Design Your Process of Becoming a World-Class Engineering Student

Submitted by: Steffen Peuker
University of Alaska Anchorage
speuker2@uaa.alaska.edu

and

Ray Landis
California State University, Los Angeles
rlandis@calstatela.edu

ENGR A151 **Introduction to Engineering** **Fall 2012**

Semester Project:
Design your Process for Becoming a "World-Class" Engineering Student
Due on December 4th

Engineers design products or processes to meet desired needs. Your desired need or goal (hopefully) is to graduate with your Bachelor of Science degree in engineering. But what is the process you need to apply to be successful in achieving this goal?

This project in combination with the lecture is intended to help you designing your process to success. The textbook "Studying Engineering" will be an excellent resource as well as many of the assignments, homework and, very importantly, your journal. As you will learn and study throughout the semester you will encounter objectives that are essential to be successful. Below is a list of objectives:

- Set your goal(s), which major to chose at UAA, graduating, etc.
- Strengthen your commitment to your goal(s)
- Clarify your goal(s)
- Set-up a "Road Map", a plan to guide you over the next years to graduation
- Be prepared to deal with adversity
- Outline what attitudes and behaviors you need to change/add to be successful
- Enhance your self-awareness and improve your skills to practice academic success strategies
- Build relationships, making effective use of your peers
- Manage time and tasks
- Organize your learning process
- Co-curricular activities
- Navigate the UAA system, resources and academic advising

→ add at least 3 additional objectives you perceive are important for your success

To develop your process to be successful, evaluate each topic/objective based on:

a. Where are you currently on implementing these topics/objectives
b. Where a "world-class" engineering student would want to be on each of these objectives
c. What you need to do to move from where you are to where you want to be

By analyzing a. and b. you will be able to answer c., which will tell you your process to success! Keep in mind that your report will describe *your* process to success. Some tips to get started on the project:

- Start early, meaning now!
- Make use of your journal, while reading the chapters of the textbook, always write down notes in your journal (you are required to do this anyway) with focus on how you would implement the topics covered to make them work for you.

- Assignments, in class-activities and homework is aimed to accumulate material which will be very useful for your report, for example there will be a homework where you will need to develop a 4-5 year plan to graduation which you can copy into your report.
- Although this will be your process, study/discuss topics with other students from the course
- Avoid copying verbatim from the textbook or other resources. You can reference to sections of the textbook, e.g., "Understanding the importance of early course preparation, as Landis [1] discusses in Chapter 4.1, will help me to implement the following changes in my attitude and behavior..."

Length of Report

The length of the report should be around 10 pages. The minimum acceptable length is 8 pages, there is no maximum page limit. Reports that contain verbatim copied passages without proper citation will receive 0 credit. In addition, reports that contain lengthy copied passages from sources, even if they are properly cited, will be severely marked down.

Format Requirements

Your report as to be to be written in Microsoft Word or some other software program with the following specifications:

- use font styles Arial, Calibri or Times New Roman with a font size of 12
- use 1.5 line spacing
- use 1 inch margins on all sides

Your report needs to have a cover sheet which must include the name of the course, the title of the report, the submission date, your name as the author. You can find a template on blackboard in the "Project" folder.

Submission Requirements

Submit a digital copy of your report by December 4th through blackboard (see the "Project" folder on blackboard). Only doc(x) and pdf files are accepted! Name your file in the following way:

- lastname_firstname_ENGR151_Project

For example, if your name is Steffen Peuker your file name should be: peuker_steffen_ENGR151_Project

Submit a printout of your report at the beginning of class on Tuesday December 4th.

SUBMITTED BY: Antonella Pompo
Raritan Valley Community College
apompo@raritanval.edu

Group Presentation Project
Requirements & Assignment Descriptions
Engineering Disciplines

Objective: Using a variety of resources, your group is required to create a 15-20 minute presentation

Guidelines

1. First step is to research information
2. Prepare an outline of the Presentation (it is very helpful, especially if you assign the time and/or number of slides for each subject!)
3. Prepare slides

4. Oral Presentation will be graded as:
    1) Actual Presentation: way each one of you present it
    2) Slides
    3) List of References cited in the last slide

Assignment Details

List of Possible Disciplines

1) Aeronautical/Aerospace
2) Biomedical
3) Bio-Environmental
4) Ceramic
5) Chemical
6)) Civil
7) Electrical & Computer
8) Industrial and Systems
9) Materials Science
10) Mechanical
11) Nuclear

Research

The oral presentation project is designed for students to express their creativity while creating a presentation with useful content for the whole class. Here are some suggestions for content areas for the presentation (in the order that you prefer):

1. **Industries served by the discipline**
2. **Common job titles and descriptions**
3. **Nearby colleges/schools that have that program**
4. **Comparison of our Engineering Program and the 4 year college of your choice: how does the program transfer? Extra courses to take to enroll as a Junior?**
5. **The current job market and salary averages**
6. **Professional societies related to this discipline**
7. **Things you learned you did not know before**
8. **Last slide should account for all the references you used as source of information.**

Note that points 3,4 and 7 are mandatory. Make sure that in point 4 you do not list courses in our program or a 4 year program. That is bo-o-ori-i-i-i-ng…! A comparison is what we need highlighting only courses you need to take for getting Junior status.

When conducting your research, keep in mind that a final reference list is due with your presentation and therefore your group should save information on all references you may use in the final presentation and/or handout (even engineers you speak to for information about the discipline). You must use at least five references for your presentation

Some places to start researching:

Written Resources

- Web
- Technical Journals
- Books
- Magazines

Some Websites

- Listing of Engineering Jobs: http://ecojobs.com/engineeringjobs.htm
- Career Advice & Salary Calculator: http://www.nesnet.com/salary.asp
- What Engineers Do: http://www.discoverengineering.org/eweek/about_eng.htm
- Career Profiles: http://www.graduatingengineer.com/careerprofiles/index.html

Please print your presentation in "handout format", four slides per page and black and white

General Tips for Using PowerPoint Effectively

- Minimize the number of words on text slides
- Avoid making graphs too complex
- Use a consistent background, font, and bulleting scheme
- Be creative when designing your slides, but avoid being too creative. The design must not detract from your message

Oral Presentation

The actual presentation should last 15-20 minute total.
The presentation must be very formal as in front of an audience you have never seen before (I will grade your professionalism too).
The first slide should have the title, date, course and all names of the people in the group.
At the beginning of the talk, each member should introduce him/her self (first and last name).
During the presentation every speaker should re-introduce the next speaker just by first name.
While presenting always look at the audience, not at the slides.
You should practice, practice, practice! Write notes on a piece of paper that you can peek at for help.
Everyone in the group must present some portion of the material, or points will be taken off. You are required to use PowerPoint to make your presentation.

Grading of the final presentation will be based on creativity, content, organization, accuracy, usefulness, clarity of slides and talk, flow, understandability, and enthusiasm. Each one of you will influence the final grade on the presentation!

SUBMITTED BY: Antonella Pompo
Raritan Valley Community College
apompo@raritanval.edu

Paper Bridge Competition

Goal

To construct a paper bridge that can withstand many textbooks…!

Material

Each team will be given:

- A Maximum of **FIFTEEN** sheets of recycled paper(A4).
- Masking tape can only be used for adhesive purposes, no structural use (you cannot use a LOTof tape!).

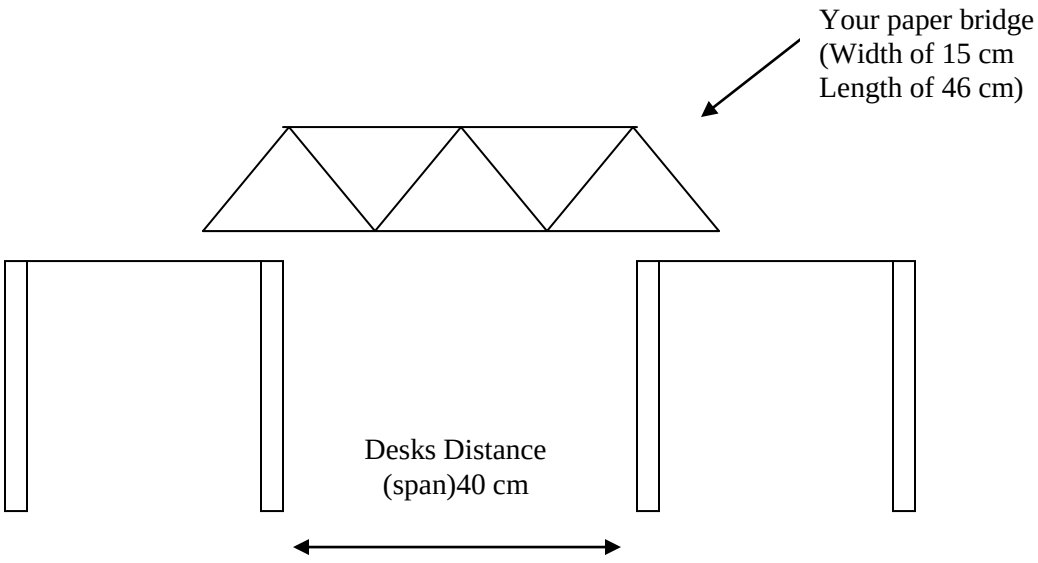
Specifications

- The paper bridge may be of any size or shape, so long as it meets the following requirements:
- The span distance to be covered will be 40 cm.
- The paper bridge must have a **flat base**, with a **width of at least 15 cm** and **length of atleast 46 cm**. The bridge must be constructed in such a way that it can be supported atboth ends on a flat horizontal surface. The bridge cannot be secured to surfaces by any means.

Time

- Each team will have 30 minutes to complete the projectincluding any brainstorming/discussion within the group.

GOOD LUCK!



Revised: 10/25/2011

MEMORANDUM

TO: EGR101 Engineering Teams

FROM: K. R. Swinney, Course Instructor (CI)

DATE: Tuesday, November 1, 2011

SUBJECT: **EGR** 101 Final Design Project

Future Engineers and Mathematicians of Bevill (FEMB) plans to enter the American Society for Engineering Education's (ASEE) Annual Year College Division Model Design Competition held in San Antonio, Texas this summer. The competition requires the construction of an autonomous machine that will carry a golf ball around a track. The machine must have two parts that will exchange the golf ball. In addition FEMB is considering entering the annual Rube Goldberg Machine contest held at Purdue University. This year's task is inflate and pop a balloon in 20 steps or more.

In an effort to integrate both projects, effective immediately, I am assigning all EGR101 Engineering teams to design and construct a Rube Goldberg device that will incorporate elements of the ASEE competition. The mechanism must meet the *Constraints and Criteria* in the attached documents.

See the attached documents for project deliverables and due dates.

I know that each of you will rise to the occasion and produce a product that meets the high standards that have become the trademark of BSCC-PED.

Kenneth R. Swinney, CI

Bevill State Community College

Physics and Engineering Department

2631 Temple Ave.

Fayette, Alabama 35555

Revised: 10/25/2011

EGR101 Final Design Project Description

Project Description

The EGR101 class will design and build an autonomous device that once activated will execute at least 20 steps that will inflate then pop a balloon. The number of steps per team depends on the total number of teams.

All criteria are subject to modification in writing by the instructor.

Constraints and Criteria

The machine must follow the official 2012 Rube Goldberg Contest Rules with the modifications listed below.

Summary of the 2012 Rube Goldberg Contest Rules

1. The machine must fit in a 6 ft x 6ft x 6ft space.
2. The task is to inflate and pop a balloon.
3. No part of the device should cross imaginary sides along the base.
4. The device is to be autonomous and must be started with one touch.
5. The device must complete a run with 120 seconds after starting.
6. The device must execute a minimum of 20 'steps'
7. There can be no operator in the loop except to initiate the device. Penalties will be accessed if the mechanism is touched after it is initiated. This rule prohibits remote control.
8. The machine must be safe.

Additional rules and details of what constitutes a step are found in the official rule Rube Goldberg Contest Rule Book.

Additional Constraints and Criteria for EGR101 Rube Goldberg Machine

1. The machine will be assembled on the plywood base in the Fayette engineering lab (room 148).
2. The base area is divided as shown in the track drawing.
3. Teams are assigned an area, designated by a letter on the track drawing. The areas will be assigned by a random drawing.
4. Each teams machine must fit inside its designated area.
5. Team A will start the machine then pass a golf ball to team B.
6. Team B receives a golf ball from team A and will pass a golf ball to team C.
7. Team C receives a golf ball from team B and will pass a golf ball to team D.
8. Team D receives a golf ball from team C and will pop the balloon.

9. Teams A, B and C must either partially inflate the balloon or cause team E to partially inflate the balloon.
10. Team E is responsible for the balloon inflation and making the balloon available to team D for popping.
11. Team E's balloon inflation must be initiated by at least one other team.
12. Teams must stay within their designated area except when passing the golf ball to the next team.
13. The device must be designed to run autonomously, but if the machine fails, then one person from the team may touch the machine. See the scoring section for penalties for touches.
14. One team member must be designated before the run to touch the machine if needed.
15. Each team's machine must perform a minimum of four steps, as defined in the official Rube Goldberg Contest Rule Book.

Scoring System

Scoring will be done for individual teams using the official Rube Goldberg scoring form. The team scores will be averaged to get the score for the entire machine. The device will have 120 seconds from the time it is started until the balloon is burst. The trial will end when the balloon pops. The class will receive 2 trials and the bonus points will be totaled for each trial. Bonus points will be awarded to each individuals final point total. You must be present for all trials to receive bonus points. Bonus points are only awarded if a team's machine works without a touch.

Team Bonus Points:

10 points for each step over the minimum.

10 bonus points awarded to all teams for each perfect run of the entire machine.

Time Penalty

½ point (entire device score) for each second over 120 seconds.

Touch Penalty:

4 point penalty against group for each touch after first that starts machine.

Budget Constraints

The total budget for the device is the number of teams times $50. Each team starts with a maximum allowable budget of $50, but may trade with other teams to raise or lower their budget within the above constraint. Here budget refers to material purchased for the team or by member of the team.

Revised: 10/25/2011

The following items must be listed in the materials, but are not part of the budget as defined above:

1. Lego parts.
2. Boe-bot parts that come with the original Boe-bot kit.
3. Batteries
4. Scavenged parts and material.

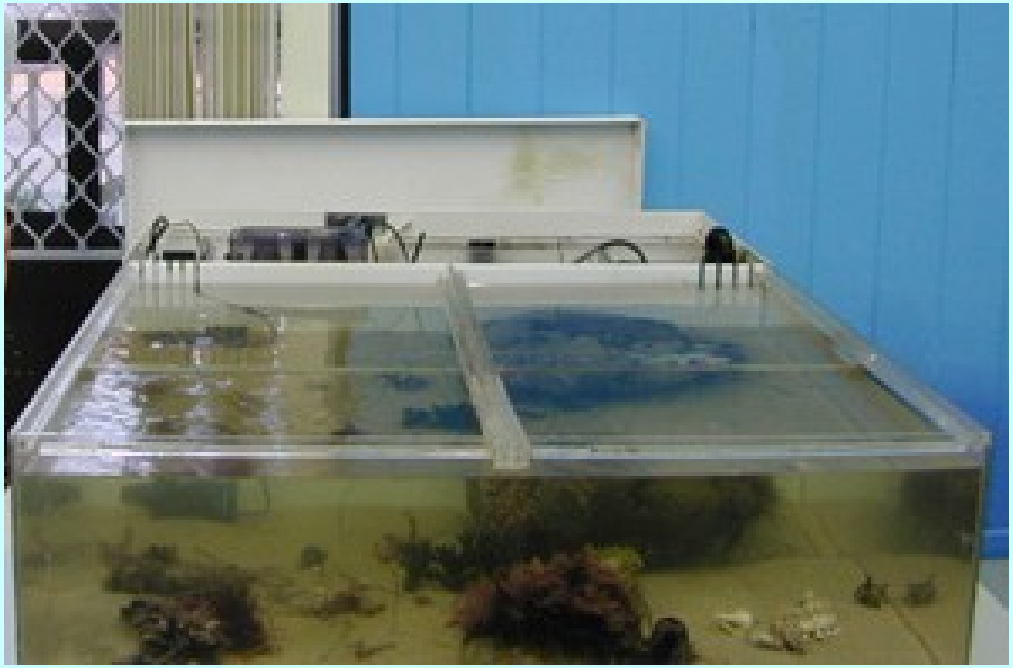
Engineering 11

Tank Agitator Design Project

Bruce Mayer, PE
Registered Electrical & Mechanical Engineer
BMayer@ChabotCollege.edu

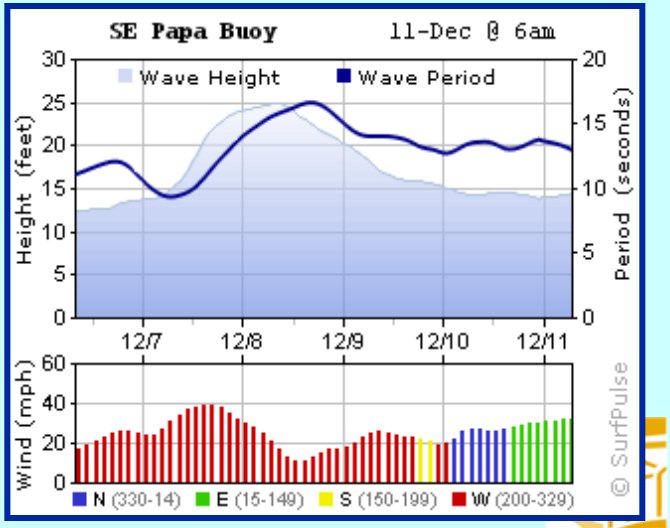
Design Goal

- Design a 24/7 “Wave-Like” Agitation System for a TidePool Culture Tank in a Marine Biology Lab



Design Requirements - 1

1. Must Run Unattended and Automatically 24 hrs/day, 7 days/wk
2. Power Sources Available
   - 115 Vac, 15 Amp Electricity (1725 W)
   - 100 psig, 5 cfm Compressed Air (1630W)
3. Gentle, Back-and-Forth Surface Agitation to Approximate Waves Breaking over an Exposed Tide Pool



Design Requirements - 2

4. Wave Period = 10-15 seconds
5. Tank Size in feet = 2W x 3L x 1D
6. Must Resist Sea Water Corrosion
7. Low Cost → $500 Budget
8. Must be Easy to Install and Uninstall (Biologists will use it) Tools Available
   - Basic Mechanical, Plumbing, and Wiring Hand-Tools
   - Hand Power Drill
   - Reciprocating Saw (a.k.a. “SawzAll”)

Design Requirements - 3

9. FULL Set of CAD (AutoCAD or SolidWorks) Design and Fabrication Documents
   - Fabrication Dwgs for Machined Parts
     - Material Callout and Finish
     - Full Dimensioning
   - Assembly Drawing
     - Views and Basic Instructions for Assembly
     - Bill of Materials with Part Numbers
   - Electrical/Pneumatic Schematics
10. Project Management
    - Sources of Supply and Catalog No.s for purchased Parts

Design Requirements - 4

10. Project Management cont.
    - Projected Cost excluding Assy
      - Cost for Machine Parts from Chabot Machine Tool Technology Instructors A. Long & M. Absher
      - Purchase Parts from Supplier Catalog or Price-Quote

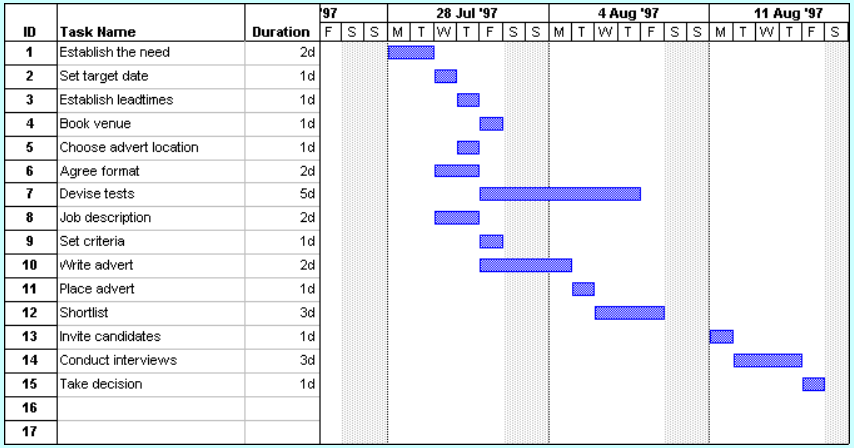
11. Design Analysis & Literature Research
    - Pro's & Cons of Alternative Designs
    - Safe Operation – Mech. & Elect.
    - Force Load Analysis (statics)
    - Corrosion Resistance
    - Possible Failure Modes (FMEA)

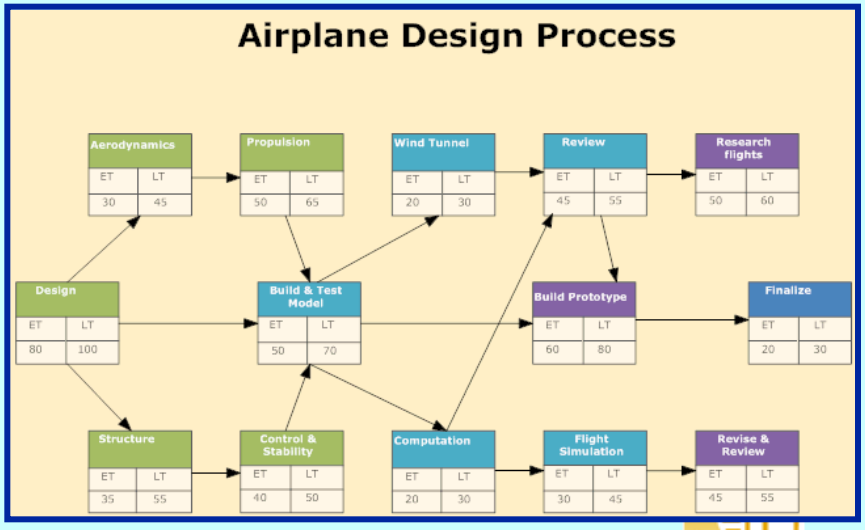
Design Requirements - 5

11. Extra Credit

- Milestone Schedule or PERT Chart
- GDT Dimensioning
  - Must be able to EXPLAIN it
- Written Assy & Test Procedures
- MockUp or Working-Prototype
- User Manual

ID	Task Name	Duration
1	Establish the need	2d
2	Set target date	1d
3	Establish leadtimes	1d
4	Book venue	1d
5	Choose advert location	1d
6	Agree format	2d
7	Devise tests	5d
8	Job description	2d
9	Set criteria	1d
10	Write advert	2d
11	Place advert	1d
12	Shortlist	3d
13	Invite candidates	1d
14	Conduct interviews	3d
15	Take decision	1d
16		
17		





Design Presentations

- Assumes 4 Member Teams: M1 → M4
- Presentations Last 15-20 min
  - Two Members Team Up for Presentation
    - Must Divide Presentation Approx. Equally
- Formal Presentations (as would be given to Management or Customers)
  - Done Using POWERPOINT
  - **Professional** APPEARANCE (dress UP)
- FollowUp → Write Action Item List
  - WHO will do WHAT by WHEN

Design Presentation ➡ CDR

- CONCEPTUAL Design Review (CDR)
  - By Team Members M1 & M2
  - Describe Alternatives Considered
    - Why the Selected Alternative?
      - Identify Risks
  - Concept Drawings and Sketches
  - Likely Materials
  - ROUGH (±15%) $-Cost Estimate
  - Team Member Assignments → Division of Project Effort

