy, happiness, etc. that affect speed of actions
- Definitive behaviors corresponding to being excited, hungry, sad, angry, sleepy, etc.

This is certainly not a complete list! Other ideas for features should be presented to your Learning Center instructor for approval. A primary limitation in the selection of features you incorporate is the number of motors in the NXT Lego kit (3), so consider this as you decide upon individual states.

Transitional Behavior

Your Pet should be programmed as a Finite State Machine, which is a specific way of programming that establishes each feature, behavior, or capability as a separate state and includes directions for "transitions" between these states. That is, your Pet should move from one state to another state to exhibit each feature/behavior incorporated in your design. All pets must start from a "resting state" (which does not count as one of your features) and will move to an active state through sensor input.

Exiting the Resting State:

Your project demonstration should start in a resting state (waiting for sensor input). The signal for your Pet to exit the resting state should be from input to a homemade sensor which will be built in Learning Center 5.

Active States:

The transition between states should be carefully planned and executed so that the features incorporated are appropriate for the Pet your group designs. There should be multiple possible sequences for showing all of your features.

Re-entering Resting State:

Your project demonstration should return to the "resting state" after you have demonstrated all its features.

The states (4 or 5) your group incorporates into your project must transition within your program using sensor inputs without your group having to turn the power off and on or otherwise physically "reset" the Pet. Running multiple programs or altering the configuration of your robot during the demonstration is not encouraged but you can seek approval from your learning center if you can present a well thought out plan for states you plan to incorporate with a state transition diagram.

Examples of state transition diagrams will be discussed in lecture (you will develop your own and present it to your learning center instructor for approval).

Demonstration

The seventh week of learning center will be used for each group to demonstrate their Pet (week of Oct. 3rd).

A diagram of all possible states and transitions will be required at the demonstration. For your demonstration, you will follow just one path in this diagram, in such a way that you show each of your Pet's features.

Your entire demonstration should be completed in ten minutes. The demonstration each of your Pet's features in a predetermined order can take up to 8 minutes, after which point your learning center instructor may request you to demonstrate other possible state transitions that you have indicated are possible on your diagram.

Demonstration Grading Criteria

- State transition diagram that accurately explains — 15 pts
  - Order of your demonstration (5 pts)
  - The sensors used and how Pet moves from state to state (5 pts)
  - The expected behavior of each state (5 pts)
- Sensor used correctly to initialize demonstration of Pet (from "Resting State") — 10 pts
- States/Features — 60 pts
  - Locomotion and Object Avoidance (20 pts)
  - Additional States/Features (40 pts)
- Return to Resting State — 5 pts
- Miscellaneous — 10 pts
  - Creativity
  - Smooth Execution, Less than 10 minutes for demonstration

Individual Project Contributions (Peer Evaluation)

We expect everyone to contribute to the success of their group's project, as such you will be evaluating your peers based on their individual contributions and you will likewise be evaluated by your peers as part of the project grade. The system we will use is administered on-line, and although each person will receive feedback all ratings are confidential. The system is: Comprehensive Assessment of Team Member Effectiveness (CATME), it asks a series of questions regarding the behaviors of your team members and you select the best description for each person in each category (you will have a chance to practice using this system before the project is complete). Under the guidelines of the University of Notre Dame Honor Code, we expect HONEST feedback from each person in the group. If you have any questions or concerns feel free to ask your Learning Center Instructor. Note that your grade for the peer evaluation is based on a calculation of similarity and difference within your group (meaning there is no benefit to an individual for rating a team member highest or lowest in all categories)

Project 1 Overall Grading (20% of Course Grade):

Demonstration (as evaluated above)	40%
Report (guidelines in another document)	50%
Peer Evaluation	10%

Project Turn-in

You are responsible for maintaining your Lego Kit, and are required to inventory the components upon completion of the project demonstration and turning it in to the Learning Center Manager, Natalie Gedde ngedde@nd.edu (201 Stinson-Remick) no later than when you learning center section meets the week of October 10th (11th, 12th or 13th). Groups will receive a homework grade for turning in a properly inventoried kit (identifying any missing pieces).

Best in Section:

If your project is voted best in section by your classmates you will be invited to demonstrate your pet at the local intermediate school to the 5th graders that offered input into the design of your pet. This will take place the morning of October 12th, transportation will be provided by the University. These groups will be given an extension for turning in their project kits.

The Tower Builders

Submitted by: Victoria Froude
University Notre Dame
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EG 10111: MODULE 2 – THE TOWER BUILDERS
PROJECT DOCUMENT
DESIGN DEADLINE: Learning Center 6 (week of 11/28)

An investor wishes to commission an engineering firm to design a tower with a specific function and pre-defined height and geometry, while meeting the following objectives:

(1) Limit the deflections of the tower to a defined level under a given load, subject to specific general and functional constraints;
(2) Meet this limit state as efficiently as possible, i.e., using the least amount of materials (saving the owner money!).

Your team must modify the basic tower introduced and tested in Learning Center 1 to meet your team-specific deflection limits summarized in this document, thus satisfying Objective 1. You will do so by bracing your tower, subject to the general and functional constraints, and attempting to be as efficient as possible, i.e., use the least amount of braces to do so. As a result, you will need to vary your bracing scheme over the height of the tower. Two metrics, a stiffness ratio and bracing ratio, will be used to calculate the efficiency of your design, evaluating your ability to satisfy Objective 2. These quantities will be defined in Learning Center 4.

As with any engineering project, there are **general constraints** that all teams must honor. These constraints are:
(1) The tower must maintain its original dimensions of 150 mm x 150 mm in plan and 750 mm in height. (Note that 150 mm is the length of the red K'NEX bars used to construct the basic tower.)
(2) The roof and floors (blue bars) of the tower cannot be modified; however, their connectors can be changed to allow for the addition of other vertical elements.
(3) The tower must be constructed only out of the K'NEX pieces allocated to your group. You may NOT use the orange connection pieces in your boxes. All teams have received the same number of pieces.
(4) The four corners of each floor above the ground floor should continue to use the "double blue" interlocking connectors.
(5) The connectors at the base of the model must be configured so that all 9 base points snap to the testing plate pins, as in Learning Center 1.
(6) You are only to brace in the direction of the applied loading, as discussed in Learning Center 4.
(7) Bracing on the exterior faces of the tower must be identical, e.g., if an "x" brace is used on one exterior face, it must also be used on the other exterior face (this insures a symmetric tower that will not twist excessively when tested).

**Be sure to assign the material property K'NEX to all members in your SAP model. Any time you add a new member, it defaults to STEEL. This will drastically affect your model's predictions! To be safe, before running the analysis go to Select→Select all, then Assign→Frame→Frame Sections→K'NEX.

There are also **functional constraints** that will be imposed on each team, based on the owner's intended usage for the tower. These are now detailed along with the target **limit state** for each team (See the separate PowerPoint File: Team Project Constraints posted in Concourse). The deflection limit states noted refer to the deflection of the top floor under a **4.5 N load.**
Your team may use any bracing scheme you like as long as it satisfies the above stated general constraints and your team-specific functional constraints. <u>You will be expected to use SAP to model</u>

various design concepts and predict the deflections of your proposed design prior to Learning Center 6. You cannot physically test your design prior to Learning Center 6. All design will be done virtually in the SAP environment; however, you may explore the feasibility of your design and practice its construction using K'NEX prior to Learning Center 6.

Learning Center 4 will introduce you to a variety of bracing schemes, and Learning Center 5 will provide some additional guidance on the design optimization process. After predicting deflections using SAP and assessing the efficiency of your design, you will then verify its performance physically by testing your design in Learning Center 6. You will be allowed to bring your fully constructed tower to Learning Center 6 to expedite testing.

Functional Constraints:

Team 1: A new dorm on Notre Dame's Campus (with air conditioning!) to offer dorm style housing for student families and alumni for special events such as athletic events and university ceremonies (orientation, Junior Parent's Weekend, and graduation). This will be a tall building on campus that is to offer scenic views of campus and the stadium, no exterior bracing on floors 4 & 5 to allow unobstructed views. And no interior bracing is permitted on the first-floor to allow a spacious area for special event gatherings.
Limit state under 4.5 N load: 8 mm

Team 2: An office building for YouTube, a subsidiary of Google: the CEO will have a grand penthouse office on the top floor of the tower. As a result, no braces are permitted on the top floor, so that he will have wide open floor plan with unobstructed views of the surrounding skyline. Also, the third floor will be a theater / media room with no interior bracing permitted.
Limit state under 4.5 N load: 10 mm

Team 3: An ultimate gaming complex which allows multi-story laser tag, paint ball, and rock climbing. No exterior diagonal bracing is permitted on the first floor to allow onlookers clear views (to try to lure them in!). And no interior bracing is permitted on floors 2-4 for open play of laser tag, paint ball, and rock climbing.
Limit state under 4.5 N load: 4 mm

Team 4: NBC studios has contracted a new building to be constructed in downtown Chicago for live, open view taping of reality TV shows. To allow onlookers unobstructed views there are no diagonal braces permitted on the exterior of the tower, though other forms of bracing are permissible.
Limit state under 4.5 N load: 10 mm

Team 5: Multiple tenant facility in an urban setting is needed with the bottom floor being reserved for store front (the user of which has not been determined). In order to maximize flexibility no diagonal bracing is permitted on exterior of the first floor. The middle 3 floors are accounting office suites, any bracing is permitted. Finally the top floor is for a Japanese Steakhouse, so no exterior bracing of any kind on that floor.
Limit state under 4.5 N load: 7 mm

Team 6: This tower will house corporate offices for Facebook (www.facebook.com). Facebook's founder, Mark Zuckerberg, is willing to allow you to brace the interior plane on any floor, but he will only permit you to brace the exterior planes on no more than two floors, of your choosing.
Limit state under 4.5 N load: 7 mm

Team 7: This tower will serve as offices for Engineers without Borders (http://www.ewb-usa.org/). This organization embraces a communal approach to sustainable engineering design projects to benefit communities across the developing world. As a result, the floors that will house their design studios (floors 2 and 3) cannot have any interior braces to permit the open spaces required for this communal approach. And to permit the use of high efficiency windows, no exterior diagonal braces can be used on any floor.
Limit state under 4.5 N load: 13 mm

Open Ended Design Modeling Project

Submitted by: Victoria Froude
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EG10112 - SPRING 2012
Open Ended Design / Modeling Project

This document describes the expectations and technical requirements for your open ended design project which will take place over the entire spring semester. For this project, your group will select a project of your interest to demonstrate to members of the College of Engineering. Your team will incorporate the use of mathematical models to describe a system of your choice and can even create a physical model to test your computer model. Through the use of MATLAB, your team will create a graphical user interface (GUI) as a tool for users to predict how that system would perform – and then actually demonstrate it.

OVERALL CONCEPT

Each group will be required to develop a computer model to describe a system. Some groups will choose to be more simulation or software focused while others will be more focused on building a physical model. In either case, your team is required to create a GUI and collect and interpret some data based on repeated testing. If your project is more simulation-based, there will be a higher expectation on the GUI and modeling. Collecting and interpreting data may be based on running repeated tests of your simulation or correlating the model by using real world data to demonstrate that your output is reasonable.

Once you have identified the overall system or concept for your modeling demonstration, your goal is to:

1. Identify the theory and mathematical representations that describe system performance
2. Determine values for the critical parameters of the system which will be used in developing a prototype of the system
3. Identify the approach used to correlate the model with the prototype
4. Create a prototype or other form of representation (hands-on or computer simulation)
5. Use a GUI to take input from the user to predict performance
6. Collect data from repeated testing and make comparisons to your model system
7. Demonstrate your system for your faculty member and classmates (the last learning center)
8. Prepare a poster which illustrates the critical concepts associated with your demonstration (You will present it to the Notre Dame engineering community during the final week of the semester).

You will be evaluated based on your ability to illustrate, simulate, and validate the concepts that underlie your project through reports and presentations as outlined at the end of this document (and staying within your budget).

PROJECT CRITERIA & REQUIREMENTS

You will develop your project within a project group of 4-5 students. Your group is responsible for identifying all aspects of the project from initial concept through final representation (prototype and/or computer simulation) and presentation. You will receive guidance and feedback from your instructor and student assistant, but they will NOT define your project for you. Be creative and use your instructor to ensure that you remain within a reasonable project description.

The following are a list of project requirements:

- Your project (prototype/computer simulation) must be functional
- You are expected to define:
    - The underlying mathematical and/or scientific principles
    - The assumptions and/or limitations under which your model applies
    - The approach to validate/correlate the model

- You are expected to identify and document:
  - How the demonstration is supposed to work.
  - A minimum of 2 credible sources/references that support the relationship you are demonstrating
    - http://engineering.library.nd.edu/
  - How your GUI is used to simulate the performance of the system.
  - How your system performs as compared to how you expect it to perform and account for uncertainty.
  - How your project made efficient and effective use of space and money. Constraints are given below, but you should aim to be as efficient as possible in your design and able to discuss the ways in which you were efficient in your report and presentation.

Physical Constraints:

The following are a list of constraints on your demonstrations requiring hardware:

- The demonstration must be safe (i.e., free of conditions that could result in significant danger to students or faculty).
  - NO chemical explosives (no rocket fuel, hair spray, or other ignitable substances)
  - Pressure vessels cannot have internal pressures that exceed 15 psi above atmospheric pressure.
- If the demonstration is designed to be outdoors, it must function in all reasonable weather conditions (e.g., it must function while it is sunny, raining or snowing, but does not have to be functional, for example, during thunderstorms or tornados!)
- Project costs are limited to $100 (see below for specifics of this constraint)
- The demonstration, when not in use, must be easily stored within the space available in Stinson-Remick. Smaller spaces in the learning center are available for free; other space is available for a fee (see costs, below). When in use (i.e., not stored), there is no limitation on the length, width, or height of the demonstration, as long as it meets the other constraints listed above. (We encourage you to be creative with the way your system is built, and use items like nuts and bolts, rather than nails, to allow for easy assembly and disassembly.)

Cost Constraints:

The total value of all parts currently available in the learning center PLUS parts purchased for your demonstration MAY NOT EXCEED $100 including:

- Learning Center Equipment:
  - Parts and equipment currently available in the learning center e.g., Lego or K’NEX kits and are charged a ‘usage fee’ can be checked out from the Learning Center Manager, Natalie Gedde ngedde@nd.edu in 201 Stinson-Remick.
  - Common supplies (screws, nails, etc.) will be provided without charge.
  - Hand tools will be available for use without charge.
  - Power tools will be available for use without charge but require signing up in advance.
- Parts which you identify for purchase from identified parts suppliers (Meijer, Lowe’s, Jameco, & Office Depot) will be paid for by the College of Engineering with the following conditions:
  (1) In-store Selections: We will provide one opportunity for free transportation to Lowe’s and Meijer on Wednesday, March 21st where you can pick out items directly
  (2) Online Selections: We will provide one opportunity for you to submit a request for parts to be purchased online. All requests must be made to the Learning Center Manager, Natalie Gedde ngedde@nd.edu by 4:00 on Friday, March 23rd and include section #, group #, item description, item number, and cost:
    - Office Depot http://www.officedepot.com/
    - Jameco http://www.jameco.com/