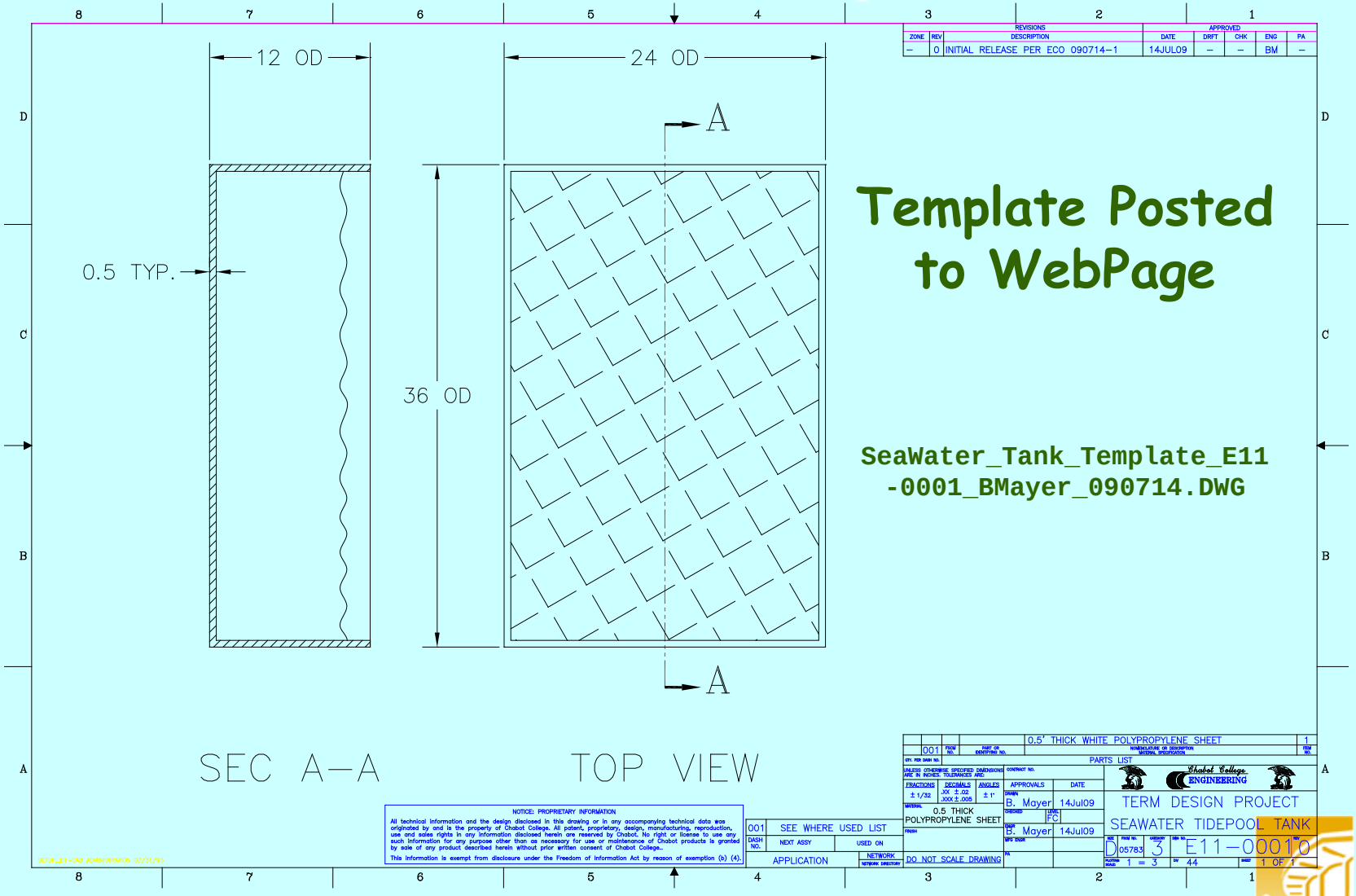
Design Presentation ➡ CrDR

- CRITICAL Design Review (CrDR)
  - By Team Members M3 & M4
  - Detailed Layout and Schematics
  - Engineering Physical Analyses
    - Force/Loading
    - Corrosion/Wear
    - Energy/Power
  - Materials & Component Selection
  - 95+% Accurate $-Cost Estimate

Design Presentation ➡ CrDR

- First-Cut Drawing Package
  - Parts, Assy, Schematic
  - Bill of Material With Part Numbers
  - Sources of Supply for Purchase Parts
    - Phone Numbers of Suppliers
    - Catalog Number for Purchase Parts
- FINAL Cost Estimate to ±5%
- Demonstrate (INSTALL on Tank MockUp)
  - Non-Working MockUp (Std extra credit)
  - Working ProtoType (High extra credit)

AutoCAD Tank Template



Template Posted to WebPage

SeaWater_Tank_Template_E11-0001_BMayer_090714.DWG

Labor & Materials Estimates

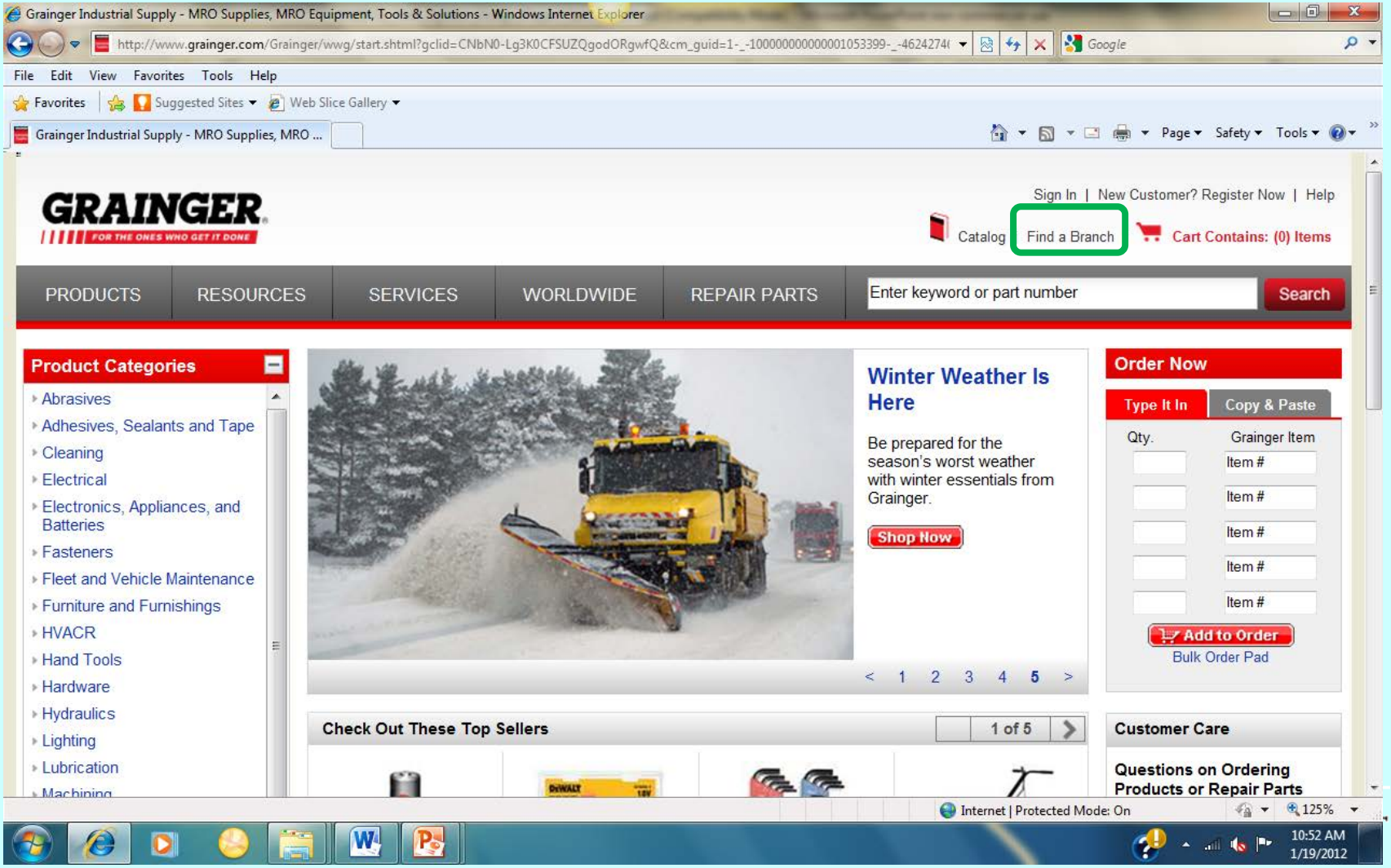
- For Parts Designed by the STUDENT, the Part-Cost will NOT be published.
- Instead the Designer must solicit from Fabricators ESTIMATES or QUOTATIONS for the Cost to Fabricate the Parts
- Material-$ Estimates
  - Find Materials Costs on the InterNet
- Production Labor-$ Estimates
  - Call Fab Shops
  - See During Office Hours MTT instructors
    - Mr. Ashley Long
    - Mr. Mike Absher
  - See B. Mayer
    - Last Resort

Design Resources

- Good Component Catalogs
  - McMaster-Carr (the best)
  - Graingers (Motion Generators – motors)
  - Omega Engineering (Sensors)
  - Newark Electronics (Electrical Elements)
  - PIC Design (Mechanical Elements)
  - Cajon/SwageLok (plumbing & valves)
  - Bimba (Motion Generators – Pneumatic Linear Actuators)

Grainer Branch in Hayward

- Google “Grainger”



Example Schedule

Item	Start	Finish	Task/MileStone Description
1	Wk-01	Wk-02	UnderStand Functional Requirements
2	Wk-02	Wk-03	Form Team
3	Wk-02	Wk-04	BrainStorm Solutions, Select 2-3 for Feasibility Assessment
4	Wk-04	Wk-05	Concept Feasibility Analysis (Pros & Cons); Select Best Concept
5	Wk-05	Wk-06	Select Source-of-Motion; Finalize: Agitator Concept, Mtg to Tank
6	Wk-06	Wk-08	Make AutoCAD Layout, Find Supplier for Source-of-Motion
7	Wk-07	Wk-08	Prep for CONCEPTUAL Design Review – Ref. CDR ScoreSheet
8	Wk-08	Wk-08	**CONCEPTUAL DESIGN REVIEW** (CDR) PowerPoint Presentation
9	Wk-09	Wk-09	Iterate on Design based on CDR “Post Portem” Review
10	Wk-10	Wk-12	Design Control System, Find Supplier for Control-Sys Components
11	Wk-10	Wk-14	Detail-Design and Formal ACAD dwgs for “Piece Parts”
12	Wk-10	Wk-14	Research Suppliers and Select Purchased-Parts; Need Cat. No.s
13	Wk-12	Wk-15	Construct Accurate and Complete Bills of Material
14	Wk-12	Wk-15	Determine Manufacturing Methods, Collect Cost Data
15	Wk-12	Wk-15	Detail-Design and Formal ACAD dwgs for SubAssys & FinalAssy
16	Wk-15	Wk-16	Prep for CRITICAL Design Review – Ref. CrDR ScoreSheet
17	Wk-17	Wk-17	**CRITICAL DESIGN REVIEW** (CDR) PowerPoint Presentation
xtra	Wk-10	Wk-17	Build, Assemble, Test, and Demonstrate ProtoType HardWare

Weekly Reports

- Each TEAM will submit a Weekly Report (WkRpt) on the Dates Listed in the Course Schedule
  - Suggest Team Members Alternate Writing the Reports
- Report Form → Chabot_Engineering_Weekly_Report_Template_0906.doc
  - Posted to WebPage

Weekly Reports

- Report Length → 1-2 pages
  - Appendices NOT included
- Report Content
  - Two Required §'s →
    - Previous Week Accomplishments
    - Plans for Next Week
  - Optional § → Appendix (or Appendices)
- Example Posted on WebPage
  - Weekly_Report_Example_BMayer...doc

Design Project "Deliverables"

No.	Description	Template or Example	Notes and/or Comments
01	**Fabricated-Part** AutoCAD Drawings	Chabot_TitleBlock_D_BMayer_050910.DWG DWGs 96755[3-8] 41 in CaseStudy PPT-file	BoM is ONE item; the Primary Material of construction
02	**SUBassembly** AutoCAD Drawings (if Used)	Chabot_TitleBlock_D_BMayer_050910.DWG DWG 967546 in CaseStudy PPT-file	BoM is multiple parts; can be either ON-DWG or Separate document
03	**FINAL Assembly** AutoCAD Drawing(s)	Chabot_TitleBlock_D_BMayer_050910.DWG DWG 967541 in CaseStudy PPT-file	BoM MUST be a Separate document
04	Electrical and/or Plumbing **Schematic** Drawing(s)	Chabot_TitleBlock_D_BMayer_050910.DWG DWG 967552 in CaseStudy PPT-file	Listed on Final Assembly BoM as a REFERENCE Items
05	**SUBassembly** Bill(s) of Material (if Used)	BoM_PartsList_Template_BMayer_0906.xls 967546_BoM_Drive_Cage_Assy_BMayer_1002.xls	Use Columns A-D in BoM Template
06	**FINAL Assembly** Bill(s) of Material (if Used)	BoM_PartsList_Template_BMayer_0906.xls 967541_BoM_PartsList_Example_BMayer_0906.xls	FINAL assembly BoM MUST be done in spreadsheet form Use Columns A-D in BoM Template
07	ESTIMATED Cost	BoM_PartsList_Template_BMayer_0906.xls	Sum Column-F in the BoM Template
08	Purchased-Part and Supplier **Log**	Engineering_Design_Purchase_Part_Log_ Example_BMayer_0906.xls	Students to DESIGN **Purchased-Part** Numbering system
09	AutoCAD Drawing **Log**	Chabot_Engineering_Drawing_Log_ Example_BMayer_0906.xls	Students to DESIGN **Drawing** Numbering system

Engineering Design Reviews

- Functional Requirements Review (FRR). The purpose of the FRR is to review the functional requirements specification document, to ensure the documented requirements reflect the current knowledge of the customer and market requirements, to identify requirements that may not be consistent with product development constraints, and to put the requirements document under version control to serve as a stable baseline for continued new product development.
- Conceptual Design Review (CDR). The purpose of the CDR is to review the conceptual design to ensure that the planned technical approach will meet the requirements.
- Critical Design Review (CrDR). The purpose of the CrDR is to review the detailed design to ensure that the design implementation has met the requirements
- Final Design Review (FDR). The purpose of the FDR is to ensure that the design is completely and accurately documented and ready for formal release to manufacturing.

Engineering 11

Appendix

MileStone Schedules

Bruce Mayer, PE
Licensed Electrical & Mechanical Engineer
BMayer@ChabotCollege.edu

Design Reviews

- Functional Requirements Review (FRR). The purpose of the FRR is to review the functional requirements specification document, to ensure the documented requirements reflect the current knowledge of the customer and market requirements, to identify requirements that may not be consistent with product development constraints, and to put the requirements document under version control to serve as a stable baseline for continued new product development.
- Conceptual Design Review (CDR). The purpose of the CDR is to review the conceptual design to ensure that the planned technical approach will meet the requirements.
- Critical Design Review (CrDR). The purpose of the CrDR is to review the detailed design to ensure that the design implementation has met the requirements
- Final Design Review (FDR). The purpose of the FDR is to ensure that the design is completely and accurately documented and ready for formal release to manufacturing.

GS³ Visit – Dec00

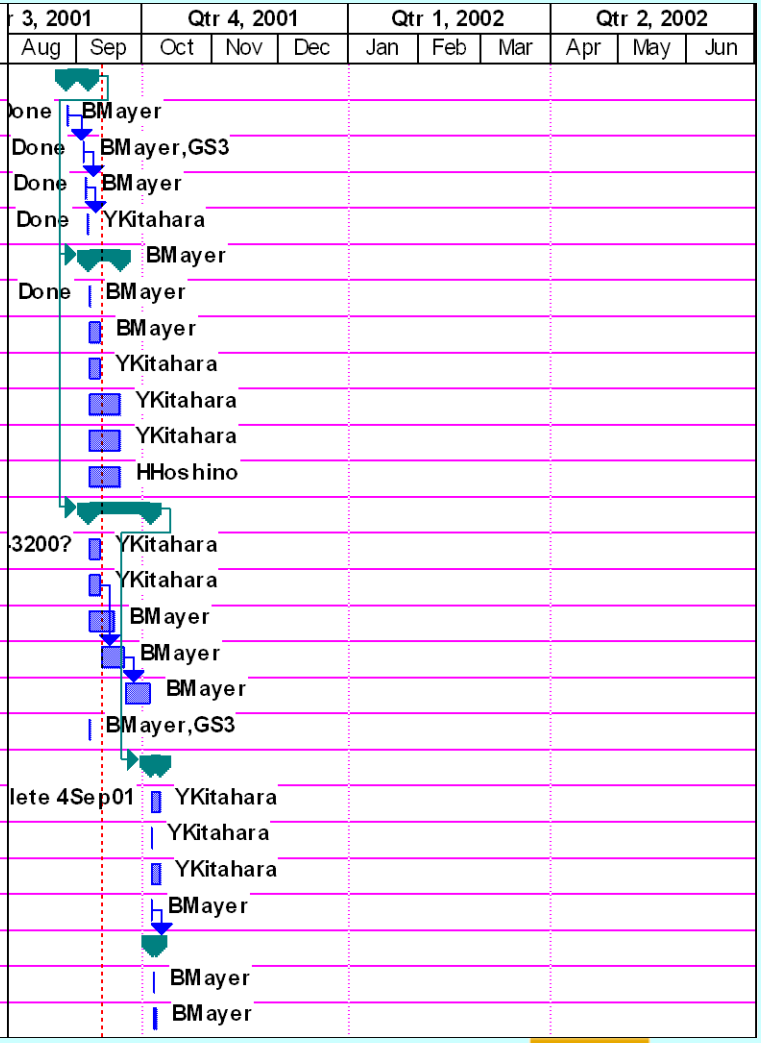
PC030053a

The S2 investigators pose in front of their subject at the conclusion of the inspection. Mr. W. A. on Left. Bruce Mayer on right. Circa Dec00.

S2 Team Inspect Primary Power Box (PPB)

Full S2/S8/CE Compliance – Detailed Schedule

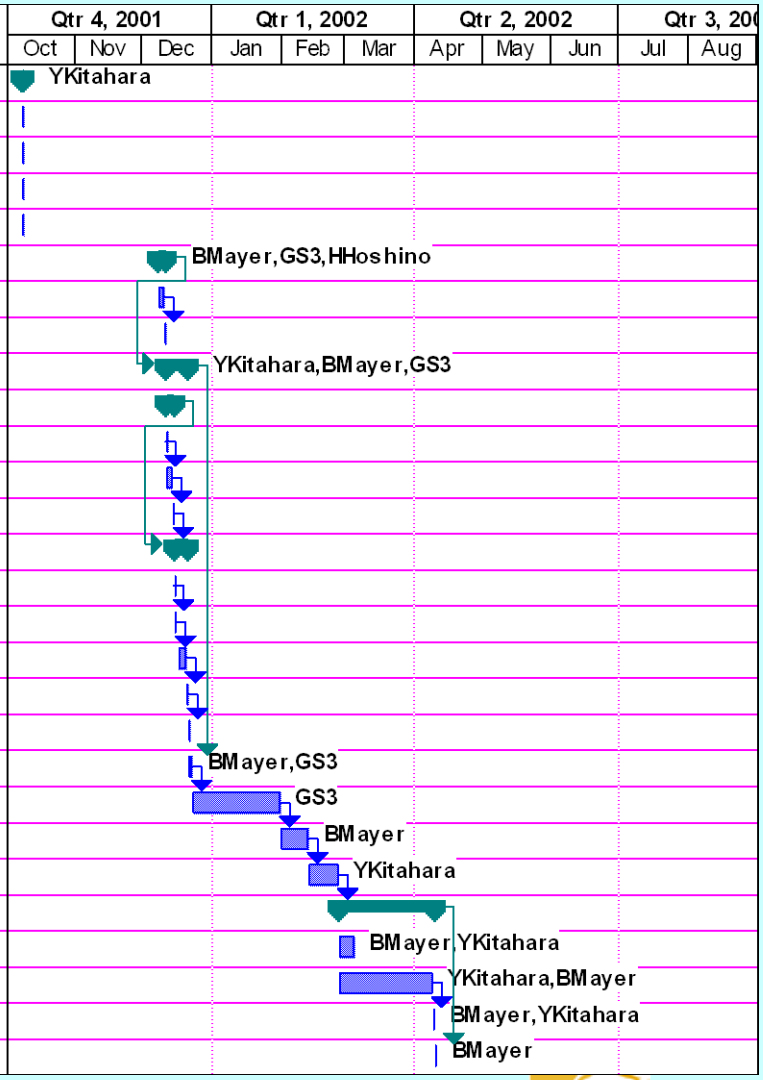
ID	Task Name	Duration	Start	Finish
1	**Preliminary Review & Remediation**	1.6 wks	Tue 8/28/01	Thu 9/6/01
2	Plan Preliminary Review at OTA	1 day	Tue 8/28/01	Tue 8/28/01
3	Conduct Review of OTA-3100	1 day	Tue 9/4/01	Tue 9/4/01
4	Analyze GS3 Report, Inform FIS Team	1 day	Wed 9/5/01	Wed 9/5/01
5	Receive Report, Plan Design Changes	1 day	Thu 9/6/01	Thu 9/6/01
6	**PreLim Review Design Changes**	2.2 wks	Fri 9/7/01	Thu 9/20/01
7	Seismic Measurements	1 day	Fri 9/7/01	Fri 9/7/01
8	Hazard Labeling Plan	5 days	Fri 9/7/01	Tue 9/11/01
9	Electrical Wiring	3 days	Fri 9/7/01	Tue 9/11/01
10	Electrical Components	11 days	Fri 9/7/01	Thu 9/20/01
11	EMO/EPO Controls	11 days	Fri 9/7/01	Thu 9/20/01
12	Instruction Manuals	11 days	Fri 9/7/01	Thu 9/20/01
13	**Plan Full S2/S8/CE Review In Tatsuno**	4 wks	Fri 9/7/01	Wed 10/3/01
14	Determine 3x00 Unit for Testing	3 days	Fri 9/7/01	Tue 9/11/01
15	Determine Target Date for Test-Start	3 days	Fri 9/7/01	Tue 9/11/01
16	Obtain Quotation For GS3 Services	11 days	Fri 9/7/01	Mon 9/17/01
17	Tentatively Schedule GS3 Services	11 days	Wed 9/12/01	Sat 9/22/01
18	Write Req for GS3 Services (Firm Schedule)	11 days	Sun 9/23/01	Wed 10/3/01
19	Make Travel Arrangements	1 day	Fri 9/7/01	Fri 9/7/01
20	**Pre-Review/Test Preparation**	0.6 wks	Thu 10/4/01	Mon 10/8/01
21	Electrical Schematics (>24 V)	3 days	Thu 10/4/01	Mon 10/8/01
22	Plumbing Schematics	1 day	Thu 10/4/01	Thu 10/4/01
23	**List NRTL Status of Safety Critical Components**	3 days	Thu 10/4/01	Mon 10/8/01
24	Instruction/Operation Manuals	1 day	Thu 10/4/01	Thu 10/4/01
25	**SubSystem S2/S8/CE Reports**	0.2 wks	Fri 10/5/01	Sat 10/6/01
26	TDK TAS-300 FOUP LoadPort	1 day	Fri 10/5/01	Fri 10/5/01
27	Rorze 700 Series Robot-Arm	2 days	Fri 10/5/01	Sat 10/6/01