        - Other on-line suppliers have not been supported in the past, however; if you can explain how an item cannot be found at either Lowe's, Meijer, Office Depot, or Jameco and you are within budget, Ms. Gedde will try to assist.
    - Items purchased outside of these two options **WILL NOT BE REIMBURSED.**
    - Note that by ordering parts through the course they are the property of the University and must be turned in at the end of the module.
- Any additional parts purchased by your group -
    - All parts (even personal property) must have a cost associated with them. This cost will be determined by the Dr. Goodrich (vfroude@nd.edu). For items not on the list of items available in the learning center or purchased through the identified stores, you should provide him with a description of the part so she can determine an appropriate cost.
- Storage Fee – Any wood, dowels, or tubing that you purchase can be stored in a workshop for free until it is cut to size for your project. Then, there are three options for storage of parts for your demonstration. You may only choose one option, but may possibly upgrade to a more expensive option on a case-by-case/first-come, first-served basis.
    - Items may be stored in the portable carts in the learning center <u>for free</u> provided everything fits inside a tote whose inside dimensions are roughly 20 inches by 15 inches by 6 inches.
    - Items may be stored in shelving in a storage room in the basement for a <u>$10</u> fee. There are two storage shelf sizes available: roughly 24 inches by 23 inches by 15 inches, and roughly 30 inches by 18 inches by 19 inches.
    - Very limited space is available an increased fee, as determined by the Course Coordinator and/or Learning Center Manager. This space is best suited for demonstrations that are longer in one or possibly two dimensions and is available on a case-by-case basis. Contact Victoria Goodrich (vfroude@nd.edu) to describe your needs to obtain a quote on the storage fee.

  Note that this fee is for storage only; when the demonstration is being conducted, you may construct it to take up the necessary volume for its completion. This fee comes from your $100 budget.
- Disposal Fee – In the interest of environmental consciousness, any project that is painted will be assessed with a <u>$25</u> disposal fee (which comes from your $100 budget).
- A tracked budget will be part of the final report submitted by your group.
    - Failure to adhere to the strict $100 budget will result in a 20% drop in all group members project grades (i.e., the highest total project grade that your group could achieve would be 80/100).
    - All receipts must be retained for review.

<u>ON DEMONSTRATION DAY:</u>

A large portion of your project grade will be determined by demonstrating your system and model to your learning center class. The demonstration will also provide data to be used in your final project report and poster presentation. This demonstration is the culmination of your project and has the following functional requirements:

- Your demonstration must be fully assembled and functional AT THE START of Learning Center.
- Your demonstration may be indoors or outdoors (at your group's preference).
- Your demonstration and explanations must take less than ten minutes.
- Your demonstration may use PowerPoint slides to explain certain concepts, but it is not required. If a Youtube video is created, that can be shown in order to enhance your demonstration – although it cannot be used to replace the demonstration.
- Questions may be asked of any individual member of your project team.

PROJECT DELIVERABLES

The project is developed so that there are several deliverables throughout the process. These will allow your group multiple opportunities to refine your model and then present the information to your peers and the large Notre Dame community. You will be required to give several presentations, turn in a final report, and complete 2 peer evaluations. Documents describing specifics of each of the project deliverables will be available on Concourse as you near each deadline; however, the deadlines for each deliverable are provided below.

Project Requirement	Timing	Notes:	% of Project Grade
Initial Presentation	LC10 Week of 3/26	During Learning Center 10	10%
Peer Evaluation 1	March 31-April 4	Online / CATME	10%
Demonstration	LC14 Week of 4/23	During Learning Center 14	25%
Poster Presentation	April 30th 7-9pm	First Floor Stinson-Remick 7-8 p.m. – Even # Sections 8-9 p.m. – Odd # Sections You will be evaluating others during the hour not presenting.	15%
Final Report	May 1st	4:00 pm in the Learning Center	30%
Peer Evaluation 2	May 3-8	Online / CATME	10%

Submitted by: Bernie Schielmann
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bfschliemann@ecs.umass.edu

ENGIN 197A Group Design Review Assignment
Handling and Disposal of Hog Waste

<u>Group Members</u> (name & intended major):

1.

2.

3.

4.

DIRECTIONS. Develop a concept for the responsible handling and efficient disposal of hog waste (this idea is taken from Richard L. Porter, *Journal of Engineering Education*, October 1998). Use the Creative and/or Analytic Problem Solving method(s) to formulate a solution. At a minimum, include:

1. problem solving method(s) used
2. assumptions
3. design specifications
4. sketch
5. any references used
6. how could have this concept been better managed? be candid

This assignment must be completed in teams during Lesson 7; submit your assignment (1 per group with full names of all group members) before you leave class today. Use the back of this page or attach pages to this cover sheet.

Submitted by: Bernie Schielmann
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ENGIN 197A Group Design Assignment
All-Season Skateboard

Group Mascot:

Group Members (name, contact information, & intended major):

1.

2.

3.

4.

5.

DIRECTIONS. Working in your group, develop a concept, initial design, and list of specifications for an ***all-season skateboard***. Use the Creative and/or Analytic Problem Solving method(s) to formulate a solution. At a minimum, include:

1. problem solving method(s) used
2. assumptions
3. design specifications
4. sketch
5. any references used

This assignment must be completed in teams formed during Lesson 4; submit your assignment (1 per group with full names of all group members), select a spokesperson, and be prepared to brief the class on your concept during Lesson 8.

(75%) Group – Limit your submission to a 1-page document; you will lose points for exceeding this constraint. You will have some class time (during Lessons 5 and 8) to get organized and manage this assignment.

(25%) Individual – submit a short paragraph on what you learned about problem solving, project management, teamwork, and engineering design. Incorporate some of the concepts presented in your text (or lecture slides) and let me know if your group experienced any project management or teamwork issues. Be candid.

Submitted by: Jenny Amos
University of Illinois Urbana Champaign
jamos@illinois.edu

Project Details for BIOE 120
Bioengineering Device or Gadget

Project Description

Can be an invention of an instrument or a device for clinical applications or a gadget for home care or any other things that qualify as bioengineering

Note that bioengineering is not defined, you need to define it yourself, use the introductory lecture given in class as a guide to help you

Project Part I

Propose design that is bioengineering related, it can be realistic based on today's technology or a futuristic vision of what Bioengineering will be 10, 20, 50 years from now

Explain your project best you can and how you would approach it in 1-2 pages
(a drawing can be added to these 1-2 pages if desired)

If the ideas came from another person or course, acknowledge that course…don't EVER be caught for plagiarism! And if referencing an existing idea, explain why yours is different (and better).

Fung, Y.C., *Introduction to Bioengineering*, Hackensack, NJ: World Scientific Publishing, 2001, pp. xv.

Project Part II

I will divide you into groups by topic of your Part I assignment

Within your group, pick the "best" of the group as your project

You will make an advertisement (poster) to sell to students in class.

Poster Requirements

This display should look like an advertisement for your product like you would see at a trade show – your peers should want to invest in this product after seeing your posters!

- Standard poster size is 36"x48"

1. Provide drawings

– They must be professional looking (use drawing software or find a **good** artist in your group)

2. Plans

– Marketing

– Impact on BIOE

– Who is your user?

3. Detailed description

– Build upon your part I and let group members add their input

4. Literature/patent review with citations

Submitted by: Allen Jayne
University of Delaware
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CIEG 161 - Spring 2012

Project 2 Assignment – Deflection of Lumber Under Load

Design of structural members may be governed by material *strength* or it may be governed by *serviceability* requirements. Serviceability refers to considerations that affect the function of a structure and includes items such as deflection, drift (lateral movement due to wind), vibration, durability, or expansion and contraction. **Deflection** is the topic of this exercise.

For this project, each group is asked to acquire a length of lumber suitable for load testing. The size and species of the lumber is not important, but must be noted. You are required to conduct a series of load tests on the lumber, measuring the deflection due to the applied load. Finally, you are asked to consider several questions and prepare a report detailing your test setup, results, and discussion.

1) Load Testing

- Support the lumber test piece securely, and apply ten different, known loads at the midspan of the beam. Each load must be placed carefully at the midspan of the piece and the deflection recorded. The load should be applied to the lumber over as small an area as possible, so that it approximates a concentrated load.
- Using the recorded ten deflections, calculate E, the modulus of elasticity of the lumber. This can be done by using the formula for deflection for this loading condition, $\Delta = PL^3 / 4Ebh^3$.
- Determine the average of the ten values of E which you calculated, and compare the calculated value of E to the published value of E for the species of lumber you are using.
- Determine the bending stress in the lumber due to each load, which is calculated as stress = $3PL / 2bh^2$. Compare the value of bending stress that you calculated to the published values for the lumber you are using.

2) Additional Considerations

- Assume deflection will control the design, and the maximum allowed deflection is span/240. Determine what **size** beam would be required to support a 2000 pound load applied at the midspan of a twelve foot span. Assume the beam is constructed of the same material as the beam which you tested. What is the stress in this beam? Is the stress less than the allowable published values?
- What would be the deflection of this beam be if the beam were made of steel?
- What would be the deflection of thisbeam be if thebeam were made of aluminum?
- Finally, vary the span of these three fictitious beams (lumber, steel, and aluminum) from twelve feet to twenty feet, in increments of one foot. Using the 2000 pound load, plot the deflection curves for all three beams on one set of axes, and comment on the results.

The completed submission for this project shall include the following:

- A table listing the ten loads applied to the beam, the corresponding deflections, the corresponding stresses, the corresponding E values, and the final average E value. Also note the published value for E and the published value for allowable bending stress for the species of lumber that you use.
- A neatly prepared sketch describing your test setup, beam span, support configuration, etc. In addition to the sketch, a photo of the test setup may also be included.
- A discussion describing the test setup, execution, any unexpected occurrences, data collected, the E value estimated as a result of the tests, the calculated bending stresses, and a discussion of the comparison of the experimental values for E and bending stress to the published values for these properties.
- A plot of the calculated deflections for the three beams described under in the **Additional Considerations** sections. This plot should be plotted with span on the abscissa (horizontal axis) and deflection as the ordinate (vertical axis).
- A discussion and response to the questions listed under the heading **Additional Considerations**.

The final submission should consist of a well-written, well-organized report (typed; double spaced; cover page; figures, sketches, and plots neatly prepared) describing the work your team completed, the results obtained, and a discussion of the results.

Submitted by: Allen Jayne
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CIEG 161 Freshman Design Project 5– Transportation Systems

Traffic Flow Project

Team Assignments - East Main and Chapel- Teams 1-4,9-12, 17-20
Delaware and South Chapel- Teams 5-8, 13-16, 21-24

Each group will do a 30 minute traffic count at their assigned intersection. The count will start on the quarter hour (00, 15,30,45). Each fifteen minute interval will be recorded on a separate data sheet. At least two people will conduct the count, one doing two legs of the intersection, the other doing one. Students can also do individual legs (3 counters). Counts will be done between 7 am and 9 am or 11am-1pm or 4 pm and 6 pm. The count does not include pedestrians and will be a combined count of all motor vehicles (cars and trucks)(no bikes, skateboards, etc). Sample data collection forms are in the project 5 folder in Sakai.

Data sheets from the intersection counts will be combined and the sum of the turn counts will be converted to hourly values (add the fifteen minute sheets together for each movement and multiply by 2).

Each group will complete a critical movement summary and signal timing plan based on the data they collected.

All data sheets, critical movement summary and timing plan will be turned in as the report for this project. Handwritten sheets are fine. Report will contain a cover sheet, the rough count sheets (using sample provided or form of your own choice), one smooth turning movement count sheet with hourly values, the completed Critical Lane Movement Summation sheet and the Traffic Signal Timing Worksheet.