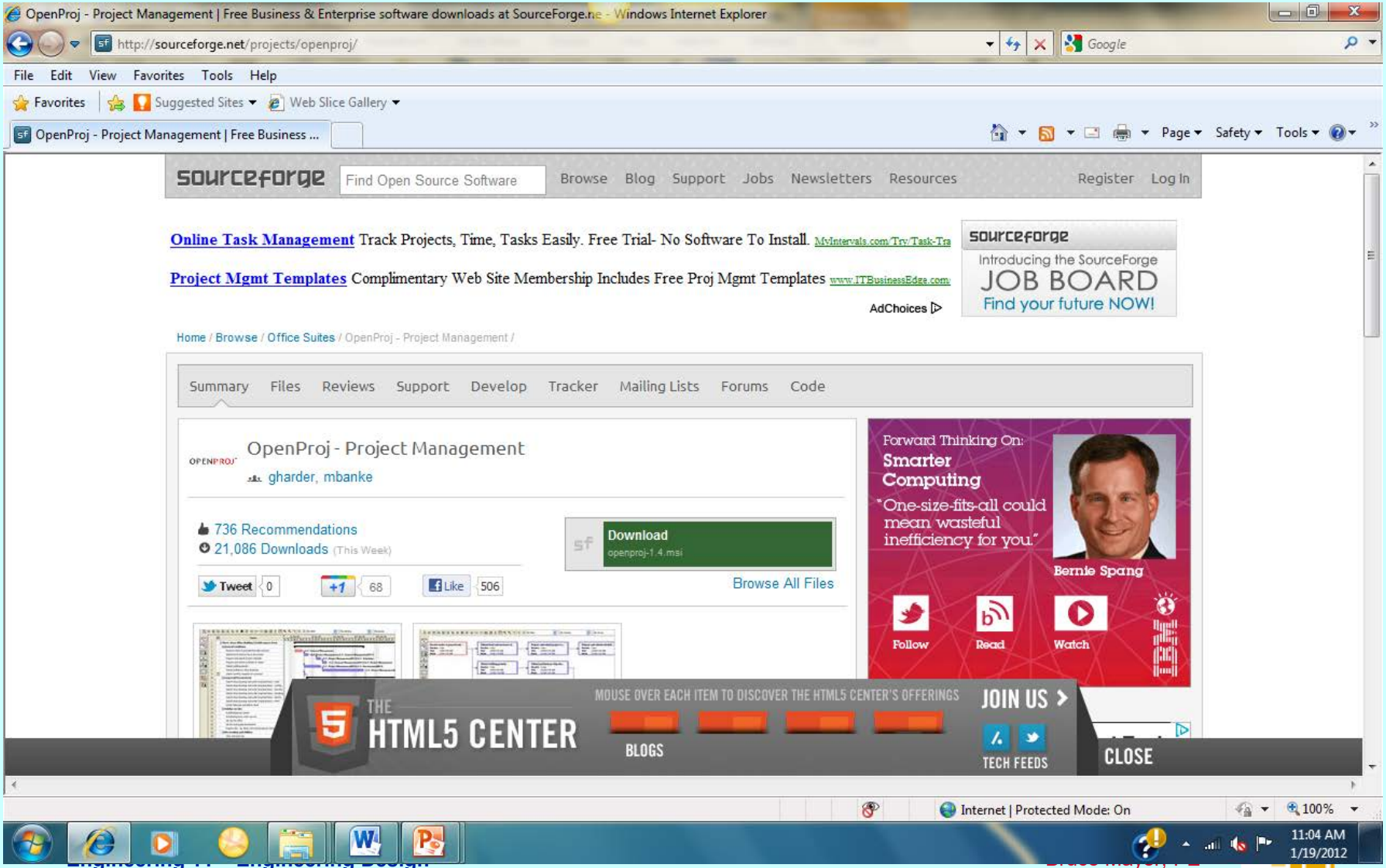
Ref. BMayer file 3100_S2S8CE_0109.mpp

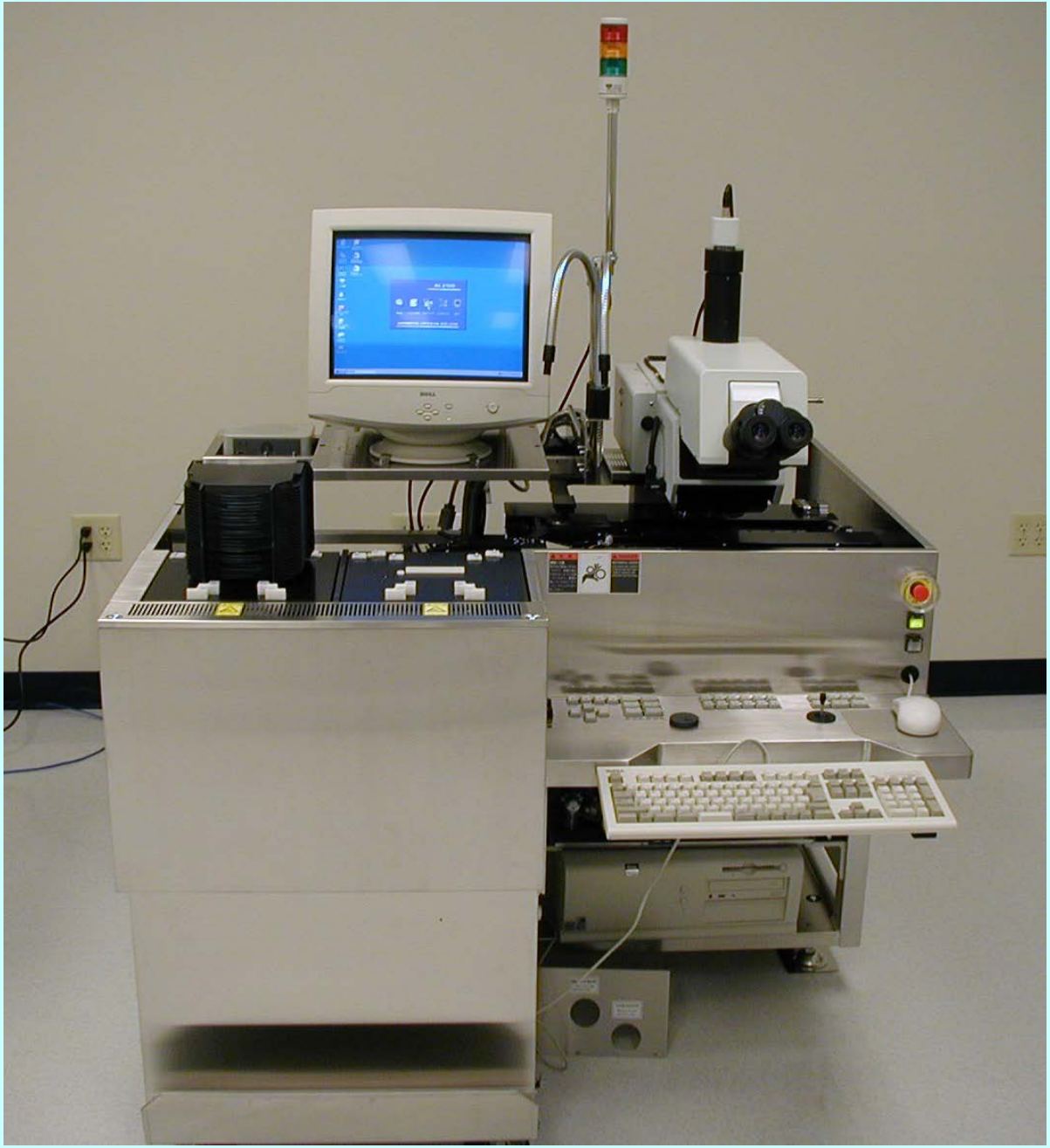
Full S2/S8/CE Compliance – Detailed Schedule

ID	Task Name	Duration	Start	Finish
28	Confirm Design Engineer Availability	0.2 wks	Mon 10/8/01	Mon 10/8/01
29	Electrical/Controls Engineer	1 day	Mon 10/8/01	Mon 10/8/01
30	Mechanical/Plumbing Engineer	1 day	Mon 10/8/01	Mon 10/8/01
31	Mechanical/Automation Engineer	1 day	Mon 10/8/01	Mon 10/8/01
32	System Engineer	1 day	Mon 10/8/01	Mon 10/8/01
33	Travel To Japan	0.6 wks	Sat 12/8/01	Mon 12/10/01
34	Air Travel to Narita/Tokyo	2 days	Sat 12/8/01	Sun 12/9/01
35	Ground Travel Tokyo=>Tatsuno	1 day	Mon 12/10/01	Mon 12/10/01
36	Full S2/S8/CE Testing at FIS in Tatsuno	1.9 wks	Tue 12/11/01	Fri 12/21/01
37	S2/S8 Review & Testing	0.7 wks	Tue 12/11/01	Fri 12/14/01
38	Intro, Task/Plan Review	0.5 days	Tue 12/11/01	Tue 12/11/01
39	Testing, Document-Review	2.5 days	Tue 12/11/01	Thu 12/13/01
40	Summary & Action Items	0.5 days	Fri 12/14/01	Fri 12/14/01
41	CE (EMC/EMI) Testing	1.2 wks	Fri 12/14/01	Fri 12/21/01
42	Plan Test Activities	0.5 days	Fri 12/14/01	Fri 12/14/01
43	Contingency Day	1 day	Sat 12/15/01	Sat 12/15/01
44	Testing<=>Remediation Cycles	3 days	Mon 12/17/01	Wed 12/19/01
45	Summary & Action Items	1 day	Thu 12/20/01	Thu 12/20/01
46	Contingency Day	0.5 days	Fri 12/21/01	Fri 12/21/01
47	Return Travel	1.5 days	Fri 12/21/01	Sat 12/22/01
48	Write Reports	29 days	Sun 12/23/01	Wed 1/30/02
49	Analyze Report	9 days	Thu 1/31/02	Tue 2/12/02
50	Review Report Analysis	9 days	Wed 2/13/02	Mon 2/25/02
51	Remediation Effort (if Needed)	6.2 wks	Tue 2/26/02	Tue 4/9/02
52	Plan Remediation if Needed	6 days	Tue 2/26/02	Mon 3/4/02
53	Implement Remediation Items	38 days	Tue 2/26/02	Mon 4/8/02
54	Remediation Review	1 day	Tue 4/9/02	Tue 4/9/02
55	Write Compliance Report	1 day	Wed 4/10/02	Wed 4/10/02



OpenProject → Free "Msproj"

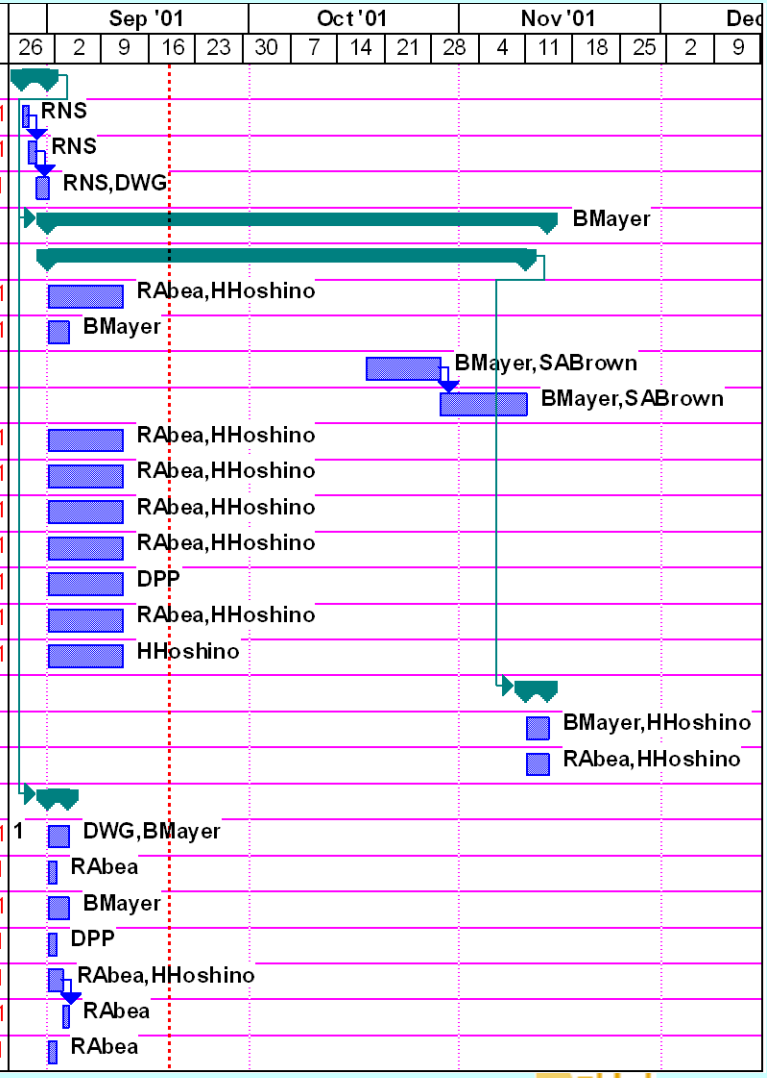




2100 ß-System: Pre Shipment Testing

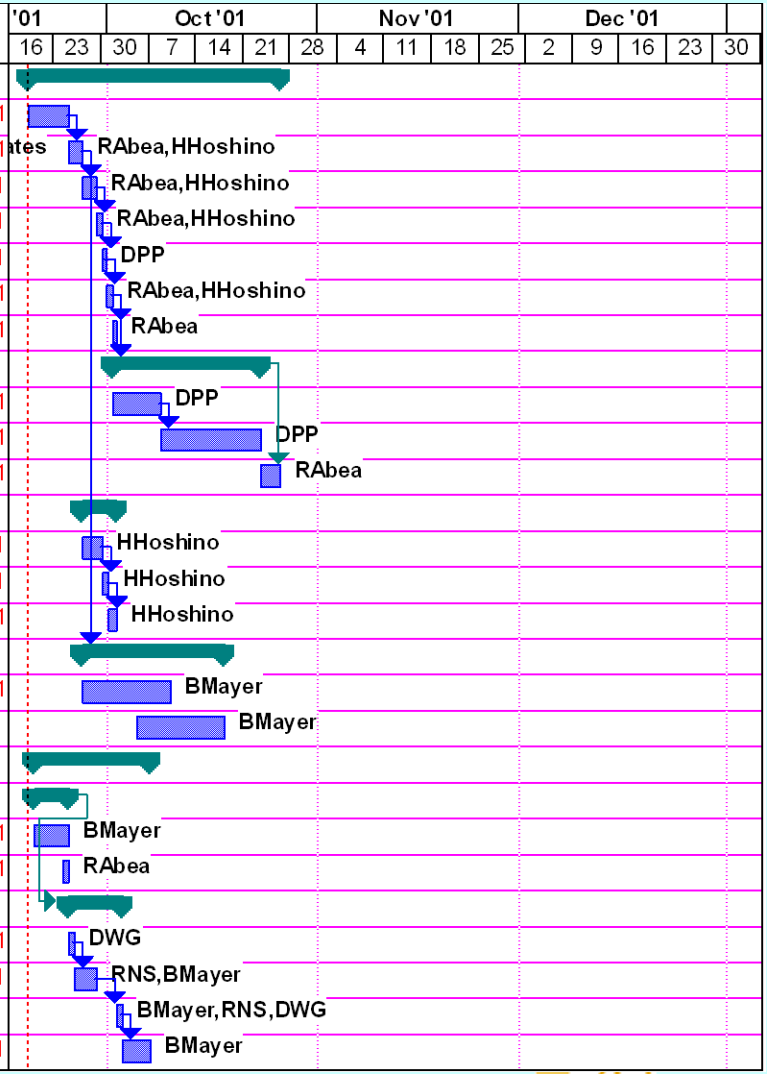
2100 ß-Site Schedule

ID	Task Name	Duration	Start	Finish
1	**Primary Project Decisions**	0.8 wks	Tue 8/28/01	Fri 8/31/01
2	List Project Primary Components	1 day	Tue 8/28/01	Tue 8/28/01
3	Finalize Shipped Unit Configuration	1 day	Wed 8/29/01	Wed 8/29/01
4	Statement of Work (ß-agreement) Signed	2 days	Thu 8/30/01	Fri 8/31/01
5	**Documentation**	14.8 wks	Sat 9/1/01	Tue 11/13/01
6	**Develop Installation Manual**	14.2 wks	Sat 9/1/01	Sat 11/10/01
7	Equipment Install & Facil Requirements	11 days	Sat 9/1/01	Tue 9/11/01
8	Contract with Tech Writer, SABrown	3 days	Sat 9/1/01	Mon 9/3/01
9	**Observe & Doc OTA install**	11 days	Thu 10/18/01	Sun 10/28/01
10	**Write Draft of Install Manual**	13 days	Mon 10/29/01	Sat 11/10/01
11	Equipment Install & Facil Requirements	11 days	Sat 9/1/01	Tue 9/11/01
12	Acceptance & Qualification Check List	11 days	Sat 9/1/01	Tue 9/11/01
13	System Operation Manual	11 days	Sat 9/1/01	Tue 9/11/01
14	System Software Manual	11 days	Sat 9/1/01	Tue 9/11/01
15	Kinemate Software Manual	11 days	Sat 9/1/01	Tue 9/11/01
16	Service & Maintenance Manual	11 days	Sat 9/1/01	Tue 9/11/01
17	Full Parts List	11 days	Sat 9/1/01	Tue 9/11/01
18	**Manual Reproduction**	0.6 wks	Sun 11/11/01	Tue 11/13/01
19	**Paper: Regular & CleanRm**	3 days	Sun 11/11/01	Tue 11/13/01
20	**CD-ROM**	3 days	Sun 11/11/01	Tue 11/13/01
21	**PreShipment Hard/Soft-Ware Prep**	0.6 wks	Sat 9/1/01	Mon 9/3/01
22	Send to OJ 150mm Cassettes PreShip Testing	3 days	Sat 9/1/01	Mon 9/3/01
23	Obtain 150mm Handler-Test Wafers	1 day	Sat 9/1/01	Sat 9/1/01
24	**Obtain 150mm Cassettes for OTA testing**	3 days	Sat 9/1/01	Mon 9/3/01
25	Obtain Kinemate License	1 day	Sat 9/1/01	Sat 9/1/01
26	Prep Lab to accept ON-2100	2 days	Sat 9/1/01	Sun 9/2/01
27	Ensure Lab has enough: Elect, CDA, Vac	1 day	Mon 9/3/01	Mon 9/3/01
28	**Order & Receive R/W CD-Drive**	1 day	Sat 9/1/01	Sat 9/1/01



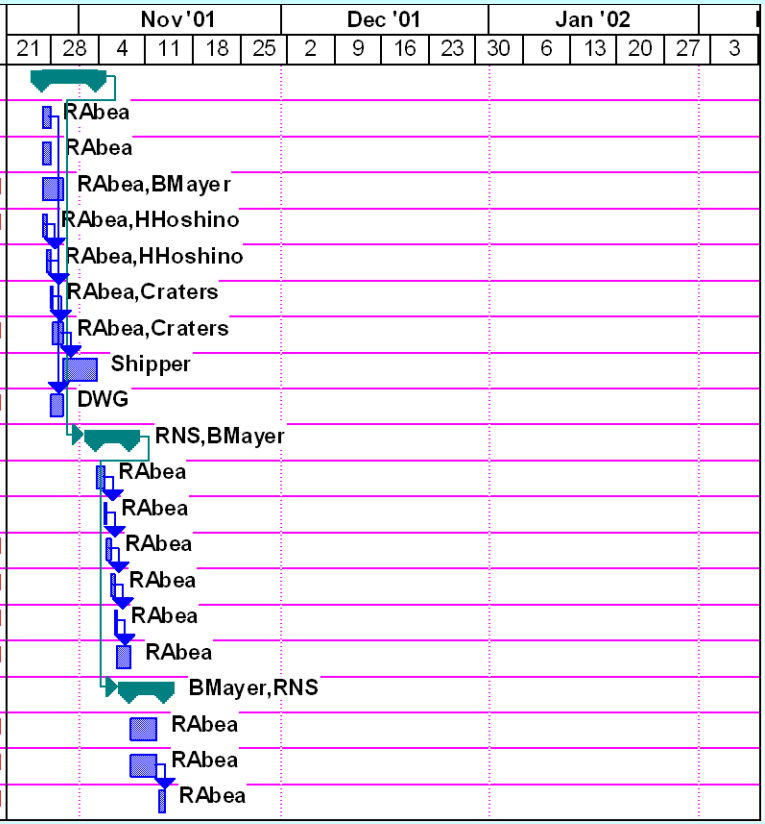
2100 ß-Site Schedule

ID	Task Name	Duration	Start	Finish
29	**OTA-Test ON-2100 Unit**	7.5 wks	Wed 9/19/01	Fri 10/26/01
30	**ON-2100 Ships OT-Japan=>OTA-USA**	6 days	Wed 9/19/01	Mon 9/24/01
31	Receive & Uncrate	2 days	Tue 9/25/01	Wed 9/26/01
32	Move to Eng Lab & Connect Electrical & Plumbing	2 days	Thu 9/27/01	Fri 9/28/01
33	Handler Teaching	1 day	Sat 9/29/01	Sat 9/29/01
34	Write Wafer-Cycling Software Script	0.5 days	Sun 9/30/01	Sun 9/30/01
35	Cycle Wafers	1 day	Sun 9/30/01	Mon 10/1/01
36	**Upgrade Control Computer => R/W CD-Drive**	0.5 days	Mon 10/1/01	Mon 10/1/01
37	**English Software for 150 mm wafers**	4.4 wks	Mon 10/1/01	Tue 10/23/01
38	**Install & Check**	7 days	Mon 10/1/01	Mon 10/8/01
39	**Burn-in: Software testing, Wafer Cycling**	15 days	Mon 10/8/01	Tue 10/23/01
40	**Operational/Applications Testing**	3 days	Tue 10/23/01	Fri 10/26/01
41	**Spare Review at OTA**	1 wk	Thu 9/27/01	Mon 10/1/01
42	Visible cameras	3 days	Thu 9/27/01	Sat 9/29/01
43	Recommended Spare Parts List	1 day	Sun 9/30/01	Sun 9/30/01
44	Others (lamps, etc.)	1 day	Mon 10/1/01	Mon 10/1/01
45	**Facilitization Kit**	4.2 wks	Thu 9/27/01	Wed 10/17/01
46	Installation Documents	13 days	Thu 9/27/01	Tue 10/9/01
47	**Special Tools**	13 days	Fri 10/5/01	Wed 10/17/01
48	**PreShip Site Visit**	3.4 wks	Thu 9/20/01	Sat 10/6/01
49	**Docs: Photos, Spec, Facil-Diagram**	1 wk	Thu 9/20/01	Mon 9/24/01
50	Consider Full Size Mylar CAD layout	5 days	Thu 9/20/01	Mon 9/24/01
51	Docs: print & disk	1 day	Mon 9/24/01	Mon 9/24/01
52	**Visit ON-Semi Factory**	1.6 wks	Tue 9/25/01	Tue 10/2/01
53	Confirm Visit Date with Customer	1 day	Tue 9/25/01	Tue 9/25/01
54	Make Travel Arrangements	3 days	Wed 9/26/01	Fri 9/28/01
55	**Visit Fab, Physical Site Inspection**	1 day	Tue 10/2/01	Tue 10/2/01
56	Write Up Post-Visit Task List	4 days	Wed 10/3/01	Sat 10/6/01



2100 ß-Site Schedule

ID	Task Name	Duration	Start	Finish
57	**Crating & Shipment**	1.6 wks	Fri 10/26/01	Sat 11/3/01
58	Schedule Shipping Truck	1 day	Fri 10/26/01	Sat 10/27/01
59	Schedule Craters (if needed)	1 day	Fri 10/26/01	Sat 10/27/01
60	Photo Documentation of Shipping Prep	3 days	Fri 10/26/01	Mon 10/29/01
61	Wipe Down Unit per CleanRm Protocols	0.5 days	Fri 10/26/01	Fri 10/26/01
62	Bag Unit per CleanRm Protocols	0.5 days	Sat 10/27/01	Sat 10/27/01
63	Make Shipping List (parts & Crates)	0.5 days	Sat 10/27/01	Sat 10/27/01
64	Crate (use original crate if possible)	1.5 days	Sun 10/28/01	Mon 10/29/01
65	Ship to ON-Semi	5 days	Mon 10/29/01	Sat 11/3/01
66	Inform Customer of Exact Ship Date	2 days	Sat 10/27/01	Mon 10/29/01
67	**Install & Set-Up at ON-Semi**	1 wk	Sat 11/3/01	Thu 11/8/01
68	UnCrate & Move to Facility	1 day	Sat 11/3/01	Sun 11/4/01
69	Connect Elect/CDA/Vac Utilities	0.5 days	Sun 11/4/01	Sun 11/4/01
70	Connect all Interconnect Cables	0.5 days	Mon 11/5/01	Mon 11/5/01
71	Install MiniEnvironment	0.5 days	Mon 11/5/01	Mon 11/5/01
72	Handler Teaching	0.5 days	Tue 11/6/01	Tue 11/6/01
73	Operational-Test & DeBug	2 days	Tue 11/6/01	Thu 11/8/01
74	**Acceptance**	1 wk	Thu 11/8/01	Tue 11/13/01
75	Operator Training	4 days	Thu 11/8/01	Mon 11/12/01
76	Acceptance Testing	4 days	Thu 11/8/01	Mon 11/12/01
77	Review & Complete Acceptance Chk List	1 day	Mon 11/12/01	Tue 11/13/01



ON-Semi_2100_0109_DWG.mpp

Submitted by: Morteza Mohsenzadeh
San Diego Mesa College
mmohssen@sdccd.edu

ENGE 101
Around the Flag Pole - Design Competition

Description:

Design and construct a device that will move in one or more circles around a stationary pole/mast that will be provided. The device must be powered only by the materials supplied in the kit.