VEHICLE TURNING MOVEMENT COUNT

FOUR-APPROACH FIELD SHEET

Time ________ to ________

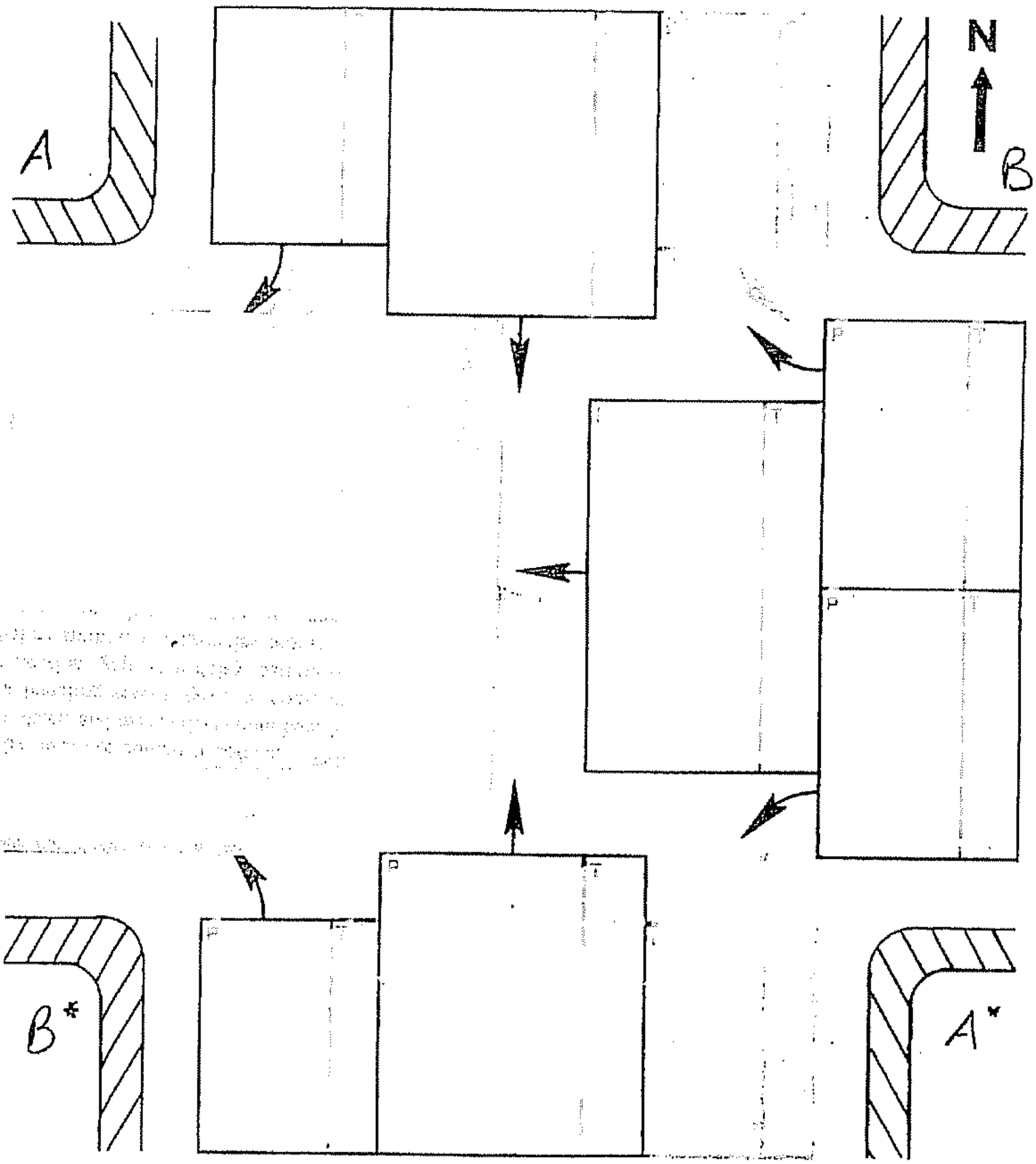
N/S Street N & S. Chapel

E/W Street E. Main St

Date ________ Day ________

Weather ________

Observer ________



VEHICLE TURNING MOVEMENT COUNT

FOUR-APPROACH FIELD SHEET

Time ____________ to ____________

N/S Street S. Chapel

Date ____________ Day ____________

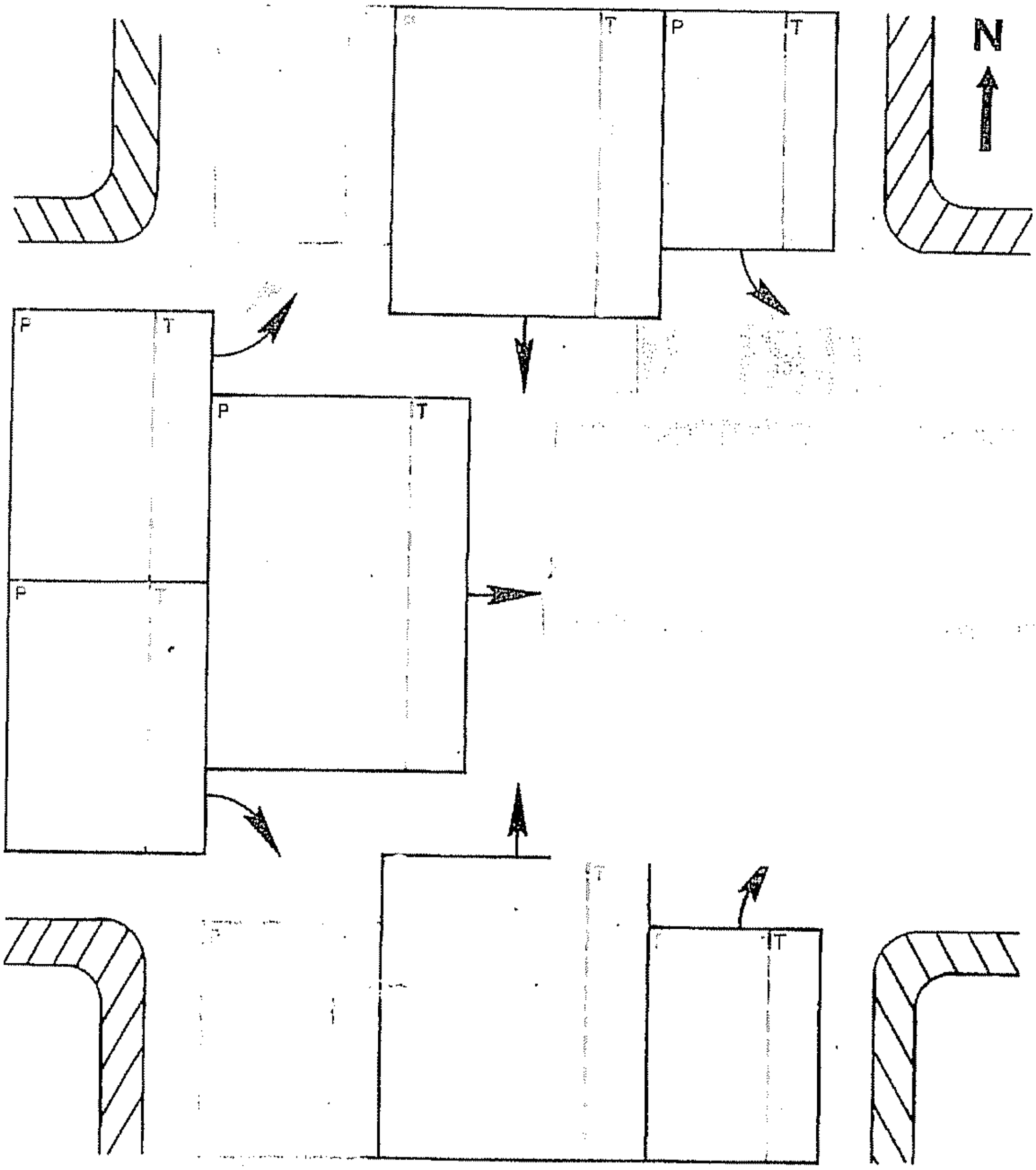
E/W Street Delaware Ave

Weather ____________

P = passenger cars, stationwagons, motorcycles, pick-up trucks.

Observer ____________

T = other trucks. (Record any school bus as SB; other buses as B).



DelDOT

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

Location:

Count Date:

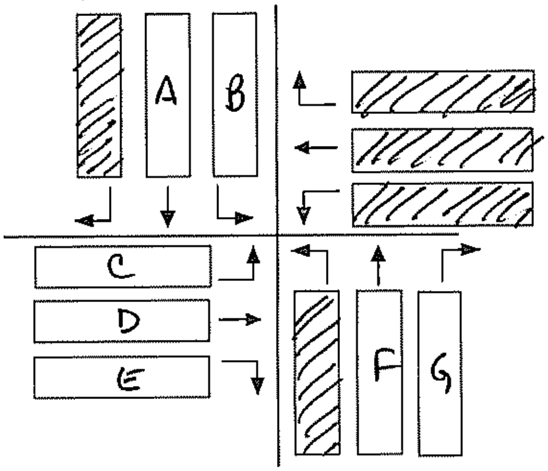
EXAMPLE

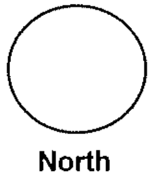
Time of Day

Computed By: Team

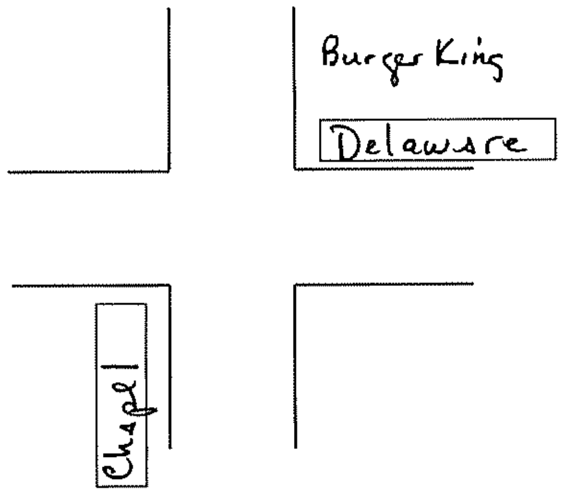
Date:

Peak Hour:

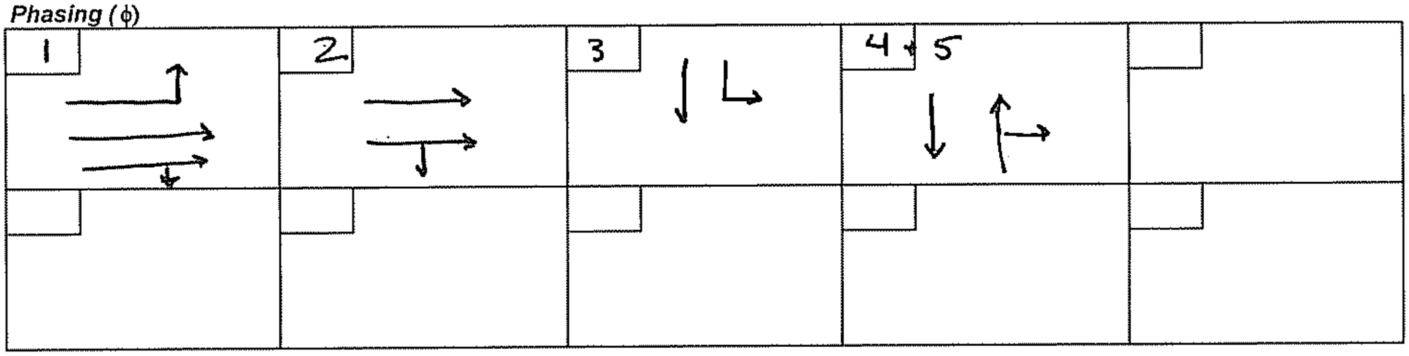




Lane Configuration:



Phasing (ϕ)



Movement	Volume Calculation	Lane Volume	OL	LTC (subtract)	Critcal Lane Volume	CM (*)
DEL WB L	C	C	ϕ	ϕ	C	*
DEL WB T+R	(D * .55) + E	(D * .55) + E	ϕ	C	(D * .55) + E − C	*
Chapel SB L	B	B	ϕ	ϕ	B	*
Chapel SB T	A	A	ϕ	B	A − B	
Chapel NB T+R	F + G	F + G	ϕ	1	F + G	

} which is larger

Remarks:

TOTAL	sum of *
LEVEL OF SERVICE	from TABLE

Level of Service

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

Lane Use Factors

No. of Lanes	Lane Use Factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30
dual left	0.60

OL = Opposing Lefts
LTC = Left Turn Credit

DelDOT

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

Location: ____________________

Count Date: ____________________

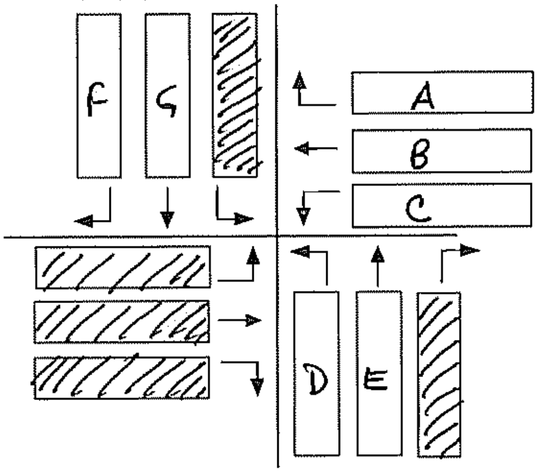
Time of Day ____________________

Computed By: Team

Date: ____________________

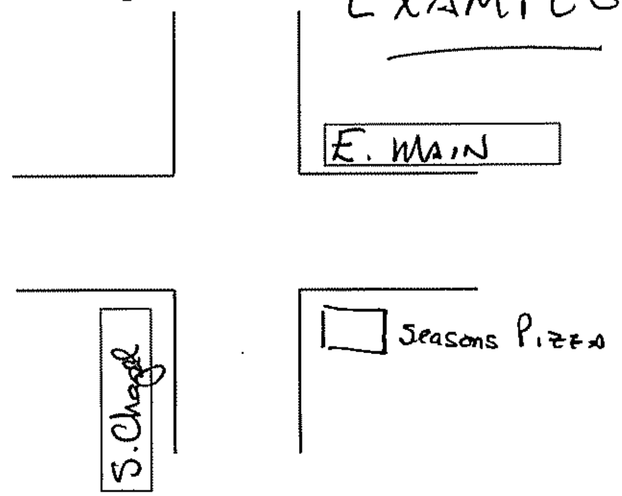
EXAMPLE

Peak Hour:

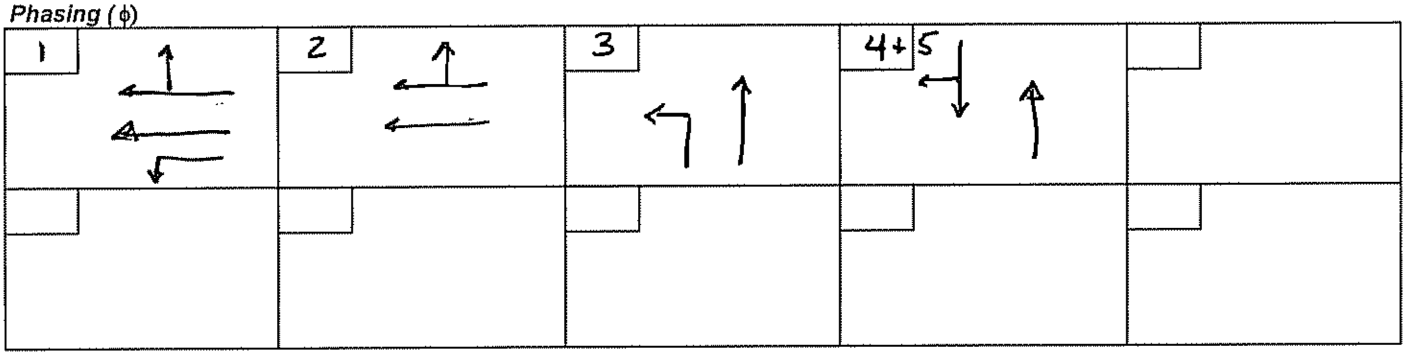


North

Lane Configuration:



Phasing (ϕ)



Movement	Volume Calculation	Lane Volume	OL	LTC (SUBTRACT)	Critcal Lane Volume	CM (*)
1. MAIN ST WB Left	C	C	∅	∅	C	*
2. MAIN ST WB Thru	(B × .55) + A	⇒ (B × .55) + A	∅	C	(B × .55) + A − C	*
3. Chapel NB L	D	D	∅	∅	D	*
4 Chapel NB T	E	E	∅	D	E − D	} ? which is larges
5. Chapel SB T+R	F + G	F + G	∅	∅	F + G	

Remarks:

TOTAL: sum of *

LEVEL OF SERVICE:

Level of Service

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

Lane Use Factors

No. of Lanes	Lane Use Factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30
dual left	0.60

OL = Opposing Lefts
LTC = Left Turn Credit

EXAMPLE

DelDOT Standards and Regulations for Subdivision Streets and State Highway Access

Figure P-2 Traffic Signal Timing Worksheet

Location: Chapel & MAIN Date: ____________

Cycle Length: 100 sec Cycles per Hour: 36 Prepared by: TEAM

Time of Day: ____________

Phases	Movement	Critical lane Volume (CLV)	CLV/36 Vehicles per Cycle	Green Time Required (see Greenshield Figure P-3)	Clearance (Red + Yellow)	Walk + Don't Walk
1	WB L				6	NA ↓
2	WB T					
3	NB L					
larger of 4 or 5					6	

just 4 ↑ critical phases

Total Green		· —	
Total Clearance		12	
Total Time Required		·	↓

Cycle Length	Cycles per Hour
45	80
60	60
75	48
90	40
100	36
120	30
150	24
180	20
210	17
240	15

STANDARDS AND REGULATIONS

FOR

SUBDIVISION STREETS AND STATE HIGHWAY ACCESS

Delaware
Department of
Transportation

Appendix P Critical Movement Summation (CMS) How-To Guide

P.1 BACKGROUND

The critical movement summation (CMS) method focuses on "raw" intersection capacity, that is, the ability for an intersection to process a given traffic demand with a given lane use configuration and given phase sequence.

Traffic signal phasing is one component of the analysis, but it is important to note that most of the subtleties of traffic signal phasing and operation are not included in the analysis.

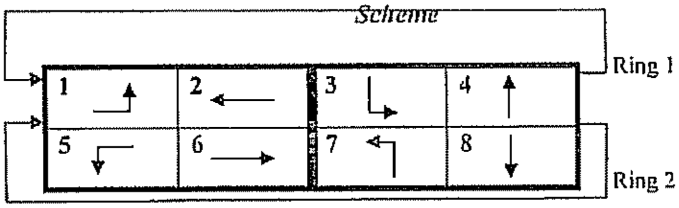
The analyst can use this simple hands-on approach to get right to the point of an intersection's ability to handle traffic demands. CMS looks at each of the "critical" movements at an intersection. It is a volume-based measure.