Materials:

- 5 feet of string
- 2 nails
- 2 water bottles
- 2 balloons
- 1 rubber band
- 1 soda straw
- 1 coat hanger
- 2 feet of tape

Tools:

- Pliers Scissors Construction knife

Rules :

Only the materials provided may be used. This device may only be set in motion by the materials given. At least one component of the device must make one circle around the pole. It must finish with all the material that it begins with intact. The device must be designed and manufactured within 45 minutes.

Contest:

For the contest each group will be allowed two attempts to complete as many circles as possible. The device will be scored according to the following.

Quality of Design: (aesthetic, creativity, etc.)	0 – 5 points
Number of revolution completed	2 points/rev
Bonus: If a team utilizes all the materials provided in a Useful/beneficial manner, and can explain their Design clearly, additional point will be awarded.	0 – 5 points

Judging:

The contest will inspect each device to determine if the contest rules have been satisfied. The number of points awarded for each category including the bonus (if applicable) will be at the discretion of the judges.

Principles:
This contest demonstrates the fundamental principles of force, friction, potential, and kinetic energy, and the conservation of energy. It also emphasizes creativity and collaborative design as the students work in teams to generate a solution to the problem.

Report:
Submit a report by the next class meeting. Explain your Design ideas; include the sketch of your final design.

Submitted by: Ryan Hutcheson
Missouri University of S&T
rhutch@mst.edu

IDE 20 Engineering Design w/Computer Applications

Project (SP12)

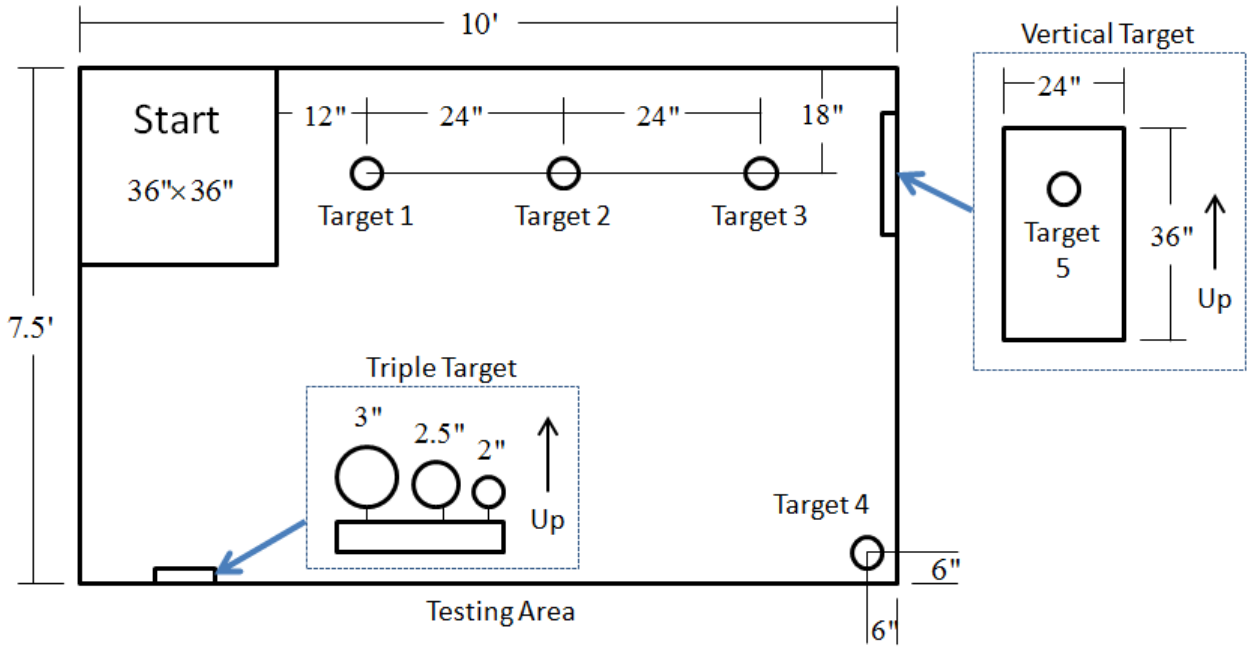
For the Spring 2012 semester, your team is tasked with building a device that projects objects towards a series of targets. Each target will be worth a fixed amount of points (see the Points section). Your objective is to score as many points as possible in a 3 min. period. Rules are as follows:

- Allowable sources of energy are: stored human energy (must be converted and stored within the device during the 3min. period though) and stored electrical energy (batteries)
- All energy sources must be verified to be safe by your lab instructor BEFORE used by your team
- During testing, all team members (and any proxies) must be at least 24″ away from the device
- The device must initially fit within a 36” by 36” rectangular area and be less than 60” tall
- Once activated, the device may go outside of the starting area (if the device leaves the starting area, no additional external energy may be supplied to it)
- Any safety issues are up to the instructor’s judgment
- The maximum allowable voltage in your team’s device is 24V
- If your team uses batteries, a maximum battery mass of 1kg will be allowed
- The maximum projected object mass is 100g
- **The device must be designed and built by your team. Components may be sourced from vendors but must be team assembled. What is and is not considered to be team-built is to be determined by your lab instructor and/or Dr. Hutcheson.**
- It is your team’s responsibility to retrieve any projected objects within the 3min. testing time (updated)

- UPDATE: The objects must be solid and have a volume (convex hull) of >0.065in^3

Testing Area

Below is a rough sketch of the testing area. All dimensions are approximate. The testing area will be made available for measurement during the third week of class.



Points*

- Target 1 – 1 point
- Target 2 – 5 points
- Target 3 – 10 points
- Target 4 – 20 points
- Target 5 – 20 points
- Triple-target – 10, 20, 40

Targets 1-5 will have a nominal inside diameter of 4″. Targets 1-4 will have a height of 6″ and will contain a material to limit bouncing out. All dimensions are approximate. The triple-target consists of three targets. They must be impacted in order, from largest to smallest, in order to score the listed points.

UPDATE: A “hit” is defined as the object being stationary and completely contained within the target (for targets 1-5). For the triple-target, the largest two targets positively lock in a rearward position when hit. The third target releases the other two and resets the triple-target. You may attempt multiple cycles of the triple-target.

**Point values may be adjusted to reflect Alpha prototype scores*

Control

- The device does not need to be automated, external control may be provided remotely, examples of allowable control interfaces include:
    - Strings that can be pulled
    - Electronic switches (low voltage only, <14V)
    - A poke with a stick, etc.
- The device can be “recharged” during testing as long as it is completely within the start area during “recharging”

Grading

- Performance: 60% (based on a linear weight between the minimum functionality criterion and the maximum score)
- Creativity: 20% (based on a creativity metric)
- Aesthetics: 20%
    - Team name on design (6%)
    - Team logo on design (6%)
    - Design is painted or decorated (8%)
- If the device meets the minimum functionality criteria, the project automatically has a minimum of 70% score on performance

Submitted by: Ryan Hutcheson
Missouri University of S&T
rhutch@mst.edu

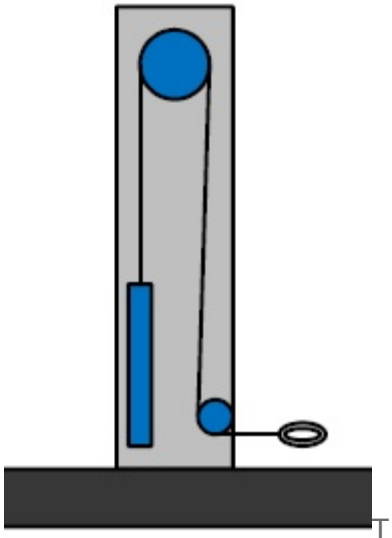
IDE 20 Engineering Design w/Computer Applications

SP ’11 Project Description

Your team is tasked with building a system (the device) that takes energy from a fixed source (the tower) and then supplies this energy to move an object as far as possible in a specified direction.

Rules

- No net external energy may be used to move the object, all energy used to move the object must originate with the energy stored in the tower
- Testing will nominally occur at an outside location on campus, with a slight up-hill grade. Unless otherwise noted, this location will be the empty field south-west of the Puck bordered by Schrenk and Toomey Halls and the Rolla building. The test direction will be North.
- Your team is at the mercy of environmental conditions during testing
- All aspects of your team’s design must be safe, and will be audited by your instructors
- The device does not need to be automated, external control can be used
- During testing, no team member (or proxy) may be closer than 24″ to the testing area
- Your team has three minutes total to test your device, there may be multiple attempts during this period



The Tower (schematic)

The Testing Area (image from Google Maps)

Device Specifications

- The tower will store approximately 50J of energy (5kg weight elevated slightly higher than 1m)
- The tower is currently in the IDE20 shop, G3 IDE
- The device must fit completely within a 48” X 48” rectangle (the testing area)
- **The 48”x48” rectangle will be fixed and marked out on the concrete sidewalk on the southern side of the testing area**

- Your team will be responsible for transporting and storing the device, design it accordingly

Object Specifications

- The object must have a final resting mass greater than 50g and less than 1kg, measured via weight using 9.81m/s^2 as the conversion factor
- Multiple objects may be moved during each attempt
- Different objects may be used during one testing session
- The device and object may be the same physical artifact
- **The object must start at a height beneath the top of the tower (to ensure that the object's potential energy does not significantly affect its motion)**

Testing Sequence

- Your team's **object** is weighed, placed in test area
- The 3 minute timer starts
- The tower weight is raised and secured
- Your team's device is connected to the tower and the object is placed in/on the device
- All team members leave the test area
- The tower weight is released by your team
- Your team's device moves the object (energy from the tower may be converted and stored within the device)
- A team member must locate the object and stand at its final resting location
- Distance to the object will be measured
- Your team may make as many attempts as possible in the 3 minute timed period
- Your team may directly interact with the device (i.e. touch) between attempts as long as the tower weight is in the lowered position and no energy is stored in the device

- After the three minute timed period is up, your team must dissemble/remove your device from the testing area within 30s
- Only distance measurement and project removal may occur after the 3 minute timer expires

Grading

Your project will be graded based on the following criteria:

- Satisfaction of all design requirements/constraints
- Maximum resting distance of object (measured along a pre-defined direction)

Devices meeting minimum functionality requirements will be given a 70% grade. Minimum functionality is defined as:

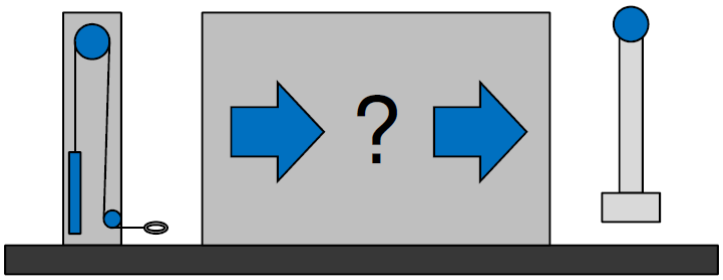
- Meeting all design requirements/constraints
- Projects object at least 10m

Grades between 70% and 100% will be awarded based on a linear weight of object distance between 10m and the farthest moved object between all sections of IDE20. Outliers may be removed from this grade weighting. These rules may be amended by the instructors at any time. Rule changes will be announced in the lecture and posted here.

Submitted by: Ryan Hutcheson
Missouri University of S&T
rhutch@mst.edu

IDE 20 Engineering Design w/Computer Applications

Project (FS10) -- Kinetic Battery



Project Description

Your team is tasked with building a system that stores energy from a fixed source (the tower) and then supplies this energy to move a ballistic pendulum (the hammer).

Rules

- No net external energy may be used, all energy must originate with the energy stored in the tower
- All aspects of your team's design must be safe, and will be audited by your instructors
- The device does not need to be automated, external control can be used
- During testing, no team member (or proxy) may be closer than 24" to the testing area
- Your team's device may not be in physical contact with the hammer until activated after the 10s storage period

Specifications

- The tower will store approximately 50J (reduced from 100J) of energy (5kg weight elevated slightly higher than 1m)
- The hammer will store approximately 50J of energy when pushed back (or pulled) 90 degrees from rest
- Your team has a volume 48″ long, 20″ wide and 60″ tall to work with
- A basic anchoring system is provided consisting of 1/2″ holes drilled every 4″ in the members connecting the hammer and tower

Testing Sequence

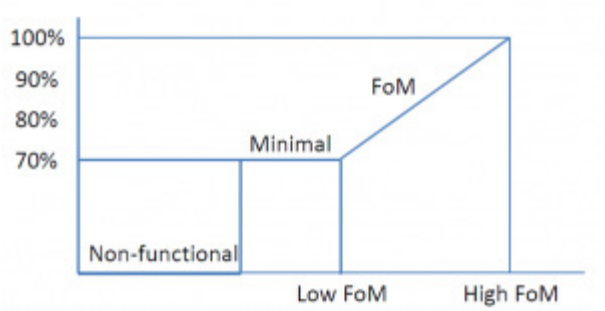
- Your team's device is weighed, placed in test area and anchored
- The tower weight is raised and secured
- Your team's device is connected to the tower
- All team members leave the test area
- The tower weight is released
- Once the weight has stopped moving, a timer is started
- After at least 10s, your team's device is activated
- After activation, your team's device pushes (or pulls) the hammer
- Once the hammer comes to rest, the maximum energy storage will be recorded
- You team removes your device and another team begins testing

Grading

A minimally functioning device meets all competition rules and has stored at least 2J of energy in the hammer during one of the formal testing periods. A minimally functioning device will be awarded a grade of 70%. Grades between 70% and 100% will be awarded based on a linear weighting of figure of merit from lowest to highest. The figure or merit will be calculated as follows:

FoM=1.0*E-0.5*m

- E: Energy stored in hammer (Joules)
- m: mass of teams device (kg)



Submitted by: Ryan Hutcheson
Missouri University of S&T
rhutch@mst.edu

IDE 20 Engineering Design w/Computer Applications

FS '11 Project – Storm the Castle

Objective: Destroy a foam block castle using a fixed source of potential energy.

Castle Tour Video

Rules

- Castle made of 18 blocks, set up in a testing area on the welding table in G3 IDE
- Points awarded for blocks outside of test area after completion of testing period
- Energy source can be either: tower of power (we provide) or 2xD-cell batteries (team-provided)
- Testing period is 3 minutes including set-up/take-down. Multiple attempts are allowed
- If the device meets the minimum criteria, the project automatically has a minimum of 70% score on performance, being linearly graded between the worst design (that met the minimums) and the best designs of the class. So the worst design would get the 70%, the best a 100% and the middle design a 85%.
- **The device must be designed and built by your team. Components may be sourced from vendors but must be team assembled. What is**

and is not considered to be team-built is to be determined by your lab instructor and/or Dr. Hutcheson.

Constraints

- All energy used to move blocks must originate exclusively from one of the two sources, however, the tower of power is only allowed one drop.
- During the setup, the castle must be rebuilt to the GTA's approval. (Same castle for all)
- For safety and reusability, designs are prohibited from having sharp points which may puncture the foam blocks or other people.
- Control of the device must be done from 2ft away, marked by tape on the table.
- The device must fit within 24" by 24" rectangular area and be less than 60" tall
- Any safety issues are up to the instructors judgment.
- The maximum allowable voltage in your team's device is 30V

Control

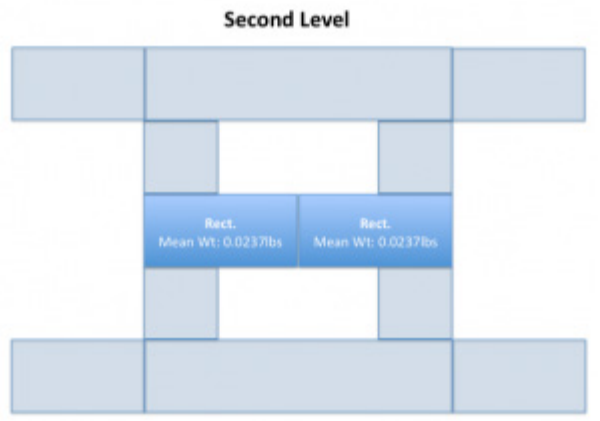
- The device does not need to be automated, external control (information, not energy) may be provided remotely, examples of allowable control interfaces include:
    - Strings that can be pulled
    - Electronic switches (low voltage only, <14V)
    - A poke with a stick, etc.
- During testing, no team member (or proxy) may be close than 24" to the test area (this will be marked with tape on the floor) for reasons of:
    - Safety
    - Ensuring only control, not energy passes to the device

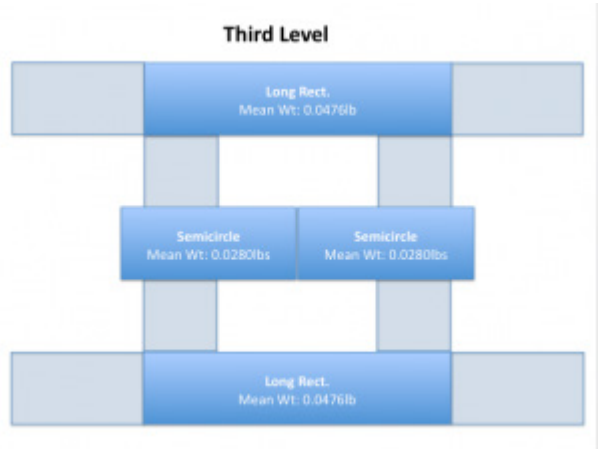
Scoring

- Performance (# of blocks outside of test area) (60%)
    - The blocks must be COMPLETELY out of the testing area to count.

- Originality/creativity (assessed using a functional classification) (20%)
- Aesthetics/style points (20%)
    - Team name on design (6%)
    - Team logo on design (6%)
    - Design is painted or decorated (8%)

Castle Plan and Weight



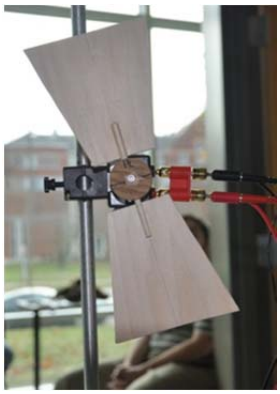
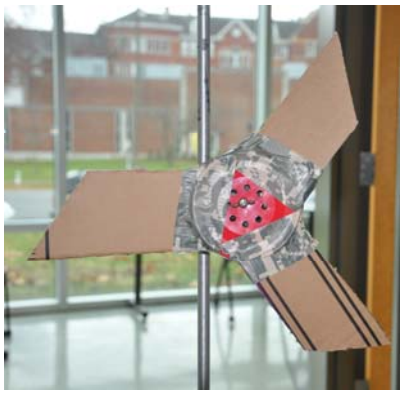


Wind Turbine Design Project

Submitted by: Isaac Wait
Marshall University
isaac.wait@marshall.edu

Freshman Design Project: Wind Turbine

ENGR 104 – Marshall University


Assignment:

Plan, design, build, test, and optimize a wind turbine blade system to fit onto the available Pasco ET-8771A Energy Transfer Generator.

Objectives:

- Maximize power generation for the average of three different wind speeds (high, medium, low)
  - Peak measured voltage and known resistance will be used in the following equation:

$$Power\ (watts) = \frac{(Voltage\ (volts))^2}{Resistance\ (ohms)}$$

  - You must conduct testing that demonstrates effort to optimize each of the following **parameters**:
    1) Blade length
    2) Number of blades
    3) Blade pitch
    4) Resistance setting

    - Testing must be thoroughly documented, as outlined below.
    - For each parameter under examination, you must try at least three different settings (e.g., 'short' blade length vs. 'medium' blade length vs. 'long' blade length; 2 vs. 3 vs. 4 blades; etc.)
    - For each of these parameters, you should test the system's operation at all three fan speeds, and compute the average power generated.
    - You may conduct runs to optimize additional parameters not listed above, such as blade shape, different materials, etc.

Grading:

Each team will receive an "activity score" and a "report score". Scoring will consider:

- Power generated on system test day
- Evidence of design iteration and performance improvement through testing
- Documentation of the testing process – completeness, neatness, and graphs
- Durability and quality of blade construction
- Innovation in design

Report:

On the day of final testing, teams must submit a typed report that includes:

a) A written summary of the brainstorming process, including a brief description and sketch / graphic / photo of initial design concepts that were considered but not ultimately implemented.
b) Recorded data from tests of teams' initial prototypes
c) Graphs of test data, identifying optimal points of operation for each of the four parameters that teams must optimize
d) Prototype photographs during each of the various stages of testing (e.g., photos of all three blade length sizes; photos during 'blade pitch' tests; etc.)
e) A written explanation of how the testing process guided design improvements
f) A log of group meeting times and dates, including time spent and which team members were present at each meeting
g) A brief summary of the work performed by each group member

Date and time of testing:

Team Members Present:

Name of person recording data:

Note: The four parameters to be optimized are: 1) Blade Length 2) # Blades 3) Blade Pitch 4) Resistance Setting

	Fan Setting									
	Low			Medium			High			
Test Conditions (i.e., parameter settings)	Ω	V	P	Ω	V	P	Ω	V	P	Avg P

*** Use multiple data-recording sheets, as needed ****

Sheet # _____ of _____

Instructor Resources Freshman Design Project: Wind Turbine

ENGR 104 – Marshall University

Parts List:

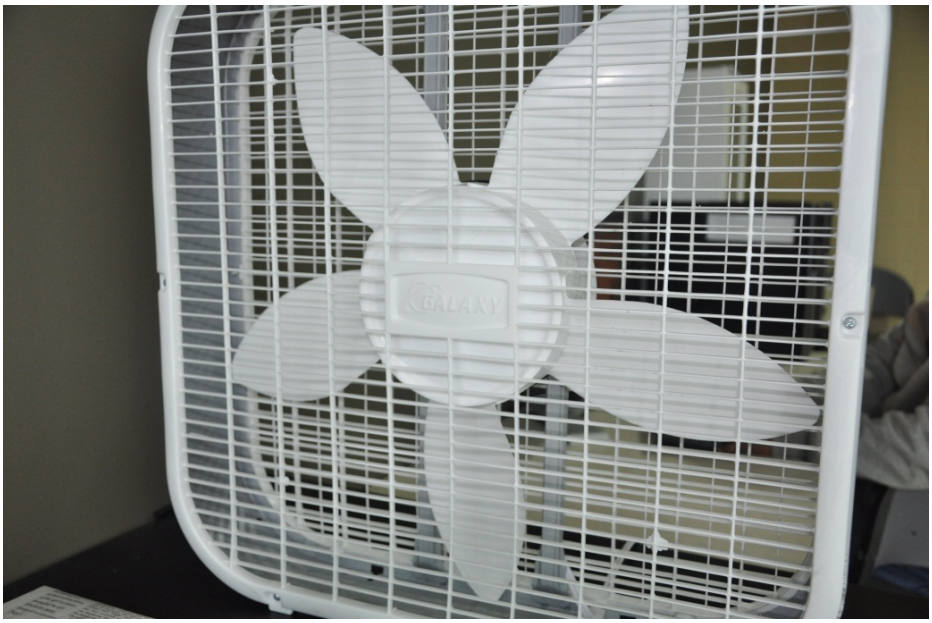


Figure 1 – Three speed box fan

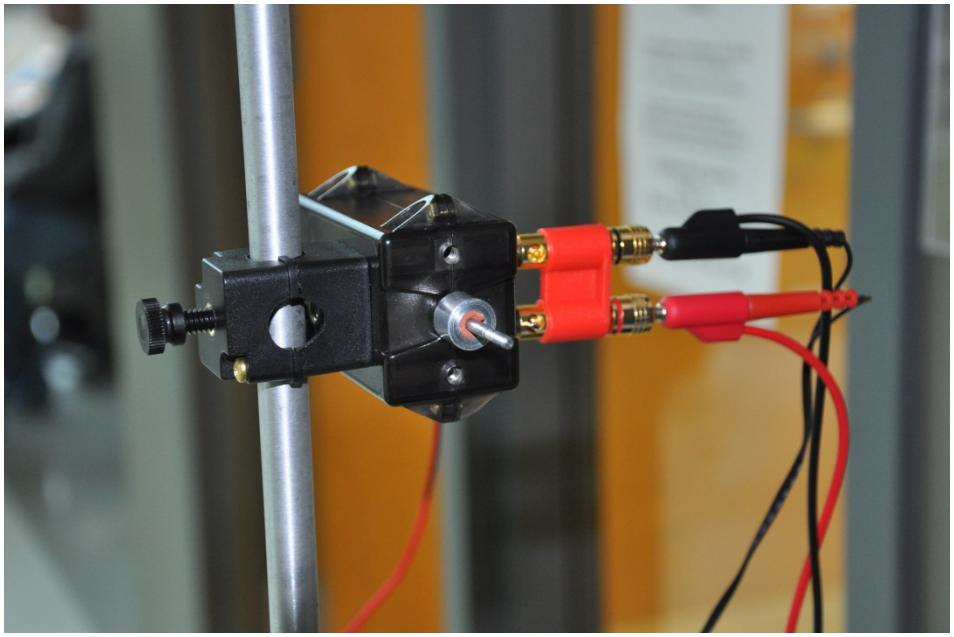


Figure 2 - Pasco ET-8771A Energy Transfer Generator

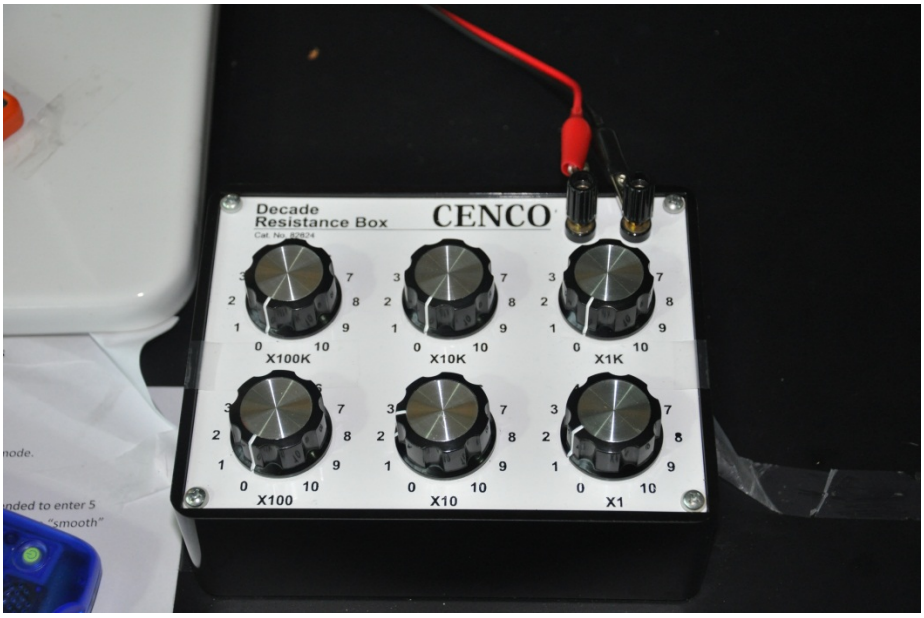


Figure 3 - CENCO Decade Resistance Box, Cat. No. 82824

Figure 4 - Extech Model 430 True RMS Multimeter

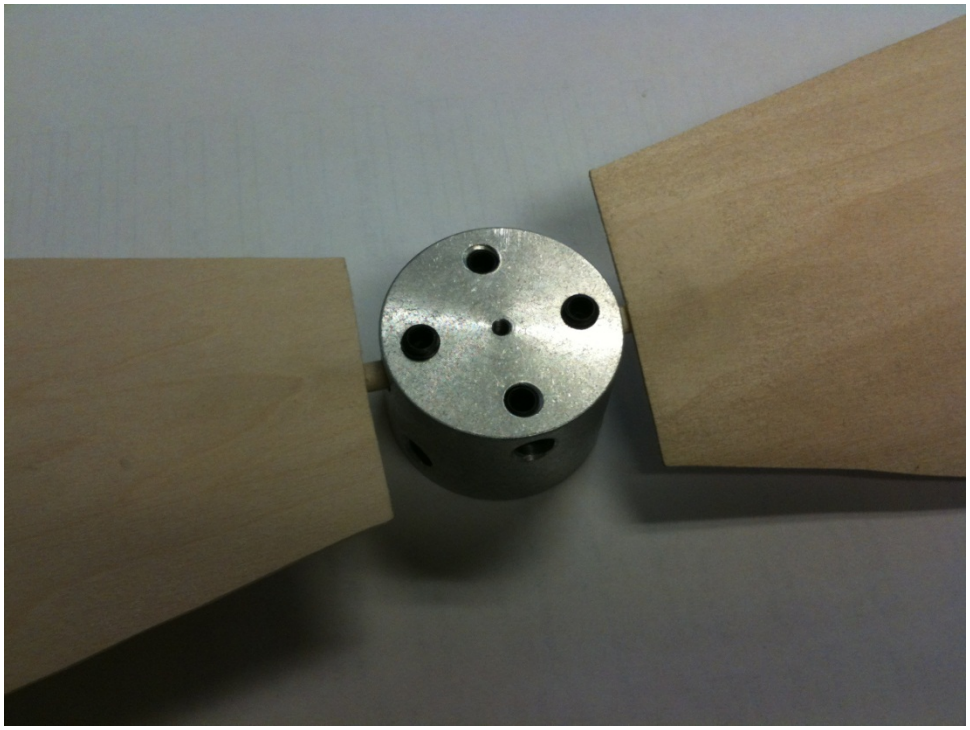


Figure 5 - Custom-machined hub assembly threaded to M3 threads, with openings for 2, 3, or 4 blades.

House of Cards: Design, Optimization, and Teamwork Activity

ENGR 104 – Marshall University

The following activity requires participants to use good planning, team work and engineering problem solving techniques. The overall objective is to design and build a structure that meets or exceeds minimum specifications while maximizing overall profit. The following information explains the specific objectives of the exercise.

Design Constraints:

- Height: Earn $100,000 for building a structure that is 36 inches tall. *Bonus* $2000 per inch above 36 inches.
- Strength: The structure must support 10 pennies a height of at least 36 inches for at least 30 seconds without falling. After this, teams can load additional pennies onto their structure – *Bonus*: $500 for each additional penny loaded.
- Speed: The structure should be built within 25 minutes. Structures built in more than 25 minutes will be charged $2000 for each additional minute. *Bonus*: $1000 for each minute under 25.
- Material costs: 3”x5” index cards are $1000 each, 100 card limit. Tape is $5000 per roll, scissors are $5000 per pair.

Rules:

- Teams will NOT be allowed to purchase additional cards or return cards once construction begins.
- Teams will be charged for the number of cards bought, not the number actually used. (No returns).
- If tape is used, it cannot be affixed to any other structure (i.e., tables, chairs, floor, ceiling, etc.)
- The structure height will be determined by measuring the elevation of the car above the surface upon which the structure is built.

- If failure occurs during loading of additional pennies, teams forfeit the opportunity to earn a strength bonus. In other words, teams should know the capacity of their design prior to the day of competition.

Brainstorming and Planning Sessions:

- Use brainstorming and planning sessions to develop a design plan and list of construction materials.
- During the planning session, each team must decide how many cards they want to "buy" and whether or not they will use tape and/or scissors.
- A typed design plan must be submitted at the beginning of the competition. The design plan is evidence that you actually did "design" and "planning" for this activity, instead of just improvising on the day of the contest. Design plan will be graded for completeness, neatness, and accuracy to actual competition results, and should include:
  1) student names and group number
  2) materials to be purchased
  3) expected structure height
  4) anticipated strength
  5) time required for construction
  6) calculations showing anticipated profit
  7) a basic construction plan (describe how the structure will be built; who will do what)
  8) a dimensioned drawing of the structure that will be built

Profit Calculation

Costs

Cards purchased _____ x $1000 each = _____

Rolls of tape used _____ x $5000 each = _____

Pairs of scissors used _____ x $5000 each = _____

Time used beyond 25 minutes _____ x $2000 each = _____

Total Costs: _____

Revenue

Successfully built structure (Yes = $100,000 No = $0) _____

Height. Additional height (inches above 36) _____ x $2000 each = _____

Strength. Additional pennies (beyond 10) _____ x $500 each = _____

Speed. Available time not utilized (minutes under 25) _____ x $1000 each = _____

Total Revenue: _____

Total Profit = Total Revenue – Total Costs = _____

Solar Power EFFECT

Submitted by: Isaac Wait
Marshall University
isaac.wait@marshall.edu

Note: Formatting modified from originals for distribution to instructors.

Name: _____ Partner Name: _____

Solar Power EFFECT – Day 1 (Decision Worksheet and Driving Question)

A highway rest-stop between Battle Mountain, NV and Winnemucca, NV is being upgraded to include restroom facilities and vending machines. Because of its remote location, electricity is not available from 'the grid', and solar power is being explored as an alternative.

Driving Question:

- *How much will it cost to install a solar power system at the renovated rest-stop?*

  It will cost $_____ to install a solar power system at the renovated rest stop.

Supporting Questions

- What factors will determine the sizing of a solar power system at this location?
- What information would you need to gather in order to provide a reasonably good estimate of the cost?
- What are some methods that you can use to gather the required information?

- Identify some things that your partner thought of that you initially did not, and briefly explain why they are important.

Journal Questions given to students after this activity:

- *Besides running hair dryers, what other applications could you envision for a solar-charged deep-cycle battery system such as shown in class today?*
- *Do you think that the electricity from a solar-charged battery system is likely to be cheaper or more expensive than what AEP charges for power? Explain your reasoning.*

Note: Formatting modified from originals for distribution to instructors.

Name: _____ Partner Name: _____

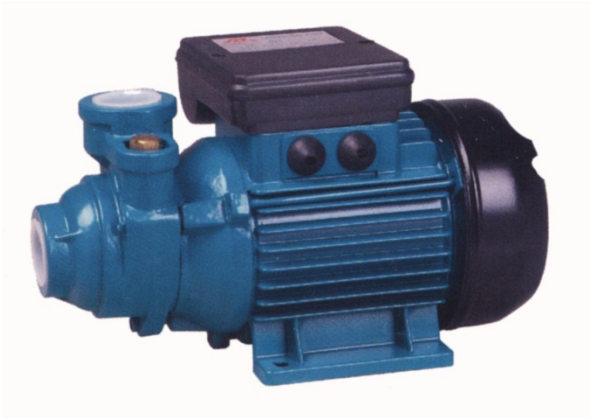
Solar Power EFFECT – Day 2 (Demand Estimation)

A highway rest-stop between Battle Mountain, NV and Winnemucca, NV is being upgraded to include restroom facilities and vending machines. Because of its remote location, electricity is not available from 'the grid', and solar power is being explored as an alternative. *How much will it cost to install a solar power system at the renovated rest-stop?*

Today you will develop an estimate of the electric demands of the system.

You have received the following additional information from the project planners:

- On average, it is anticipated that 1500 people per day will utilize the rest stop.
- There will be three candy and three soda vending machines.
- Water will be provided using a 1.5 hp pump.
- The building footprint is anticipated to be approximately 30 ft x 60 ft.
- Information not specifically provided should be reasonably estimated.



Activity Questions

1. Fill in the table below.

Device	**Volts**	**Amps**	**Watts**
Fan			
Computer			
Hair Dryer			
Air Pump			

What is the relationship between Volts, Amps, and Watts?

2. What fraction of the hair dryer's power requirements are for the fan vs. for the heating elements?

3. If the computer idled 24 hours per day for 1 year, how many kWh would be consumed?

4. How long could the hair dryer run on 'high' if 100 Amp-hours of 12-Volt power was available? (Note: assume 100% efficiency in converting DC to AC.)

5. Make a list of devices in the rest stop that will consume power, and how long you anticipate they will run during the day.

Item	Starting Watts	Running Watts	Running Hours per Day

We estimate the peak electrical requirements for the rest stop to be _____ Watts.

We estimate that the rest stop will consume _____ kWh per day.

Journal Question:

The worksheet from "Day 2 – Demand Estimation" asks you to determine (1) the "peak electrical requirements" (Watts) and (2) the amount of kWh consumed per day.

What are the design implications of these two different figures?

In other words, describe which parts of the electric system will be sized with 'peak requirements' in mind, which parts of the electric system will be sized with the total power consumed (kWh per day), and which parts might be sized with both factors in mind. Explain your reasoning.

Note: Formatting modified from originals for distribution to instructors.

Name: _____

Solar Power EFFECT Day 3 –Inverter Efficiency Characterization

Fan Setting	Heat Setting	Kill-A-Watt Measurement (watts)	Inverter Measurement (watts)	Efficiency
Low	Cool			
Low	Low			
Low	Medium			
Low	High			
High	Cool			
High	Low			
High	Medium			
High	High			

Average Efficiency: _____ %

Activity 3 Questions:

1. At high-fan, high-heat, how many volts, amps, and watts was the hair dryer drawing from the inverter?

2. At high-fan, high-heat, how many volts, amps, and watts was the inverter drawing from the battery?

3. If you were going to run the hair-dryer on high-fan, high-heat for 30 minutes:
   - How many kWh is required?
   - How many Amp-Hours will the hair-dryer consume?
   - How many Amp-Hours will the inverter consume?

The **ampere** is a measure of the amount of electric charge passing a point in an electric circuit per unit time with 6.241×10^{18} electrons, or one coulomb per second constituting one ampere.

The **volt** is defined as the value of the potential difference (voltage) across a conductor when a current of one ampere dissipates one watt of power in the conductor.

One **watt** is the rate at which work is done when one ampere (A) of current flows through an electrical potential difference of one volt (V). (1 W = 1 J/s = 1 N·m/s)

Journal Question:

In class this week we characterized the efficiency of the inverter. Explain how knowing the inverter efficiency will affect your design of other system components, such as (1) the batteries, and (2) the solar panels.

Note: Formatting modified from originals for distribution to instructors.

Name: _____

Solar Power EFFECT Day 4 –Battery Weight, Capacity, and Modeling

Run Time Experiment

Weight of battery (lb): _____

Load Applied[1] (W): _____

Actual run time (min): _____

Power used (kWh): _____

[1]Note: Be sure to account for inverter efficiency

Previously determined demand (kWh required) for the highway rest stop: _____

Previously determined inverter efficiency (%): _____

Part A) Go online, and find six different deep-cycle batteries where the weight and capacity specifications are quoted. Try to get a wide range of data points. Fill the table provided below.

Battery Model	Website	Weight (lb)	Capacity (Amp-Hr)	Capacity (kWh)[2]

[2] Note: kWh = (Amp-hr) x (battery voltage) / (1000 W/kW)

Part B) In Microsoft Excel, perform a linear regression to determine an equation that relates battery capacity (kWh) and weight (lb).

- Create a plot of the data (Select the data, then go to Insert, Scatter…)
- Right-click on one of the data points, and choose “Add Trendline”
- Check “Display Equation” and “Display R-squared”

Part C) Based on the weight of the battery tested in-class:

- What should the capacity (kWh) be according to the equation developed in Part B?
- What is the “Percent Error” between the actual capacity and predicted capacity?

$$\%Error = \frac{Actual - Estimated}{Actual} \times 100$$

Part D) Based on your previously determined demand for the highway rest stop, what is the weight of batteries that will be required?

Journal Question:

What factors, besides a deep-cycle battery's weight, could have an impact on its capacity?

In other words, try to think of things that could impact how much power can be taken out of a battery.

Note: Formatting modified from originals for distribution to instructors.

Name: _____

Solar Power EFFECT Day 5 –Solar Panel Characterization

Panel Characteristics

Length (cm) _____

Width (cm) _____

Quoted Capacity (W): _____ *Measured* Capacity (W): _____

*Identify the **factors** that will influence how much solar panel area is required to supply the electrical demands that you have previously estimated.*

Based on the demonstration and measurements performed today, what data sources could you use to calculate the solar panel surface area that would be required?

What panel area would be required to collect 176.6 kWh per day? Make assumptions and estimate parameters as needed, and identify them clearly as you perform this calculation.

Journal Question

What can be done to adjust the system design to account for the fact that it will occasionally be cloudy at the project site?

Name: _____

Solar Power EFFECT – Final Design of Electrical System

Fill in the blanks and submit calculations that address the following sections:

1. Demand Estimation

Based on the devices that you believe will be used in the rest stop, revise your Demand Estimation calculations in order to take into account the principles that have been illustrated in the active learning exercises, and the corrections that you previously identified as necessary. *Attach calculations and a summary of your demand estimation, and fill in the blanks below.*

Estimated peak electrical requirements for the rest stop: _____ Watts

Estimated power demand for the rest stop: _____ kWh per day

2. Inverter

Based on the peak electrical requirements identified above, go to the following website and select an inverter to be used at the rest stop. http://www.solarelectricsupply.com/inverters.html *Fill in the blanks below, attach a printout of the specifications of the inverter that you have selected, and attach a printout of your numerical model of cost (explained below).*

Inverter selected – Size / Capacity: _____

Manufacturer: _____ Model #: _____

Efficiency: _____

Estimate the cost of this inverter by creating a linear-regression model in Excel with the following inverter price data:

Watts	Cost ($)	Manufacturer
5000	4100	SMA
2000	1680	Magnum
8000	4676	Radian
2000	1277	Exceltech
3000	1188	Samlex
300	241	Morningstar

Estimated Cost of Inverter: _____

3. Batteries

Based on the power demand identified in Part 1, the efficiency of the inverter, the batteries available on this website (http://www.solar-electric.com/batteries.html) and any other factors that you deem important (e.g., extra power storage for cloudy days), fill in the following:

Total battery capacity required (Amp-Hr @ 12 Volts): _____

Battery manufacturer & model selected: _____

Number of Batteries Required: _____

Total Cost of Batteries: _____

Note: attach your calculations for this section.

4. Solar Panels

Based on the estimated power demand for the rest stop (i.e., kWh required per day), the assumption of 15% efficiency for solar panels, and the solar irradiance data provided below, determine the total surface area of solar panels required for the highway rest stop.

Time	Irradiance (W/m^2)
7:00	0.0
8:00	14.6
9:00	86.1
10:00	137.1
11:00	182.7
12:00	201.1
13:00	255.9
14:00	293.7
15:00	302.7
16:00	203.7
17:00	0.0

Total surface area of solar panels required (m^2): _____

Assuming \$375 per m^2, total cost of solar panels: _____

Note: attach your calculations for this section.

Summary: How much will it cost to install a solar power system at this rest stop? _____

Submitted by: Rainer Heller
Seattle Central Community College
Rainer.Heller@seattlecolleges.edu

ENGR 110: Statics
Balsa Wood Bridge Project

What you will have to deliver and when (note: dates are tentative, ask in class for details)

Deliverable/Activity	Points	Due Date
Design Proposal	20	Wed, Apr 29
Bridge Model	30	Wed, May 20
Constructed Bridge (test day)	50	Wed, June 3 or 10 (tba)
TOTAL		**100**

Introduction

Each team (2 students) will design a bridge that will be made of balsa wood and wood glue. The bridges will be modeled and optimized using online modeling software. Teams will then build their bridges out of balsa wood and carpenters glue provided by the instructor. Bridges will be tested to failure and efficiency load will be determined. At the conclusion of the test, each team will briefly perform a failure analysis of their bridge. Each team is free to build more than one bridge.

Design Proposal

Prior to building your bridge, each team will write a design proposal outlining the specifics of your chosen design. Your design proposal must be typed and should consist of the following:

• A list of design constraints and objectives. Use the information listed under the bridge construction to help you come up with a complete list.

Example:

Design Constraint	Description
Materials	Bridges will be constructed with balsa wood and glue supplied by the instructor. Balsa wood will be no larger in cross section than 1/8 inch square.
Span	The bridge must span a gap of 30 cm between two level platforms

Design Objective	Description
Weight of Bridge	Keep the weight of the bridge as low as possible in order to maximize the efficiency loading.
Aesthetics	Bridge should be aesthetically pleasing.

• Sketches and descriptions of at least **three** design concepts for your bridge design.
• One paragraph for each design concept that outlines the advantages and disadvantages of the design, particularly in the context of the structural engineering
• Selection of at least one concept to pursue for your final bridge design and construction.
• A paragraph explaining why you chose the design you did.

Bridge Modeling – Optimizing your Design:

Teams will model their bridges using free online bridge builder software. The software is available at http://www.jhu.edu/~virtlab/bridge/truss.htm. You will want to use the software to model your bridge as closely to the actual design as possible.

Start with the final design presented in your design proposal. Model the bridge you designed and use the software to determine the forces in each member (a scaled version of your bridge is acceptable). Change the design to see what happens to the forces in the members. Use the software to optimize your bridge design. You will probably need to go through multiple iterations of your design. Keep in mind that you want to keep your bridge as light as possible.

Summarizing your finding:

1. Introduction paragraph explaining how you designed your model. Discuss any external loading you applied to the bridge.
2. Include a printed copy of your original bridge design and your optimized bridge design. If you are not able to improve on your design, you will need to show adequate evidence (multiple plots of designs with higher forces in members). For each bridge, show the forces that exist in the members.
3. Include a paragraph explaining the difference between the original design and the optimized design. What are the advantages and disadvantages of the designs?
4. Based on the cross-section of your bridge members, determine the member with the maximum stress in your optimized bridge. Note the location and value of this stress.
5. From your investigation and preliminary calculations, how and where do you expect your bridge to fail?
6. Conclusion: summarize your findings.

Bridge Construction:

A. Design Specifications:

1. The bridge will span over a gap of 30 cm between two level platforms (measuring 5 x 15 x 5 cm) on the test stand. Since the span is 30 cm, the bridge will have to be somewhat longer to rest on the platforms.
2. The bridge supports will only be able to rest on the platforms. No glue or attachments can be made to the top or sides of the test stand. No braces can be placed against the sides of the test stand or extended to the floor.
3. The minimum bridge width is 5 cm.
4. There is no limit on height or distance below the test stand (as long as it will allow enough room for the test bucket of sand under the bridge). However, keep in mind that the bridge supports will only be able to rest on the platforms (refer to #2).

5. The bridge will support a fixed load at the center of the 30 cm span. Since it is not required to support moving loads, the bridge could more properly be termed a structure. No scale path or roadway for movement across the bridge is required.
6. The loading block will support a concentrated load (bucket of sand) at the center of the 30 cm span. You can support the loading block at the top, middle, or bottom of your structure. Refer to the Testing Requirements section for more information regarding the size and position of the loading block.

7. The maximum mass of the bridge should not exceed 30 grams (approximately one ounce).
8. The center span of the bridge cannot deflect more than 2.0 cm below the surface of the platforms.