P.2 PROCESS

Step 1. Gather CMS Inputs

- Hourly Volumes – Use vehicles per hour. If analyzing the peak hour, use the largest sum of 4 consecutive 15-minute periods for that intersection, e.g. 7:45 – 8:45 AM.
- Lane Use Configurations – Determined through observation of existing geometry and operations.
- Signal Phasing – Use National Electrical Manufacturers Association (NEMA) standard 8-phase operation with adjustments as needed. The top line of phasing on the CMS worksheet is intended to show existing phasing. The adjacent line below is workspace intended for conceptual improvements to phasing. See Figure P.1 for a typical NEMA phase numbering schemes.

Figure P-1 Typical Phase numbering Scheme



Step 2. Fill in CMS Worksheet

For each row, fill in the columns:

- Movement (describe in words, e.g. NB through, SB through, EB left, etc.)
- Phase (indicate movement number)
- Volume (in the case of a shared lane, write each volume long-hand, and then sum, e.g. 100 + 150 + 25)
- LU (Lane Use factor, see table at bottom of worksheet.)
- Lane Volume (multiply the Volume by the Lane Use Factor.)
- OL (Opposing Lefts, to be added. See description of Permissive Only Lefts below.)

- LTC (Left Turn Credit, to be subtracted. See description of Concurrent Lefts or Lead/Lead-Lag Left below.)
- Critical Lane Volume (apply OL or LTC to the Lane Volume to get this Critical Lane Volume.)

Step 3. Determine Critical Movements

In the CM column, note the highest of each movement pair (e.g. highest of NB/SB through, highest of NB left/SB left, etc.) with an asterisk*. There should be an asterisk (*) corresponding to each block in the top line of phasing on the CMS worksheet.

Step 4. Sum the Critical Movements

Fill in the "Total" by adding the movements that have asterisks*. Assign a Level of Service (LOS) by using the Level of Service table at the bottom of the CMS worksheet.

P.3 RULES FOR TURNING MOVEMENTS

P.3.1 RIGHT TURNS

If right-turn is "hot" or "free" (i.e. has a dedicated, channelized deceleration and acceleration lanes) and is not signal controlled, leave out of computation.

If right-turn has a dedicated lane and is signal controlled with right-turn-on-red permitted, assume 50% of right-turn volume.

If right-turn has a dedicated lane and is signal controlled with "No right turn on red," assume 100% of right-turn volume.

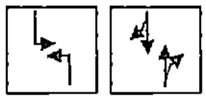
If right-turn has a dedicated lane and is signal controlled for rights to move concurrently with lefts (e.g. NB rights move with WB lefts), reduce the right-turn volume in the amount of the left-turn volume.

If there is a shared through/right lane, add through and right volumes.

P.3.2 LEFT TURNS

Left turns are to be treated as either protected (signalized left-turn arrow) or permissive (no left-turn arrow). If existing condition allows a left-turn movement to be both protected and permissive, analyze as protected (only) in CMS.

P.3.2.1 Concurrent Lefts

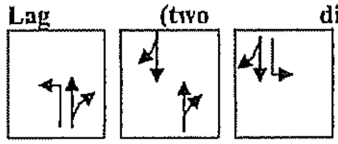


Account for Left Turn Credit (LTC) as follows:

- Calculate lane volumes for left-turn moves
- Apply lane-use factor
- Calculate difference of lefts (e.g. NB/SB lefts or EB/WB lefts)
- Subtract this difference from the through movement that's in the same direction as the greater left-turn volume.

CMS may over or underestimate the impact of left turn traffic on shared left-through-right lane in situations where through opposing volume is high. Additional Analysis (such as the methods of the *Highway Capacity Manual)* may be warranted.

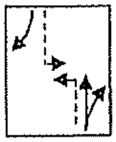
P.3.2.2 Lead Left (one direction), or Lead-Lag (two directions)



Account for Left Turn Credit (LTC) as follows:

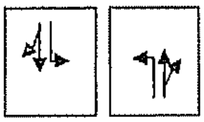
- Identify left-turn volume associated with the lead (or lag) phase.
- Apply lane-use factor.
- Subtract that left-turn volume from the through movement on the same approach.

P.3.2.3 Permissive Only Lefts (no left-turn arrow)



Account for Opposing Lefts (OL) as follows:

- Identify left-turn volume that will be awaiting gaps in the through volume. (These lefts are considered "opposing lefts" – opposing the through volume being analyzed.)
- Add that left-turn volume to the opposing through movement.
- The left turns cannot move until the opposing through movement is complete. So you must consider the total of these two movements, since they cannot move simultaneously.



P.3.2.4 Split Phasing

- Left-turn credit (LTC) does not apply.
- Opposing lefts (OL) do not apply.

P.4 SIGNAL TIMING

CMS can be used as a prerequisite to signal timings. The following steps follow CMS to determine cycle length and required green and clearance (yellow and all red) time:

Step 1. Transfer phasing and Critical Lane Volume (CLV) Inputs from CMS worksheet onto the Traffic Signal Timing Worksheet (see Figure P-2)

Step 2. Determine number of vehicles per cycle per phase. The table included in the Traffic Signal Timing Worksheet can be used to determine the number of cycles in an hour (or simply divide 3600 seconds by the cycle length).

Step 3. Determine green time required from Greenshield's model (see Figure P-3)

Step 4. Determine clearance and pedestrian timings.

Step 5. Determine total time required and compare to cycle length.

P.5 CMS SAMPLE EXERCISE PROBLEMS

See Figures P-5 through P-14 for CMS sample exercise problems.

P.6 SIGNAL TIMING SAMPLE EXERCISE PROBLEM

See Figure P-16 for a sample signal timing exercise problem.

Figure P-2 Traffic Signal Timing Worksheet

Location: ______________________ Date: ______________

Cycle Length: ________ Cycles per Hour: ________ Prepared by: ______________

Time of Day: ______________________________

Phases	Movement	Critical lane Volume (CLV)	Vehicles per Cycle	Green Time Required (see Greenshield Figure P-3)	Clearance (Red + Yellow)	Walk + Don't Walk

Total Green			
Total Clearance			
Total Time Required			

Cycle Length	Cycles per Hour
45	80
60	60
75	48
90	40
100	36
120	30
150	24
180	20
210	17
240	15

Figure P-3 Traffic Signal Green Time Requirements (Greenshield's Model)

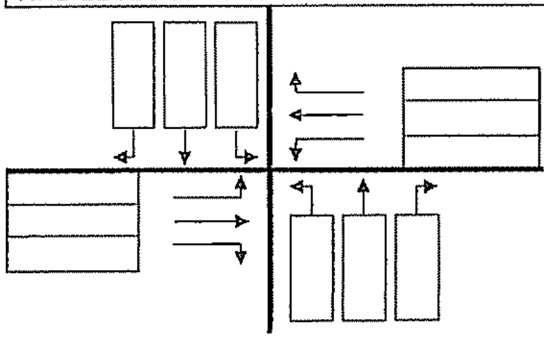
Vehicles per Cycle per lane	Seconds per Vehicle	Cumulative seconds	Vehicles per Cycle per lane	Seconds per Vehicle	Cumulative seconds
1	3.8	3.8	24	2.1	54.1
2	3.1	6.9	25	2.1	56.2
3	2.7	9.6	26	2.1	58.3
4	2.4	12.0	27	2.1	60.4
5	2.2	14.2	28	2.1	62.5
6	2.1	16.3	29	2.1	64.6
7	2.1	18.4	30	2.1	66.7
8	2.1	20.5	31	2.1	68.8
9	2.1	22.6	32	2.1	70.9
10	2.1	24.7	33	2.1	73.0
11	2.1	26.8	34	2.1	75.1
12	2.1	28.9	35	2.1	77.2
13	2.1	31.0	36	2.1	79.3
14	2.1	33.1	37	2.1	81.4
15	2.1	35.2	38	2.1	83.5
16	2.1	37.3	39	2.1	85.6
17	2.1	39.4	40	2.1	87.7
18	2.1	41.5	41	2.1	89.8
19	2.1	43.6	42	2.1	91.9
20	2.1	45.7	43	2.1	94.0
21	2.1	47.8	44	2.1	96.1
22	2.1	49.9	45	2.1	98.2
23	2.1	52.0	46	2.1	100.3

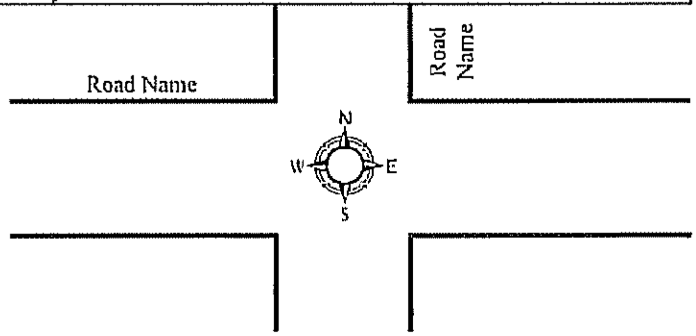
Figure P-4 CMS Blank Sheet

DelDOT

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

Location:			
Count Date:			
Scenario:			
Computed By:		Date:	
Checked By:		Date:	





Signal Phasing (Φ)

Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)

Remarks:	TOTAL:	
	LEVEL OF SERVICE:	

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Design of Surface Drifter with GPS Sensor

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Drifter Design Project 4 CIEG 161

Quite often in coastal engineering and oceanography researchers and engineers are interested in flow phenomena variability along a moving current. In fact, long ago a cargo ship capsized in the western pacific sending loads of rubber duckies bound for the US overboard. The duckies, a few of them, made it albeit months later, riding the oceanic currents. We can use the sneaker concept and the Global Positioning System (GPS) to determine current speeds using purpose-built drifters. If we wanted other information, we could attach additional sensors like temperature, salinity, depth etc, but for this exercise, all we care about is position as a function of time from which we can determine speed as a function of position and time.

Your job is to design a drifter that will house a small GPS sensor (http://shop.delorme.com/OA_HTML/DELibeCCtdItemDetail.jsp?item=19914&section=10268). The battery weight is about half again the weight of the device. The unit requires a small external antenna of negligible weight. It is desired to have the package as small as possible but it must not sink and must be extremely stable. Flows of interest may reach depths as shallow as 30 cm. It is critical the drifter does not drag bottom for this smallest design depth.

You are allowed to use PVC pipe (circular cross section) material, check out Lowes.com or homedepot.com or google.com. You will have to estimate the weight of the material you use. Do your best. In addition, you may need some additional ballast weight in your PVC drifter. Just specify what that weight may be without determining the type of material.

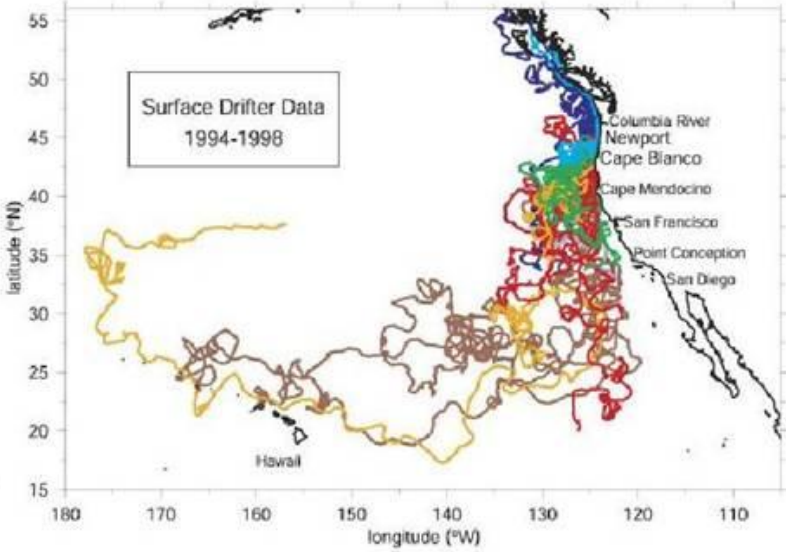
This exercise has no right answer and you will have to make estimates where you do not have exact values. An example might be an estimate of the center of gravity.

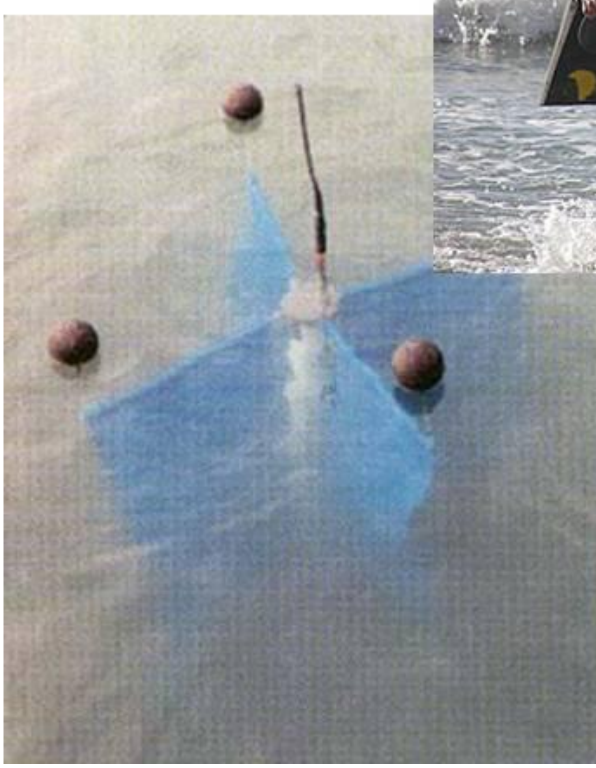
I note that I am presently building these types of drifters so this is a real-world problem.

What is required from you: **A scaled drawing of your drifter. Calculations on the buoyancy and stability. I need to know how low it will ride in the water and how stable it is. A table of the parts you will use, the cost and how you would put the parts together.**

On the next page are some example drifters I found on line from various projects. Yours does not have to look like any of them, but keep in mind we want them small so they do not drag bottom in shallow water.

http://diana.oce.orst.edu/drift/





Recall from our class discussions:

Buoyancy:

1) Floating object experiences a resultant fluid force

2) The force (buoyant force, F_B) acts through the center of buoyancy and vertically upward.

3) The buoyant force is equated to the weight of *displaced* fluid.

4) $F_B = \rho g V$, where the right hand side is the weight of displaced fluid. ρ is the fluid density, for us it has a value of 1000 kg per meter cubed or 1.94 slugs per foot cubed. g is the acceleration due to gravity and has a value of 9.81 m per second squared or 32.2 feet per second squared. V is the volume of the submerged part of the object.

Stability:

1) A floating object is stable if the center of gravity, CG, is below the center of buoyancy, CB.
2) A floating object ***may*** be stable if the CG is above the CB
3) A floating object stability is determined using the Metacentric Height equation (created by nautical engineers)

$$\overline{MG} = \frac{I}{V_{displaced}} - \overline{GB}$$

Where $\overline{MG}$ is a quantitative measure of the stability. If greater than 0, stable. Less than zero implies unstable

I is the moment of inertia of waterline area about the roll axis. For cylindrical objects, $I = \frac{\pi r^4}{4}$, for radius of cylinder, r.

$V_{displaced}$ is the submerged volume of the floating body

$\overline{GB}$ is the original distance between the CG and CB. Set up a coordinate system at the base of your drifter, then measure vertically up to the estimated locations of the CG and CB. Then, $\overline{GB} = CG - CB$