B. Material Requirements:

1. The materials used in the construction of the bridge should consist only of commercially available balsa wood stock and wood glue. The cross section of the balsa stock can be no larger than 1/8 inch square. No other materials are allowed.
2. The mass of the structure should not exceed 30 grams.
3. Unlimited lamination (bonding together layers of wood) is not allowed.
4. No coating the outside of the bridge with glue or paint is allowed.

C. Performance Goal:

1. The designs will be judged by measuring the maximum load (at failure) supported at the center of the 30 cm span. This number will then be divided by the initial mass of the bridge to determine the efficiency load. The design that has the best efficiency load will be the winner.

Efficiency Load = Load Supported (grams) / Mass of the bridge (grams)

2. The total load supported includes the mass of the bridge, loading block, bucket, and sand.
3. The mass of the loading block and bucket used to place the load on the bridge is not included in the 30-gram bridge weight.

D. Testing:

1. The testing load will be applied using a small loading block that has a bucket suspended below it. Dry sand will be added (by you!) to the bucket at a slow, steady rate until either an audible cracking sound together with visual evidence indicates the failure of some structural member or glue joint of the bridge, or until a suitable reference point on the roadway at the center of the span has been lowered by more than 2.0 cm. All decisions of the judge (instructor) are final.
2. The loading block will be provided by the instructor.
3. This loading block is not part of the bridge structure and is not included within the 30 gram weight limit.
4. The loading block will be placed at the center position of the 30 cm span. It is the designer's responsibility to provide a location to support the loading block.
5. The dimensions of the loading block are approximately 5 x 5 x 2 cm. A chain is attached from below to the center of the plate as shown in the figure. During loading, the 5 cm edges of the loading plate will be parallel to the longitudinal axis of the bridge. The load will be applied by the means of a loading hook hanging from the eyebolt.

E. Tips:

1. Clamp glued pieces for about half and hour (use protective strips to avoid damaging the balsa). If you don't have any clamps, you can use clothespins.
2. Reinforce key joints with balsa plates to increase strength.
3. Design for strength at the load application point.
4. Design a place for the loading block piece (the loading block is not part of your structure) so that the balsa does not crush under the loading block as the weight increases.
5. Check your weight well ahead of time. A good plan is to weigh materials and develop a materials budget. Remember to reserve 15% for glue and extra reinforcement weight.

Submitted by: Rainer Heller
Seattle Central Community College
Rainer.Heller@seattlecolleges.edu

2012 PINEWOODDERBY RULES

General:

G-1.Teams: A team shall consist of one, two, or three racers. It is preferred that racers race in teams of two.

G-2.CompetitorCategories: There will be two categories, student and faculty.

G-3.Attendance: One student from the team must be present to enter their car in the competition.

G-4.SingleEntry: A student team or faculty member may enter only one car in the derby.

TechnicalStandards:

The inspection judges at race-day check-in are responsible to evaluate each car's adherence to the technical standards. Their decision may be appealed to the inspection chairman and the event chairman, who, after consultation with the inspection team and the student team shall render a final, binding decision.

T-1.Material: Race cars shall be constructed for this event from the parts contained in the Official Grand Prix Pinewood Derby Kit as sold by scoutstuff.org. Materials from the kit maybe supplemented but not replaced.

T-2.Weight: Race cars may weigh no more than 5.00ounces (total weight) as determined on the official scales during race day inspection.

T-3.Size: Racecarsmaybenolongerthan 7.00inches,nor widerthan 2.75inches, nor taller than 3.00inches, as determined by the official gages during race day inspection.

Note: Underside clearance of at least 0.38inchesand inside wheel to wheel clearance of at least 1.75 inches is recommended, so that the car will run on the racetrack. Adequate clearance is the responsibility of the race car builder. The center of the track is raised 0.25inches tall and is 1.63 inches wide.

T-4.Body: The wood provided in the kit must be used for the car body. The block maybe shaped or modified any way.

T-5.WeightsandAttachment: Weight may be added to the car and will be considered part of the car for purposes of all measurements. "Weight" is considered to be any material on the car that is not provided in the kit. All weight must be securely fastened to the car, e.g. by permanent glue, nails or screws, but not by "sticky substances", e.g. tape,or tack spray. Weights shall be passive,i.e. non-moveable,non-magnetic,non-electric,non-sticky,etc.

T-6.Wheels and Axles: The car shall roll on the wheels from the kit. The wheels shall turn about the axle nails from the kit. The axle nails shall befirmly affixed tothewood of thecarbody.The axle dimensionsmaynotbechangedsubstantially.The outside surfaceof theaxle head(the non-contact surface)maynot bechanged substantially, suchas,by polishing.Itmustbe obvious tothejudgesthat thewheelsand thenails fromthekit arebeingused.

The following may NOT be used in conjunction with the wheels or axles: hubcaps, washers, inserts, sleeves, bearings.

The wheels may be shaped or modified any way that is desired as long as material is not added to the wheels. The words "Official B.S.A. Made in U.S.A." and other lettering on the wheels shall remain intact and clearly visible to the inspector on the inside and outside of thewheels. The original "tread" on the front of the wheel face must be present, i.e. apparent to the inspector.

T-7.GravityPowered: The racecar may not be constructed or treated in such a way that the track's starting mechanism imparts momentum to the car.(For instance, this provision disqualifies cars with sticky substances on the front of the car and protrusions which may catch on the starting pin.)

T-8.Lubricants: Only "Hob-E-Lube" brand dry graphite lubricant with molybdenum will be allowed. This can be ordered online or purchased from local hobby stores or

Michaels.

T-9.Staging: The entire car must stage behind the starting pin. The car cannot contact the starting pin at a height greater than 1.38inches from the track.

T-10.Body: The car body may have no moving parts.

T-11.FrontofCar: The front of the car should be designed so that it will trip the electronic timing sensor at the finish line. The sensor will be located in the center of the lane.

ConductoftheRaces:

Track officials are responsible for the proper conduct of the races. Decisions of track officials on questions of rules interpretations and procedure may be appealed to the event chairman. Decisions of track officials on questions of fact may not be appealed beyond the track chairman.

C-1.InspectionGages: All inspection will be conducted by one team at a special inspection area using scales and gages approved by the Chairman.

C-2.Modification: If a car does not pass inspection it may be modified and resubmitted for inspection up until the inspection table closes.

C-3.Impounding: Once the car has passed inspection and received its number sticker, the car will be placed on the impound table. A car may not be lubricated or otherwise improved after being placed on the impound table.

C-3.Car Handling Responsibility: Student teams shall be responsible to stage their own cars at the starting line, to retrieve their cars at the finish line (after the race has been called)and return their cars to the pit after their heat is finished. If, In the opinion of the track chairman, a student's physical limitations prevent him/her from fully complying with this requirement, the student may nominate an assistant who serves subject to approval of the track chairman. In any case, the student shall participate up to his/her limitations.

C-4.LaneAssignment: Lane assignment for each heat shall be determined by lot.

C-5.Car Repair: If, during the race, a wheel falls off or the car becomes otherwise damaged, then the racer will be given two minutes to complete the repairs before the car is returned to the impound area. The racer may not use any additional materials such as glue or adhesive to repair his or her car.

C-6.Car Interference: If, during a race heat, a car leaves its lane and, in so doing, interferes with another racer, then the car at fault shall be declared to have lost the race heat.

C-7.Car Leaves Lane: If, during a race heat, a car leaves its lane but proceeds down the track in a manner that does not interfere with its opponent, then the race will be called normally.

C-8.Car Leaves Track: If, during a race heat, a car leaves the track without interfering with its opponent, it shall be considered to have ended its heat at that point.

C-10.NoFinishers: If, during a race heat, a car does not finish the race it will be awarded a time of 9.999seconds.

Track Specifications:

We will be racing on a 48-foot Freedom Track made by Pinewood derby track.com. We will be using a Microwizard timing system.

The following table summarizes the track profile.

HCC Track Data

Location on Track	Horizontal Distance (in)	Vertical Height (in)
Start pin	0.0	44.0
	1.6	43.1
	11.6	37.2
	21.6	31.5
	31.6	26.2
	41.6	21.3
	51.6	16.6
	61.6	12.7
	71.6	9.4
	81.6	6.6
	91.6	4.4
	101.6	2.6
	111.6	1.4
	121.6	0.5
	131.6	0.1
	141.6	0.0
	151.6	0.0
	161.6	0.0
Start of Section3	171.6	0.0
Start of Section4	265.6	0.0
Start of Section5	359.6	0.0
Start of Section6	453.6	0.0
Finish	535.6	0.0

Race Format:

The race will be conducted using the following racing format.

RF-1.Round One Race Format: Each car will be raced 2 times in each lane. Cars will be paired using a Perfect-NType Scheduling such that no car will race against the same car twice. The total time for all four races will be tabulated.

RF-2.Championship Round Selection: The three cars with the lowest cumulative times will advance to the Championship Round. A tie for third place will be decided by a coin toss.

RF-3.ChampionshipRoundRace Format: In the Championship round cars will be raced head to head once in each lane using the following schedule. Racers will draw the letter designating their lane assignments.

Championship Race Matrix

Race	Lane1	Lane2
1	A	B
2	A	C
3	B	C
4	B	A
5	C	A
6	C	B

RF-4.Championship Round Scoring: Cars will be awarded one point for each win and zero points for a loss. The car with the most points will be awarded first place and the car with the second highest number of points will be awarded second place. The car with the lowest number of points will be awarded third place. In the event of a tie, the car with the lowest cumulative time for the championship round will be declared the winner.

Submitted by: Mason Hansen
Itasca Community College
Mason.Hansen@itascacc.edu

INTRODUCTION TO ENGINEERING

Fall 2012 Project 1: Medical Supply Drop Device

Scenario:

A non-profit organization has contacted Itasca Engineering to submit a design proposal for a device that can protect fragile medical supplies (e.g. glass medicine vials) and sensitive electronic equipment for emergency airplane drops to relief workers. The medical supply drop device could be used during relief efforts for natural disasters, remote villages, etc. Each team's design will be evaluated against the organizations given design criteria.

Parameters:

To simulate these needs, you team will be designing a medical supply drop device that will:

- Protect a $400 dollar data acquisition unit and accelerometer
- Be dropped from the Mount Itasca Ski Jump (~80')
- Be constructed from readily available ("off the shelf") items. These items will be purchased at L&M Fleet Supply in Grand Rapids or be available in large quantity as a recycled item.
- Be ready for testing on Friday, September 7th
- The device must be able to be released from the plane (ski jump) without any connections and cannot incorporate the use of a zip line. This would be an unreasonable risk when used with a plane.
- The device must have a cargo capacity that can contain the approximate 4" x 11.25" x 13" data acquisition unit storage box. The device must allow the storage box to be inserted just prior to the drop and removed immediately after the drop.

Design Criteria: See the following rubric for specific details

Scored Criteria:

- Ability to hit the drop target (~1m^2)
- Minimal volume due to space constraints on airplanes
- Minimal weight due to lift capacity
- Minimal cost ($5 max while readily recycled materials are considered free (ie. cardboard, water bottles, etc.))
- Ease of manufacturing
- Provides a soft (minimal deceleration) impact when dropped from a minimum height of 80 ft to protect the contents

Medical Drop Scoring Rubric

2012 Introduction to Engineering

- Minimal environmental impact (ie. made from reused or recycled materials? reusable on the ground? biodegradable?)

Graded Criteria w/ associated weight	1 point (poor)	4 points (ok)	7 points (decent)	10 points (great)
Small Volume (x2) (Respective to class)				
Low Impact (x3) (Respective 'g's to class)				
High Accuracy (x2) (Distance from target respective to class)				
Low Environmental Impact (Biodegradable/Reusable)				
Low Cost and Easy to Make(Mason's discretion)				

TEAM SCORES OUT OF 90: _____ _____ _____ _____

_____ _____ _____ _____

This rubric is for competition purposes only.
Your group report will dictate your grade on this project.
See Mason with any questions.

Walk-On-Water Project

Submitted by: Matthew McGarry
University of San Diego
mmcgarry@sandiego.edu

The University of San Diego Walk-On-Water Competition is a design competition for self propelled buoyancy shoes.

USD Walk-On-Water Official Rules

The University of San Diego Walk-On-Water Competition is a design competition for self propelled buoyancy shoes. Original and innovative designs are encouraged. As such, minor modifications of items such as boats, surfboards, body boards, etc. are not within the spirit of the competition. The following rules govern the competition:

1. Each entry must consist of two separate and mirror image buoyancy shoes, not to exceed 8' in length, such that one person can operate and control the shoes using only his or her feet. External propulsion devices are prohibited. This is a human powered apparatus.
2. All materials are allowable; however, shoes designed from recyclable materials are encouraged. Acceptable recyclable items are defined as those items found in the "Recycling Guide" provided by Waste Management of San Diego for the City of San Diego Recycling Program.
3. Expenditures for each team shall be limited to $100.00. Estimated value of donated materials shall be included in the total.
4. A slalom course must be traversed from one end of the pool to the other. The shoe pilot must maneuver around two floating "flags", placed at approximately 1/3 and 2/3 the length of the course.
5. The "shoe-pilot" will be required to maintain a vertical position above the shoes at all times.
6. No supports or secondary assist devices (poles, ropes, rods, etc.) may be used by the pilot to maintain the required vertical stance.
7. The shoes cannot in any way engage any part of the body above the knees.
8. The pilot will put the shoes on at the water's edge. A support team of up to six people may assist in the application of the shoes and in the transition from sitting to the officially sanctioned vertical position. Once vertical, no assistance may be offered until the pilot arrives at the far end of the swimming pool.
9. The starting line is either when the backs of the shoes are in contact with the starting edge of the pool or when the front of the shoes is 8' from the starting edge of the pool.
10. The competition is tentatively divided into the following categories:
    - High school students.
    - College students.
    - Industry and other community participants.
11. Each team will participate in a series of races within their division with the fastest crossing times used to determine the winning team of each category. Further guidelines concerning the advancement of teams will be presented on the day of the event.
12. All participants are required to fill out and complete an official entry form, which must be returned to Walk on Water, USD, Department of Engineering, 5998 Alcalá Park, San Diego, CA 92110 (FAX 619.260.2303) prior to 12:00 p.m. on Friday before the competition. The event will start at 10:30 AM at the USD pool. Industry participants and professional engineers must submit a twenty-five dollar entry fee along with their application form.
13. Safety guidelines will be provided to each entry. The guidelines must be strictly followed. Failure to comply with the safety guidelines may lead to disqualification. Lifeguards will be in the water at all times and will be available to assist "we t" shoe-pilots. A mechanism for quick release of the shoe pilot from the buoyancy shoes is mandatory.
14. Penalties for rule infractions include:
    - 5 second penalty for every dollar over $100 limit.
    - 30 second penalty for every inch over 8'.
    - 60 second penalty for safety violations.
    - 60 second penalty for attaching buoyancy shoes together.
    - 60 second penalty for not maneuvering around a flag.
    - 60 second penalty for attachment above knees.
    - 60 second penalty for secondary assist devices.
    - 10 second penalty for touching shoe.
    - Disqualification for infraction of propulsion rule
    - Disqualification for aid to shoe pilot while traversing the pool.
    - Disqualification for use of boats, surfboards, body boards, etc.
15. The rulings of the judges are final. There are no appeals.

21st Annual USD Walk-On-Water Competition

OFFICIAL ENTRY FORM

Team/Shoes' Name: _____
Organization or School:_____
Advisor (if High School Entry): _____

Team Captain:
Name: _____
Address: _____
City: _____ State: _____ Zip: _____
Telephone Number: _____

Other Team Members:
Team Member: _____
Team Member: _____
Team Member: _____
Team Member: _____

Entry Data:
Approximate Volume of Shoes: _____
75% By Volume Recyclable Materials? YES NO
Approximate Weight of Pilot: _____
Total Cost of Materials: _____

Please note that a realistic estimated cost of any donated materials must be included in the total.
By signing below, you (or your parent or legal guardian if you are under age 18) agree that USD may use your name, photographs or video of you, and information about you for publicity, promotion, advertising or other legitimate purposes relating to the Walk on Water Competition.

If the shoe pilot is under 18 years of age, please indicate parent or guardian:
Name: _____
Address: _____
City: _____
Signature of Parent or Guardian: _____
Telephone Number (local number during event):_____

Please submit entry to:
Walk on Water
USD Department of Engineering
5998 Alcalá Park, San Diego, CA 92110
(FAX 619.260.2303)

Entries are due by Thursday, April 19, 2012.

The event will take place on Saturday, April 21st, 2012 starting at 10:00 AM at the USD pool. Contestants may arrive at 9:00 to prepare and practice.

Submitted by: Matthew Eyre
Delta College
mattheweyre@delta.edu

BRIDGE DESIGN PROJECT

The objectives of the project and competition are to provide students with the opportunity to participate in an engineering team-oriented hands-on design and construction project. Your team is competing with others for the contract to design and build a new bridge in a high profile location. The client placing the order will be visiting today and your team has been asked to develop a model to demonstrate your proposed design. The client will judge the competing designs on the basis of:

- Strongest Bridge - The maximum load it can support at mid span
- Maximum Failure Load to Weight Ratio - The maximum load divided by the weight of the bridge (a measure of efficient use of materials)
- Most Creative Design
- Lightest Bridge
- Aesthetic appeal
- Most Accurate Prediction of Failure Load
-

1. DESIGN REQUIREMENTS

- The bridge must span a gap of 20 cm
- The deck (walkway) width must be 5 cm
- The bridge must be of a single span design
- Glue should be used only to join components
- Use light sandpaper (number 150 or higher) to gently clean your bridge and remove excess glue
- Do not cover your bridge with any material such as paper or fabric.
-

2. MATERIALS

- Balsa wood
- Elmer’s Carpenters Glue
-

3. EQUIPMENT

4. PROJECT PROGRAMME

0.00 Introduction to Design Task
0.10 Introduction to Bridge Design
0.30 Design Session
1.10 Construction Session
3.10 Test Session

3.30 Close

Bridge Building Tips

- Use a small balsa wood saw (about $3) instead of an exacto knife to make cuts
- Cut small notches to connect bridge components
- Use a basic carpenter's glue
- Yellow glues contain aliphatic resin, used in the majority of winning bridges
- Fewer pieces mean fewer problems
- Keep pedestals (feet) simple
- Clamp glued pieces for about half an hour (use protective strips to avoid damaging the balsa). If you don't have any clamps you can use clothes pegs. C-type clamps are available quite inexpensively at Canadian Tire
- Design for strength at the load application point
- Construct roadway of thin, narrow strips of balsa
- Don't glue down ends of road ways…they usually bend upwards under load
- Use minimal support under roadway, except at load application points
- Roadway must support a small Hot Wheels-type car
- Most bridges bend inwards (as viewed from one end); consequently they require horizontal bracing
- Write your team number prominently on a main horizontal beam of your bridge and on both sides of the bridge
- Double check that a 40 cm-long board will fit between the pedestals (feet) of your bridge
- Double check that a 5 cm cube will fit underneath your bridge and along your roadway. You can make a nearly perfect 5 cm cube from Lego bricks
- Do not cover your bridge with any material. Glue should be used only to join components
- Use light sandpaper (number 150 or higher) to gently clean your bridge and remove excess glue
- **Some common mistakes:**
    - Using a single sheet of balsa for roadway (solution: cut into strips)
    - Making outside width 5.0 cm instead of inside dimension
    - Making overall length 40 cm instead of span (between pedestals)
    - Forgetting 2.0 cm height requirement at 40 cm width
    - Not allowing room for bolt(s) on test frame
- http://www.garrettsbridges.com/blog/25-bridge-building-tips/

Fuel cell car design

Fuel Cell Car Performance Design Project in a Freshman Introduction to Engineering Course

Steve R. Duke, Auburn University, 230 Ross Hall, Auburn University, AL 36849-5127 and Virginia A. Davis, Department of Chemical Engineering, Auburn University, 230 Ross Hall, Auburn, AL 36849-5127.

A fuel cell car performance design competition project was developed and used as semester-long project (50% of course effort and grade) as part of the Auburn University freshman course Introduction to Engineering (ENGR 1110). The objectives of the project and competition were (1) to provide students with the opportunity to participate in an engineering team-oriented hands-on design and construction of a small chemical powered model car, and (2) to design and construct a car that is powered with a chemical energy source that will achieve specified performance criteria. Students worked with a commercially available fuel cell car kit to build the car to kit specification for the first half of the semester, and then to redesign and rebuild the car to make it faster for the second half of the semester. Design constraints were that the sole power source on the car was the kit fuel cell and costs could be no more than $80 beyond the cost of the commercial kit. Other design constraints were consistent with the AIChE Chem E Car Competition rules. Several lectures and lab sessions were developed to help student progress and learning for the project. Laboratory sessions followed lecture sessions that guided the teams in team building activities, decision making, negotiations, creativity, time management, resource management, budgets, technical communications, engineering design review, and product testing. Fuel cell car performance and product quality assessments required evaluation of chemical, electrical, mechanical, and physical principles and calculation or measurement of energy, force, gas volume, moles, mass, electrolysis reactions, and efficiency. Public events associated with the competition included timing trials and end of semester Race Day. Race Day competitions included a speed race on a 12 meter track (hallway) and a judged poster competition. Prizes for each competition were much sought after bonus points. Students were primarily freshmen or new university transfers. About 70% of the students were chemical or pre-chemical engineering majors, and the remainder was other engineering majors or undeclared science majors. The project was used with a class sizes of approximately 100 (Fall 2005) and 20 (Spring 2006). Formal and informal assessment revealed that fuel cell car project was successful for student learning and for student interest. Assessment and best practices will be discussed.

Build a tower for a shaker – Balsa wood

Submitted by: Jordi Puig-Suari
Cal Poly San Luis Obispo
jpuigsua@calpoly.edu

AERO 121 **FALL QUARTER 2007**

GLIDER COMPETITION:

Description:

The purpose of this exercise is to improve understanding of aerospace principles through designing and building a foam radio controlled (R/C) glider within a team. Teams of four to five students will be provided a starter "kit" which contains the materials to be used in the construction. The glider must be designed to carry a minimum of fifty pennies and be launched successfully from a standard R/C "hi-start". A hi-start is an elastic device which contains a length of surgical tubing tied to a length of nylon string with a ring at the end. One end of the hi-start is connected to the glider via a hook while the other end is fastened to the ground with a stake. The surgical tubing is stretched back, storing energy, which the glider uses to gain altitude during launch. The glider will receive points for the number of pennies carried during a flight attempt and for the duration of the flight.

*Flight Score = (Pennies Carried) * (Seconds Aloft-10sec)*

No single flight time may exceed ninety seconds. Flight scores longer than this will receive the ninety second maximum time. Each team will be allowed two flight attempts during the competition and their final score will be the best of the two attempts. Each group will be expected to complete their glider and successfully fly it in a competition to be held at the Educational Flight Range. Date TBA.

Glider Requirements:

- Must be assembled from the materials supplied in the kit
- Only 2 servo actuators are provided; glider must use only two controls (rudder/elevator recommended)
- Four foot maximum wing span limitation
- Must be capable of hi-start launch (tow hook will be provided)
- Must carry a minimum of 50 pennies payload
- Maximum penny payload limited by safety determined by the contest directors
- Maximum of 90 seconds aloft

Websites with good airfoil data:

http://www.nasg.com/afdb/index-e.phtml

http://amber.aae.uiuc.edu/~m-selig/

AERO 121 **FALL QUARTER 2007**

GLIDER REPORT GUIDELINES:

1. **Overall Aircraft Configuration:**
    a. A three view drawing of the Aircraft
    b. Basic dimensions (Wing and Tail dimensions and location, and Fuselage length), weight (if you had different payloads for your two flights you may want to include both values), cg location, and approximate ac location.
    c. Aspect Ratio and Wing loading calculations (Note: you need to find your wing area).
    d. Describe your reasons for choosing this particular configuration (what were you trying to accomplish?)

2. **Airfoil**
    a. Airfoil Selection for your aircraft including the approximate Reynolds number value for your airplane and the CL and CD characteristics of the airfoil.
    b. Briefly explain why you selected this particular airfoil.

3. **Stability & Control**
    a. Describe any elements of your aircraft that contributed to its stability.
    b. Describe the control surfaces in your aircraft.

4. **Structure**
    a. Describe the structural components in your glider. Include, materials and construction techniques (how did you put it together?).
    b. Results from you structural test.

5. **Results**
    a. Describe the performance of your glider during the competition (did you get lots of points?, was it stable and controllable?, was the structure strong enough?, etc.)
    b. Lessons learned (anything you would do different if you could start over and why?)

The report must be done in AIAA format. See AIAA Format Guidelines Sheet for specifics.

Rocket Competition

Submitted by: Jordi Puig-Suari
Cal Poly San Luis Obispo
jpuigsua@calpoly.edu

Rocket Competition

Saturday, October 13, 2012 (Parent's Weekend)

10:00 AM, Location TBD

General Guidelines

- Limit of $3.00 value for materials. Teams can use recycled materials like cardboard tubes, pringles cans, foam scraps in the hangar, etc.
- Epoxy, cutting tools, sandpaper, and misc. equipment is available in the hangar
- All rockets should have fins/ some way to provide stability. Rockets that don't have control surfaces will not be launched.
- The only payload allowed in the rocket is the egg. No extra loose items are allowed, even to add weight.
- Parachutes or Streamers are NOT allowed as recovery methods.
- Each team will receive one Estes D-12-0 rocket motor before the launch day. These motors can not be altered in any way prior to the competition. Dimensions: 70mm (length) x 24mm (Diameter)
- All rockets must be configured so that they can ride along the launch rail.
- All rockets will go through a safety inspection before launch, so make sure your rocket won't injure anyone during the flight prior to the competition date.

Competition Scoring

- $Total\ Score = \frac{(Time\ Aloft)\times(Egg\ Factor)}{(Mass)}$
- Egg Factor:

1	The egg survives with no visible cracking
0.5	The egg survives, but has structural damage
0	The egg does not survive the impact

Fall 2012 AERO 121 Rocket Report

I. Introduction
   a. This includes a brief summary of the origin of rockets and their importance in the Aerospace industry, as well as an introduction as to what is in the rest of the report.
II. Design
   a. Alternate designs you came up with and why you picked the design you flew.
   b. Describe what you did to make the rocket stable
   c. Material selection, including list of what you spent
   d. Overall cost of the rocket
III. Testing
   a. Deployment mechanism testing
   b. Stability testing
IV. Calculations
   a. Maximum height the rocket reached. Be sure to include your hand-written calculations
V. Three view drawing
   a. Make sure you have the rocket labeled with dimensions and location of the CG
VI. Results
   a. What did you expect the rocket to do and did it actually do?
   b. What would you change to make it better?

DUE Thursday, October 18, 2012 by 5 pm

The report must be written in AIAA format. See www.aiaa.org for more information

Prepping for an Engineering Interview, Job, and Career

Submitted by: Bert Vermeulen
Colorado State University
bert.vermeulen@colostate.edu

MECH 100/FALL 2012

Project: Prepping for an Engineering Interview, Job, and Career

The task

This project was inspired by a CU engineering senior (let's call him "Frank") who asked Bert Vermeulen for help in 2005. Frank had progressed through his undergraduate program with slightly below average grades while having a great time skiing. He faced the daunting possibility of graduating, and had little sense of how to get hired as an engineer. This project is designed to help you avoid Frank's fate. Here's what you need to do and turn in:

1. Choose one of the job descriptions provided in the Appendix (at the end of this document) to pursue as a first job out of college or find another job description online for a job that requires a mechanical engineering degree. If you find a job description online yourself, make sure that you include the full description, requirements etc in your report and identify where you found it. Identify the job that you selected and why you chose this job

2. List the CSU undergraduate courses that would prepare you for the chosen job description. That table should be in the following format:

Course Number & Title	What's Learned in this Course	How this Applies to Chosen Job

You can list as many courses as you think are appropriate. Points will be deducted if you forgot to list courses that are relevant. Points will also be deducted if you listed courses that are likely not to be directly relevant. We are looking for the list of 5-8 classes that are likely to be the most important to focus on. Those classes may not all be engineering classes.

3. Find three additional companies (or organizations) that hire mechanical engineers to do jobs similar to your chosen job description. Find out where these companies have operations that require mechanical engineers and how you might be able to contact someone who would hire mechanical engineers. Provide us with a list of these companies and make sure that you include the following information in that list:
   - Company/organization name
   - Company/organization address and phone number
   - Brief description of the engineering jobs available

4. Do research to determine whether jobs similar to your chosen job description are likely to increase between now and the time you graduate, decrease, or stay the same. Make sure that you include references and analysis to justify your conclusion.

5. Identify a typical technical problem that you would need to solve if you were hired to do this job. Solve this problem and prepare a nicely formatted description of the problem and the process you used to solve it. That description needs to include all of the steps identified in the SOLVEM process discussed in Chapter 6 of the textbook as well as any graphs that might be useful. This step is the most important part of this project assignment and counts for at least 50% of your grade on this project. Make sure that you present your information in a professional manner: clear, detailed, well illustrated, and well organized. We don't expect you to be able to solve all of the complex engineering from a quantitative standpoint (you're a freshman, not a senior), but we expect that you should be able to have good diagrams, a clear understanding of any forces, vectors, etc, and a clear qualitative visual overview of the problem and how one would solve it. If you put your mind to it and work on it week by week, we think you should be able to amaze us (and yourself) with your ability to communicate engineering problems and their solutions.

6. Prepare a "pro forma resume" and cover letter that show the skills and experience you expect to have by you senior year. By a "pro-forma resume" and cover letter, we mean a resume and cover letter that are dated November 15, 2015. These documents should be written like you're a senior, having taken the classes identified in #2 above. The resume should also identify other significant accomplishments that you've had in your college years (i.e. between August 1, 2012 and November 15, 2015). You will be making up this information, but it should be realistic given what you plan to do between now and the time you might start looking for fulltime employment after graduating. The reason for doing this part of the exercise is that if you can have a clear idea of where you want to be in 3 years time, it will be easier during the next three years to see if you're on track to achieve your goals.

Submitting the report

The report for this project is due by **12:00 noon Monday November 12th** as a correctly named PDF (10_LastnameFirst_P.pdf or 12_LastnameFirst_P.pdf) in the drop-box folder on the T-Drive for MECH100 Note that if you need to update your project report, the right naming convention becomes (8_LastnameF_P_rev2.pdf or 10_LastnameF_P_rev2.pdf).

You can choose to do this project individually or in teams of two. If you choose to do this as a team,, you must email bert@corp21.com by noon on September 18th. Your teammate must be in the same section. Once you've declared that your doing this as a group, you cannot change or do it individually. We will send you special instructions on how to name your project file when submitting it.

To submit additional information (videos, links to YouTube videos, images, spreadsheets with working mathematical models, etc), place them into an accompanying ZIP file in the drop-box folder on the T-Drive using the naming convention: 10_LastnameFirst_P.zip or 12_LastnameFirst_P.zip.

Note:

If anything is not clear about this assignment or our expectations, please email bert@corp21.com. We will not be providing any samples of what a good submission for this project will look like. That would discourage originality and creativity in how you fulfill the requirements that we've laid out. We will show samples of good work in class after you've turned in your assignment so you can learn from it.

APPENDIX – JOB DESCRIPTIONS (Choose 1 for this project or find one online yourself)

1. Motor Vehicle Engineer

Our company is seeks an Engineering team member to work within our commercial chassis division. The ideal candidate will have a BSME with previous experience in the heavy truck industry. Experience with mechanical, hydraulic and pneumatic brake systems as they relate to heavy-duty trucks would be a plus. Candidate should be a self-motivated team player that can work with Product Management and a Lean Manufacturing environment to create new designs and solve problems. Position will require hands-on interaction with the product and its manufacturing process. Candidate will need to become proficient with industry standards and how they relate to product design.

ESSENTIAL FUNCTIONS:

- Responsible for the final design requirements and system interface management and release of engineering packages to the Supply Chain and Operations. Must initiate and lead detailed design reviews with cross-functional disciplines.
- Verification of designs through use of calculations & other analytical techniques and tools. Assist designers in developing the structural design of products, using drafting tools or computer-assisted design/drafting equipment and software.
- Solving complex problems within marketing requirements, customer expectations and needs, manufacturing departments, and suppliers.
- Participate in customer specification reviews and product meetings. Initiating innovative solutions that meet all customer, regulatory and company requirements. Research and analyze customer design proposals, specifications, manuals, and other data to evaluate the feasibility, cost, and maintenance requirements of designs or applications.
- Define test requirements and interpret test results to validate designs.
- Create and manage indented BOM in adherence to company standards. Create and fully use engineering configuration tools for BOM and design automation.
- Problem solving skills from issue identification to root cause resolution. Methodologies include six sigma, 8D, 5-way techniques.
- Lead cost saving projects through VA/VE initiatives
- Knowledge of manufacturing processes with emphasis on metal fabrication / assemblies including application of DFM methodologies to deliver robust engineering packages emphasizing productivity in the manufacturing process.
- Knowledge and use of lean principles as they apply to manufacturing and business processes.
- Develop plans for compliance to regulatory standards, adopted engineering standards and good engineering practices. Review and critique proposed changes to engineering standards, policies or details.
- Design for manufacturing, assembly and service to produce optimal total package cost to meet specified product price point.
- Fulfillment of customer requirements (i.e. shop orders) taking into consideration design rules and all applicable interface points.
- Execute engineering changes through established processes and documentation.
- Lead projects to meet business and department goals and objectives through coordination among interdepartmental activities.
- Influence & lead others without direct supervision / authority.
- Must become "Subject Matter Expert" of applicable regulatory standards - NFPA, DOT, ULC etc.
- Ability to mentor team members on design principles, regulatory standards etc.
- Senior level positions may require leadership and/or supervision of a small group or department of other engineers or designers.

MINIMUM REQUIREMENTS:

- Bachelor Degree in Mechanical Engineering (BSME)
- Advanced knowledge and practical use of drawing and drafting standards
- Proficiency in CAD systems - Pro-E and/or Auto CAD

Previous experience within the heavy truck industry

2. Biomedical Engineer

We are a worldwide leader in innovative spine products and have a newly created position for a Research and Development Engineer. This position requires a candidate who is fluent in English and also has a basic working knowledge of French. We offer a fast paced, fun, and energetic atmosphere with competitive pay, good benefits, and a great working environment.

We will only consider applicants that can speak English fluently and have a basic working knowledge of French. French is an absolute "must have skill", so please do not apply if you do not have that capability. In addition, this is an entry-level position. The ideal candidate will have 2-3 years experience, preferably in medical device.

JOB DESCRIPTION

We are in search of a Research and Development Engineer to assist with technical communication between US and our R&D department in France, provide technical support for regulatory submissions, participate in project team meetings and help design and develop special instruments for our spinal product lines.

KEY AREAS OF RESPONSIBILITY

Primary technical resource to U.S. and International Regulatory
Participation in mechanical testing plans and implementation
Reading and interpreting technical reports in both English and French
Conducting literature searches to support engineering rationales
Developing and writing engineering rationales
Design-development of special spinal implant instruments
Function as US and French liaison regarding product design and development
Assist in the collection of customer feedback and report that info to our French engineering department
Assist in coordinating product development communication between R&D department and consulting surgeons in the USA.
Other duties as assigned

REQUIREMENTS

Bachelor Degree in Mechanical or Biomechanical
1-2 years experience design and development
Experience in Medical Device preferred
Ability to speak and work in French and English on a daily basis
Experience in using a computer required.
Familiarity with common software programs (e.g., Word, Excel and PowerPoint) required.
Experience with CAD software required (Solidworks or similar)
Excellent written and verbal communication skills
Good organizational skills and attention to details
Aptitude for analysis and decision making

3. Field Sales Engineer

This is an excellent opportunity to bring your broad background in field sales of a highly technical product with a manufacturing company to expand the offerings for this premier design and manufacturer of low and high pressure gauges, controllers, switches, meters and indicators with very diverse applications. Company enjoys a very diverse customer base with their largest client representing less than 2% of their sales. Company is constantly striving to stay on the cutting edge of technology in their product offerings and methods of lowering costs. As a result, there is tremendous potential for both personal and professional growth in this small company atmosphere with big company opportunities. They are an engineering driven company that offers an outstanding benefit package including relocation.

This position is located in Denver, CO. with a territory consisting of Colorado, New Mexico, Utah, and Wyoming. There is a possibility to live anywhere in the territory

TO BE CONSIDERED FOR THIS ROLE:

You must have a four-year engineering degree (ME, EE, CE or CS)

You must have some field sales experience selling a technical product and understand distributor networks.

You must have experience dealing with OEM customers, consulting engineers, large consumer accounts and other prospects.

You also must be a road warrior - available to travel up to 75%.

You will use your demonstrated background to represent the company's highly technical instrumentation and controls products to a variety of customers in the prescribed territory. This includes demonstrated knowledge of low and high pressure gauges, controllers, switches, meters and indicators.

REASONS WHY THIS IS A GREAT JOB FOR THE RIGHT PERSON:

Leader in their product line.

Privately held - engineering driven company.

Diverse product line & customer base - largest client only 2% of sales.

Company is International in scope.

Solid track record of profitable growth.

Excellent opportunity for personal and professional growth.

Company headquarters in a great Midwestern location.

Competitive salary, benefits and relocation package.

4. Patent Examiner
Work for the largest Intellectual Property Rights Firm in the United States - United States Patent and Trademark Office (USPTO). Discover an exciting career with the USPTO as a Patent Examiner! A career as a Patent Examiner is filled with endless possibilities, where you can be a part of something that makes a difference for the country and the world. It is a career that allows you to continue to contribute to a strong global economy and to cultivate an entrepreneurial spirit for the 21st century.

A Patent Examiner reviews patent applications to determine if they comply with Federal law and regulations, in addition to scientific principle. The incumbent would be responsible for scrutinizing patent applications, determining the scope of protection claimed by the inventor, researching relevant technologies, and communicating findings and decisions to patent practitioners and/or inventors. The job is generally visually demanding in nature and almost all of a Patent Examiner's work is performed using a computer. The Patent Examiner is required to conduct an extensive review of a large body of technical information which regularly includes detailed drawings as represented in electrical schematic, 3-dimensional mechanical portrayed drawings or chemical manufacturing process diagrams. The incumbent reviews patent applications and writes office actions, in a production oriented environment that requires the analytical ability to efficiently digest large volumes of scientific information and to use this in making timely decisions regarding the patentability of an application.

The Patent Examiner position is located in the new satellite office of the United States Patent and Trademark Office in the Denver Colorado area.

The Office of Human Resources strongly encourages applicants applying for positions to read the vacancy announcement in its entirety before submitting application materials for this position. If you have any questions or concerns about the application procedure or processes, please contact the individual listed under 'Contact Information.' Failure to follow instructions in the announcement will result in your application not receiving consideration.

As a Patent Examiner with no preliminary instructions, you will perform patent examining functions and formulate or recommend appropriate action with respect to checking applications for compliance with formal requirements and technological accuracy, treating disclosure statements and claims of priority; analyzing disclosure and claims for compliance with 35 USC 112; planning a field of search; conducting search; formulating rejections under 35 USC 102 and 103 with supporting rationale, or determining how claim(s) distinguish over the prior art; determining whether amendment introduces new matter; determining whether restriction is proper; and determining whether claimed invention is operable/useful as disclosed. After preliminary instruction, you will perform patent examining functions and formulate or recommend appropriate action with respect to evaluating/applying case law as necessary; evaluating sufficiency of affidavits/declarations; determining whether appropriate line of patentable distinction is maintained between application and/or patents; evaluating sufficiency of reissue oath/declaration; and evaluating appropriateness of grounds of reexamination.

REQUIRED QUALIFICATIONS:
* You must be a US citizen or National

*You must meet the following United States Office of Personnel Management's (OPM) qualifications requirements for the advertised position. OPM's prescribed Group Coverage Qualifications Standards for Professional and Scientific Positions can be found at: http://www.opm.gov/qualifications/SEC-IV/A/gs-PROF.asp. It is available for your review in our office and in other Federal agency personnel office. Additional information on the qualification requirements is outlined in the OPM Qualifications Standards Handbook of the General Schedule Positions. You must meet all the qualification requirements by the closing date of this vacancy announcement.

* Successful completion of a full 4-year course of study in an accredited college or university leading to a bachelor's or higher degree that included a major field of study or specific course requirements in one of the following disciplines: Aerospace Engineering, Biomedical Engineering, Ceramic Engineering, Chemical

Engineering, Civil Engineering, Computer Engineering, General Engineering, Industrial Engineering, Electrical Engineering, Materials Engineering, Mechanical Engineering, Mining Engineering, Nuclear Engineering, Petroleum Engineering, Metallurgy, Pharmacology, Physics, Chemistry, Food Technology, Textile Technology, and Computer Science.

* In addition to the basic education requirement stated above, applicants must meet the following to qualify for the GS-11 level: Have at least one year of specialized experience that is directly related to the duties of the position to be filled and is equivalent to the GS-09 level in the Federal service. Directly related experience may be legal and/or prosecution experience that is directly related to patent examining functions, including drafting patent applications in compliance with formal requirements and technical accuracy, drafting disclosure and claims for compliance with 35 USC 112; planning and conducting searches; ensuring that specification and claim amendments fail to introduce new matter; assessing the potential for a proper restriction; determining whether claims distinguish over the prior art; analyzing rejections under 35 USC 102 and 103 which have supporting rationale; determining whether claimed invention is operable/useful as disclosed; evaluating/applying case law as necessary; evaluating sufficiency of affidavits/declarations; determining whether an appropriate line of patentable distinction is maintained between application and/or patents; evaluating legal sufficiency of reissue oath/declaration; and evaluating appropriateness of grounds of reexamination.

HOW YOU WILL BE EVALUATED:
Your application will be reviewed to determine if you are eligible and if you are qualified for the position. Your eligibility for consideration and qualifications for the position will be determined based upon a review of:

* Your detail and comprehensive responses to the job specific evaluation criteria (also called KSAs);
* Your detailed resume; and
* The supporting documentation required.

The job specific evaluation criteria cover the following knowledge, skills, and abilities (KSA). Submit a narrative statement individually addressing how you meet each KSA. Be sure to provide specific examples of what you actually did that would demonstrate your possession of each factor. Failure to provide this information will affect your eligibility and will result in you not receiving consideration for this position.

KSA 1 - Knowledge of patent examining functions and experience in the preparation/prosecution of patent applications.

KSA 2 - Knowledge of the scientific and technical matters associated with the patent process in a designated art area (professional scientific or engineering field).

KSA 3 - Knowledge of legal matters associated with the patent examination practices, processes, and procedures.

KSA 4 - Ability to effectively communicate in writing.

KSA 5 - Ability to effectively communicate orally.

Applicants who meet the minimum eligibility and qualification requirements will be evaluated based on their overall background as it relates to the position being filled, and the specific Knowledge, Skills, or Abilities (KSAs) needed in the job. Applicants will be rated and ranked on the KSAs identified above. Qualified candidates will be assigned a score between 70 and 100, before the addition of veterans' preference points. All application materials and interviews, if conducted, will be used in the final evaluation and selection process. Interviews are at the discretion of the selecting official.

5. Mechanical Engineer for Aerospace Company

Our company combines the experience of long-time industry leaders to supply critical systems and components to the aerospace and defense markets. Our products are found in some of the most demanding environments, from engines to landing gear, from satellites to medical implants, and from missiles to unmanned aerial systems (UAS).

We are committed to operational excellence and world-class processes. We employ lean manufacturing techniques to optimize manufacturing efficiency and accuracy on all product lines. Our products are known for their technical strength, proven reliability and overall value.

We look for flexible professionals who are capable of working with minimal supervision and can adapt to changing environments. We look for people who are challenged by other people, who like being around well-educated, well-versed professionals. For these people, our company provides a creative outlet and high level of participation. People in the company build the company.

ABOUT THE OPPORTUNITY

Our business offers the most reliable positive displacement and centrifugal pumps in the industry. Positive displacement pumps include vane, gerotor, and spur gear technology while a centrifugal pump can include one of a multitude of different impeller options. These pumps handle the oil, fuel, coolant, or water delivery for the general aviation, business jet, small/large commercial aircraft, and military markets.

We need a talented individual in our Fluid Management Group at our Northeast Ohio facility to fill the role of Engineer III, Mechanical. In this position, you will assume complete responsibility for assigned proposals, projects, investigations, and/or other activities under the guidance of a supervising manager. The successful candidate will operate within cross-functional teams (engineering, manufacturing, quality, supply chain, business development, etc.) to achieve overall program objectives. He/she will apply good program management skills on all assigned activities. The Engineer III, Mechanical, maintains control of project and product costs and schedules. He/she will satisfy all department, project, and customer requirements including customer satisfaction, cost, quality, and delivery.

SPECIFIC DUTIES AND RESPONSIBILITIES

Project Management / Technical Leadership Responsibilities

- Estimate and maintain effective control of project cost and schedule.
- Work effectively with all functional groups and/or suppliers to achieve product performance and cost targets.
- Define and management technical and program requirements, including the generation and flow-down of subsystem specifications and requirements.
- Maintain technical liaison with customers, suppliers, contractors and other functional groups through effective teamwork and communication.
- Prepare technical reports and documentation necessary to satisfy customer and program requirements, including proposals, procedures, reports, correspondence, etc.
- Provide instruction, guidance, oversight and/or support to other personnel and/or disciplines supporting program objectives through utilization of engineering orders, test procedures, purchase requisitions, correspondence and other effective means.
- Maintain accurate program accounting through effective utilization of project records and data management.
- Identify, lead and/or support process definition and improvement efforts through support of Kaizen events or similar assignments.

Engineering Responsibilities:

- Primary agent for product design insuring that all design and analysis activities are complete, accurate, and meet program requirements. Responsibilities include the following categories:
    - Product architecture / configuration
    - Performance (mechanical, electromechanical)
    - Modeling
    - Analysis

Weight
Reliability
Materials Safety

- Create, review and/or approve product drawings, drawing release packages, drawing revisions and other design documentation in concurrence with company procedures.
- Support the Material Review Board (MRB) in the assessment and disposition of non-conforming hardware and material within the scope of assigned products.

ENGINEERING COMPETENCIES

The fundamental engineering concepts presented below are required as related to product design:

- Fluid Dynamics Statics & Dynamics Design of Mechanical Components
- Vibration Stress and Strain Platings, Coatings, & Heat Treating
- Metallurgy Strength of Materials Drawing Layout / Stack-ups
- Geometric Dimensioning & Tolerancing
- Computer Skills
- Finite Element Analysis (Ansys preferred) CAD Drafting/3-D Solid Modeling (Pro/E preferred) Basic Programming
- Spreadsheets Word Processing Graphing
- Program Schedules Presentations

Supervision: There are no direct personnel reports to this position. Supervisory responsibilities include the instruction and/or coordination with other personnel supporting assigned projects.

TEAMWORK EXPECTATIONS

Teamwork and individual growth are fostered to enable employees to contribute and achieve their fullest potential. All employees must work as a team to meet or excess internal and external customer expectations by providing innovative products and services on time, every time.

EDUCATION AND EXPERIENCE

Bachelor of Science Degree in Mechanical Engineering
Demonstrated related experience

6. Mechanical Engineer with National Institute of Standards and Technology

POSITION INFORMATION: Competitive Service: Term 18 months
DUTY LOCATION: Boulder, Colorado

WHO MAY BE CONSIDERED: All qualified U.S. citizens. This notice is issued under direct-hire authority to recruit new talent to occupations for which NIST has a severe shortage of candidates.

JOB SUMMARY:
Founded in 1901, NIST is a non-regulatory federal agency within Commerce. NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

To learn more about working at NIST, please visit Careers at NIST.

The Technology Innovation Program (TIP) supports, promotes, and accelerates innovation in the United States through high-risk, high-reward research in areas of critical national need. The Program works to fill gaps within Federally funded research by providing resources to leverage technologies through high-risk, high-reward research that addresses critical national needs.

KEY REQUIREMENTS
- You must be a U.S. citizen.
- You must be registered for selective service (as applicable).
- You must be suitable for Federal employment.

DUTIES:
In this position, the incumbent will perform technical project management in broad multidisciplinary areas such as general manufacturing; materials manufacturing; manufacturing controls; equipment development and design; manufacturing and development of materials (polymers, ceramics, metals, and fibers); manufacturing automation; manufacturing control systems; combustion process; metals and glass manufacturing; energy storage technology; alternative energy technologies; civil infrastructure; and instrumentation design. The incumbent will provide technical experience and impact analysis support to the TIP during the program shut down.

QUALIFICATIONS REQUIRED:
To qualify, applicants must possess both the Basic Requirements and Specialized Experience

Basic Requirements

1. Degree: professional engineering. To be acceptable, the curriculum must: (1) be in a school of engineering with at least one curriculum accredited by the Accreditation Board for Engineering and Technology (ABET) as a professional engineering curriculum; or (2) include differential and integral calculus and courses (more advanced than first-year physics and chemistry) in five of the following seven areas of engineering science or physics: (a) statics, dynamics; (b) strength of materials (stress-strain relationships); (c) fluid mechanics, hydraulics; (d) thermodynamics; (e) electrical fields and circuits; (f) nature and properties of materials (relating particle and aggregate structure to properties); and (g) any other comparable area of fundamental engineering science or physics, such as optics, heat transfer, soil mechanics, or electronics.

OR

2. Combination of education and experience -- college-level education, training, and/or technical experience that furnished (1) a thorough knowledge of the physical and mathematical sciences underlying professional engineering, and (2) a good understanding, both theoretical and practical, of the engineering sciences and

techniques and their applications to one of the branches of engineering. The adequacy of such background must be demonstrated by one of the following:

Professional registration -- Current registration as a professional engineer by any State, the District of Columbia, Guam, or Puerto Rico. Absent other means of qualifying under this standard, those applicants who achieved such registration by means other than written test (e.g., State grandfather or eminence provisions) are eligible only for positions that are within or closely related to the specialty field of their registration. For example, an applicant who attains registration through a State Board's eminence provision as a manufacturing engineer typically would be rated eligible only for manufacturing engineering positions.

Written Test -- Evidence of having succesfully passed the Engineer-in-Training (EIT) examination, or the written test required for professional registration, which is administered by the Boards of Engineering Examiners in the various States, the District of Columbia, Guam, and Puerto Rico.

Applicants who have passed the EIT examination and have completed all the requirements for either (a) a bachelor's degree in engineering technology (BET) from an accredited college of university that included 60 semester hours of courses in the physical, mathematical, and engineering sciences, or (b) a BET from a program accredited by the Accreditation Board for Engineering and Technology (ABET) may be rated eligible for certain engineering positions at GS-5. Eligibility is limited to positions that are within or closely related to the specialty field of the engineering technology program. Applicants for positions that involve highly technical research, development, or similar functions requiring an advanced level of competence in basic science must meet the basic requirements in paragraph A. Because of the diversity in kind and quality of BET programs, graduates of other BET programs are required to complete at least 1 year of additional education or highly technical work experience of such nature as to provide reasonable assurance of the possession of the knowledge, skills, and abilities required for professional engineering competence. The adequacy of this background must be demonstrated by passing the EIT examination.

Specified academic courses -- Successful completion of at least 60 semester hours of courses in the physical, mathematical, and engineering sciences and in engineering that included the courses specified in the basic requirements. The courses must be fully acceptable toward meeting the requirements of a professional engineering curriculum as described in paragraph A.

Related curriculum -- Successful completion of a curriculum leading to a bachelor's degree in engineering technology or in an appropriate professional field, e.g., physics, chemistry, architecture, computer science, mathematics, hydrology, or geology, may be accepted in lieu of a degree in engineering, provided the applicant has had at least 1 year of professional engineering experience acquired under professional engineering supervision and guidance. Ordinarily there should be either an established plan of intensive training to develop professional engineering competence, or several years of prior professional engineering-type experience, e.g., in interdisciplinary positions. (The above examples of related curricula are not all-inclusive.)

Specialized Experience

ZP-IV (GS-13/14 Equivalent):

Applicants must possess at least three months of specialized experience equivalent to at least the ZP-III (GS-9 Equivalent). Specialized experience is defined as experience as a project manager using cooperative agreements; and communicating outcomes and results; and experience in two of the following fourteen areas: manufacturing; materials manufacturing; equipment development and design; equipment maintenance; non-destructive evaluation; manufacturing and development of materials (polymers, ceramics, metals and fibers); manufacturing automation; manufacturing control systems; combustion processes; metals and glass manufacturing; energy storage technology; alternative energy technologies; civil infrastructure; and instrumentation design.

Qualification requirements in the vacancy announcements are based on the U.S. Office of Personnel Management (OPM) Qualification Standards Handbook, which contains federal qualification standards. This handbook is available on the Office of Personnel Management's website located at: http://www.opm.gov/qualifications.

This position has an education requirement. You must submit a copy of your transcripts to document that you have met the education requirement. Unofficial transcripts will be accepted in the application package. Official transcripts will be required prior to a final offer of employment. Special Instructions for Foreign Education: Qualifying education from colleges and universities in foreign countries must be evaluated in terms of equivalency to that acquired in U.S. colleges and universities. Applicants educated in whole or in part in foreign countries must submit sufficient evidence, including transcripts, to an accredited private organization for an equivalency evaluation of course work and degree. A listing of these accredited organizations can be found on the Department of Education's website - http://www.ed.gov/international/usnei/us/workrecog.doc. You must provide a copy of the letter containing the results of the equivalency evaluation with a course by course listing along with your application. Failure to provide such documentation when requested will result in lost consideration.

Applicants must meet requirements by the closing date of this announcement.
HOW YOU WILL BE EVALUATED:

Applications will be evaluated against the basic qualifications. Qualified candidates will be considered in accordance with the Office of Personnel Management Direct Hire Guidelines. Veterans' Preference does not apply to the direct hire recruitment procedures. Selections made under this notice will be processed as new appointments to the civil service. You may not be considered for the position if any part of the application is incomplete. Your application may not receive appropriate consideration without the required supporting documentation. Falsifying your background, education, and/or experience is cause for not hiring you or adverse action after hiring.

BENEFITS:
NIST offers a comprehensive benefits package that includes, in part, paid vacation, sick leave, holidays, life insurance, health benefits, and participation in the Federal Employee Retirement System. NIST also offers a broad array of work-life flexibilities and services to employees such as flexible work schedules, teleworking transit subsidies, on-site child care, fitness center, credit union, employee assistants programs, and free parking. Learn more about NIST's work life programs by visiting www.nist.gov/hrmd/worklife.cfm. The following web site is provided for your reference to explore the major benefits offered to most Federal employees www.nist.gov/hrmd/benefits/summarychart.cfm

OTHER INFORMATION:
A one to three year probationary period may be required. Term Appointment may be extended to 4 years without further competition. If selected by management, you may be required to complete a Declaration for Federal Employment (OF-306) to determine your suitability for federal employment and to authorize a background investigation. This position is covered by an Alternative Personnel Management System (APMS). This system replaces the General Schedule (GS) pay plan and grades with career paths and pay bands. For more information regarding on how our pay bands correspond to the General Schedule grade levels, visit: http://www.nist.gov/hrmd/compensation/upload/nistcareerpathchart.pdf. Payment of relocation expenses is not authorized. At NIST we are striving to make the application process as easy and efficient as possible. With that in mind, the resume and corresponding responses of successful candidates may be shared with other selecting officials at NIST with opportunities like the one you are applying to. Additional selections may be made through this vacancy announcement.

The Department of Commerce provides reasonable accommodation to applicants with disabilities where appropriate. If you need reasonable accommodation for any part of the application and hiring process, please notify the Human Resources Specialist identified in this vacancy. The decision on granting

reasonable accommodation will be made on a case-by-case basis. TTY users can contact Office of Workforce Management via the Federal Relay Service, 1-800-877-8339.

HOW TO APPLY:
A complete application package includes the following: -Your resume AND -The supporting documentation required (click on Required Documents).

You MUST apply on-line through WWW.USAJOBS.GOV. Your application must be received by 11:59 p.m. Eastern Time on the closing date of this announcement.

Uploaded resumes must include the following: applicant contact information and educational and professional background information including dates of employment and education, salary (and Federal grade level, if appropriate), and work schedule (i.e., FT/PT). Please also include in your resume a list of all publications and patents/patent applications on which you are a named inventor and provide the title and patent/patent application number for each. Incomplete applications will not be considered and you will not be contacted to provide any missing information.

If you do not have access to the internet: If you do not have internet access, please contact the HR Specialist identified for this vacancy for alternative application methods.

Problems Completing Your Application: If you have problems completing your on-line application, including problems submitting your supporting documents, please contact the Help Desk by email at mgshelp@monster.com. The help desk is available Monday - Friday, 7:00 a.m. to 7:00 p.m. ET.

REQUIRED DOCUMENTS:
What documents do I need to submit? In addition to your resume, you must submit any documents needed to support your qualifications for this position (i.e., college/university transcript). How do I submit my documents: You may submit required and/or supplemental documents through any ONE of the following methods: >Upload you file(s); >Download from your USAJOBS account; >Fax using the on-line fax cover sheet; >Mail your documents, ONLY IF YOU DO NOT HAVE INTERNET ACCESS;

All required supporting documentation mentioned in this vacancy announcement, and all vacancy applications submitted electronically or via fax must be submitted and received by 11:59 pm ET on the closing date of this announcement. You are not required to submit official documents at this time; copies are sufficient.

Are you CTAP or ICTAP Eligible? If you are a Federal employee claiming special priority selection rights under DOC's Career Transition Assistance Program (CTAP) or your Agency's Interagency Career Transition Assistance Program (ICTAP), you must meet the threshold of "well qualified" for the position to receive priority consideration. DoC defines well qualified as receiving a overall score of "85". You must also submit proof that you meet the requirements of 5CFR 330.605 (a) for CTAP and 5 CFR 330.704 for ICTAP. This includes a copy of your agency's notice, a copy of your most recent Performance Rating and a copy of your most recent SF-50, Notification of Personnel Action, noting current position, grade level, and the duty location. Please annotate your application to reflect that you are applying as a CTAP or ICTAP eligible. For more information about CTAP and ICTAP, please refer to the following web sites: CTAP ICTAP

AGENCY CONTACT INFO:
Eric Nist
Phone: 303-555-1212
Email: eric@nist.gov

WHAT TO EXPECT NEXT:
If your application is referred to management for consideration, you may be contacted to interview for the position. You may be contacted by NIST upon consideration for employment to inform you of additional qualification requirements (i.e., selective factors) that would be required for a particular position.

ES 110 Engineering & Society – Fall 2012
Group Design Project

Submitted by: Jan E. DeWaters
Clarkson University
jdewater@clarkson.edu

Design of a Solar Water Heater

Background: Fossil fuels currently provide about 85% of the energy used by most of the developed world. Because of concerns over the limited supply of fossil fuels, as well as the detrimental environmental effects associated with their use, renewable energy resources such as solar, wind, hydro and geothermal energy are attracting increased attention ranging from research and development efforts to wide scale implementation. Among these renewable resources, solar energy provided about 1.4% of the total renewable energy consumed (or 0.1% of the total energy consumed) in the U.S.in 2010.[1] Solar is growing quickly in the U.S. – according to the Solar Energy Industries Association, more solar was installed in the third quarter of 2011 than in all of 2009 combined.[2]

Solar energy can be converted to electrical energy (electricity) using photovoltaic cells. Another use for solar energy is to heat water. As much as 20% to 30% of the total energy consumed by an average U.S. household is used to heat water.[3] Most commonly, that energy comes from fossil fuels – either directly from natural gas, or indirectly through electricity, which in the U.S. is produced mainly from fossil fuel combustion. A solar water heater can be an effective way to conserve fossil fuel resources and save money. There are two types of solar water heating systems: active systems, which are the most common, use a pump to circulate water; passive systemsare used less commonly and circulate the water without the aid of a pump. Household solar hot water systems have a storage tank connected to a solar collector, which is the unit where the water heating takes place. There are three types of solar collectors used for residential applications: the flat plate collector, which is basically an insulated flat box (typically black) through which the water flows; an integral collector-storage system, which is a batch system that preheats water before it enters a conventional heater; and an evacuated-tube solar collector, which uses a system of inner- and outer-tubes of glass that act as heat exchangers to transfer heat energy from warmer recycled fluid to the water being heated. Most solar systems operate as a preheater for a conventional water heater, but in warmer climates or for swimming pool applications they may operate as stand-alone systems.

Solar pool heaters essentially consist of a simple collector on its own, with no storage tank. Water is pumped from the pool by the recirculating pump, through a filter and the solar collector, and is then returned to the pool. Solar pool heaters are made out of various materials but are generally flat, flow-through structures that use simple principles of long *residence time* (the length of time the

[1]U.S. Energy Information Administration, 2011. Annual Energy Review, October 19, 2011. Retrieved 8/3/2012 from http://www.eia.gov.
[2] Business Day: Energy & Environment. New York Times, May 17, 2012. Retrieved 8/3/12 from http://topics.nytimes.com/top/news/business/energy-environment/solar-energy/index.html.
[3]EnergyTrust of Oregon.Retrieved 8/3/2012 from http://energytrust.org/residential/incentives/solar-water-heating/solarwater/.

water is in the collector) and maximum exposure to the sun's rays to provide the most possible benefits.

Design Objective: Design and demonstrate a prototype for a solar water heater that uses heat generated by a "solar simulator" to increase the temperature of a given amount of water within a specified time period.Each design team will prepare several Progress Reports and give a summary presentation including a demonstration of the prototype (see Deliverable #5). A final design final report including peer evaluations will be submitted when the project is completed (see Deliverable #6).

Specifications/Performance Requirements: Each team is tasked to design and demonstrate a bench-scalesolar water heating system. Systems may be active or passive; teams will be supplied with a container holding 1 liter of room temperature water and a pump to use at their discretion. Simulated solar energy will be provided by two300-Watt halogen lamps, which will be located a minimum of 50 cm from the nearest point of the bench-scale solar collector.

The system should be constructed to heat a minimum of 1 liter of water in less than 5 minutes. Teams are expected to maximize the temperature gain of the water, as measured by the difference between the temperature of the influent (room temperature) and the temperature of the effluentin the collection vessel at the end of the test period (5 minutes, or possibly less for passive systems). Additional goals will be to maximize the *energy efficiency* (measured by the energy gained in the heated water divided by the total energy supplied to the system, %) as well as the *cost efficiency* of the heater (as measured by theheat gained in the water per unit cost of the system [Joules/$US]).

Materials Provided and Constraints:

1. **Materials**: Each team will have access to a station that is equipped with a vessel of room temperature water and a peristaltic pump. The pump will be equipped with a short piece of inflow/outflow tubing, to which the collector may be attached with additional fittings, nozzles, etc. Two300-watt halogen lights will be provided to simulate solar energy. Teams will be responsible for procuring all materials to construct the collector, as well as materials to connect the collector to the pump if desired. A collection of fittings will be made available for use. Students wishing to design passive systems may obtain additional vessels for effluent collection. Materials for construction may include standard craft items and throwaways or recyclables, such as empty containers, tubing, hosing, plastics, string, wire, etc. Additional construction materials may be purchased, including but not limited to tubing, fittings, adhesives and fasteners (screws, bolts and nuts) as long as the total charges do not exceed the maximum allowable budget. Materials that are not available through local vendors may be purchased over the Internet with the assistance the assigned ES110 Design Project Teaching Assistants.

2. **Tools**: Construction of the prototype may employ typical hand tools used in crafting. Hand tools such as pliers, wire cutters, saw, and screwdrivers are allowed; hot glue guns are allowed. In general, power tools and machine tools *are not*to be used by students. If you need a hole drilled or a special cut made, you may request assistance from shop personnel. In addition to the tool kits, a work area will be made available to the design teams.

3. **Cost**: The cost of materials used to construct the bench-scale solar water heater should not exceed $35.00 U.S. A detailed budget must be included in Progress Report #3. The detailed budget,detailing all costs and including copies of receipts for all purchased materials, must be provided in an appendix of the Final Report.**A 10 point penalty will be assessed on the final report for any design with a cost exceeding $35.00 U.S. as demonstrated.**

4. **Assistance:** Two teaching assistants will be available on a limited basis to help with laboratory procedures and material procurement. For example, if a team does not have any means for making on-line purchases, arrangements can be made through the design project assistants. Regular lab hours will be posted, during which time design teams will find one assistant onsite and available to help. Additional assistance may be obtained by contacting a teaching assistant by email. Details will be forthcoming.

Teams: Teams will be self-selected (form your own teams) and consist of 4-5 members each. Instructors may institute special requirements for team selection.

Deliverables: ALL REPORT DELIVERABLES MUST BE PREPARED ACCORDING TO THE ATTACHED GUIDELINES – SEE 'Team Design Project Reporting Guidelines'

1. **Progress Report #1: Background/Introduction, Project Description, andSpecifications (due 9/24, 10 points)**. Based on the Design Objective stated, prepare and submit a Progress Report that includes:
    a. Project background. Using the materials compiled from design-project related homework questions, if appropriate, as well as additional resources,provide background information that explains the societal context of – or societal need for – renewable resources, and the potential role that solar energy could play. At a minimum, include:
        i. information on energy consumption both globally and nationally;
        ii. energy production by various energy resources, including renewable sources; and
        iii. adiscussion of the pros and cons related to solar power installations (photovoltaic as well as hot water).

        Include references for the information you use.
    b. A brief description of the project task. Explain what you were tasked with (the *Design Objective*), and why the design of this product is important. Describe who will benefit from your design, how your design will be marketed or distributed, and how your design will impact society at large. *Include references for the information you use.*
    c. A list of specificationsthat includes:
        i. the performance requirements of the design; and
        ii. theconstraints for the project(these are provided in the problem statement).
    d. Any additional performance goals and constraints that may be identified by your team (include an explanation for these additional items).

2. **Progress Report #2: Results of Brainstorming; Identification and Evaluation of Possible Design Strategies; Description of Preferred Approach (due 9/24, 10 points)**.
   Submit a Progress Report that includes:
   a. A summary of the factors that influence the performance of a solar water heater, including a description of which factors can be controlled by engineering design. Keep in mind that "performance" includes the performance requirements for this project, described above.
   b. A description of the results from the brainstorming process completed in class. This should include both a description of the process itself and a summary of the design approaches (ideas) that were generated as a result of the process.
   c. A description of the preferred design approach (the approach your team has chosen to pursue) and why it was selected over the other approaches identified in (b) this should include an explanation of why the other approaches were eliminated. Try to put these design decisions in the context of 1) the information you provide in part (a), and 2) the feasibility of each approach.

Note: A formal brainstorming process will be conducted in class using the methods outlined in Chapter 2, Section 5 of ES 110 Engineering and Society(Moosbrugger, et al.) with a summary similar to that shown on p. 52 (Example 2). Deliverables 1 and 2 may be combined into one document, but must have separate authors.

3. **Progress Report #3: Design of Prototype (due 10/12, 10 points)**: Provide a Progress Report containing:
   a. Asummary (~ one page) of the main features of the prototype design (this should be understandable by a non-technical person, much like a patent disclosure).
   b. Aprofessional-quality,scaled drawing showing the key features and dimensions of the prototype design. *Either*hand sketches*or*computer-aided drawings are acceptable, but drawings *must* be to scale and hand drawings must be of professional quality; rough sketches prepared without measurements or a straight edge (ruler) *will not* be accepted.
   c. A detailed budget, including a complete list of supplies, where they will be obtained, and with itemized costs.

Note: Your report should provide enough accurate detail to enable a person not familiar with your design to construct your prototype using the drawing and text you provide.We will conduct a peer-review of this Progress Report in class on the due date, with the final edited version due on Monday 10/15. The original version with peer comments should be attached to the final version. Details will follow.

4. **Progress Report #4: Prototype Build and Test procedures (due 11/7, 25 points): Each design team will provide a Progress Report describing the build process, the test procedures, and the test results (b-e, PR):**
   a. A description of the build process and any iterations required.

b. A description of the test procedures. As you plan your test procedures and perform the testing, keep in mind that the goal of the engineering design process is to deliver a product that meets specifications or performs as advertised.

c. A summary of the test results (both qualitative and quantitative). See note above regarding design process.

d. A brief summary and explanation of any design modifications resulting from the testing process. *Optional: Include a photo showing build and test.*

5. **In-Class Presentation and Final Product Demonstration (7 minutes): Design Iterations; Final Design and Prototype;and Prototype Demonstration (due ca. 11/28, TBA, 25 points): Prepare and present a power point presentation (~ 7 minutes or less) that includes:**

   a. Asummary of your prototype design (original design, and design iterations, and prototype design).

   b. A summary of the main features and advantages of your prototype.

   c. A summary of your test procedures and results including design modifications.

   d. A description of the final design.

   e. A demonstration of the final product showing that it meets the specifications and adheres to the design constraints.***While all team members must be present, it <u>is not</u> a requirement that <u>all</u> team members speak****.*

   10 points for performance:

   1. **Water flows successfully through the system with no leaks or spills.**

   2. **Bench-scale solar water heater is able to raise the temperature of the water by at least 1.5˚C, measured as the difference between the initial water temperature and final temperature at the end of the test period (5 minutes or less).**

   3. **Cost efficiency of system is at least 200 Joules/$US.**

   4. **Energy efficiency of system is successfully calculated using data collected during the demonstration.**

   - **0 points: (0/4 of above)**
   - **3 points: (1/4 of above)**
   - **6 points: (2/4 of above)**
   - **8 points: (3/4 of above)**
   - **10 points (4/4 of above)**

6. **Final Report* (due 12/6, 20 points):** Submit a final report that is prepared according to the attached guidelines. Deliverables submitted previously (or materials included in them)may be included as appendices and referred to in the main body of the report for details.

ES 110 Engineering & Society – Fall 2012
Group Design Project

Note: The self- and peer-evaluations (described below)must be completed by each team member using the attached form and submitted with the final report in order that the final design projectbe considered "complete" andproject grades computed and assigned!!

Grading: Each team member will receive an individual score for the project, computed according to the attached grading procedure and rubric. In most cases, each member of a team will receive the same score. Occasionally, however, someone will simply not put forth much effort or will contribute virtually nothing to the project and this will be clear from the peer evaluations. Such individuals will receive a lower score, accordingly.

******** Team Design Project Reporting Guidelines *********

These guidelines must be followed for all Progress Reports and the Final Report. Progress and Final Reports do not need to be extensive, but must convey the necessary information in a clear, concise manner. Ideally, one group member will be primarily responsible for writing portion of **each** of the 5 deliverables (the 4 written progress reports and the final report). The designated person will change for each new deliverable. This method is to provide each student with a chance to have technical writing practice in the course.*Since this is a group project with a team grade, it is strongly encouraged that all team members review all reports and pay particular attention to grading feedback before writing their own sections.*

All reports are to be typed in 11 or 12 point font, with 1-inch margins and page numbers bottom center or bottom right. Hand-written reports will be returned with a 0 grade. Calculations, where present, can be hand-written, but must follow the same guidelines for that of typed fonts. (However, use of an Equation Editor is strongly recommended.) When possible print all reports double sided.

Each Report must contain a Title Page with the following information:

- Title (e.g., Progress Report #3: Design of Prototype)
- Date
- Team Members (names *with signatures*)
- Group member responsible for writing the report

The **Final Report** should be roughly 5 to 6 pages long *excluding* sketches, drawings, appendices, figures, tables, etc.). Deliverables submitted previously (or materials included in them) may be included as appendices and referred to in the main body of the report for details. A word of caution: if a progress report was poorly graded, do not include this as an appendix – rather, correct your mistakes as you re-write these sections in the final report document.

In addition to the Title Page, the **Final Report** must contain the following sections:

1. Introduction (introduce the design problem at hand; provide background information similar to what you prepared for Progress Report #1)
2. Design Criteria and Performance Standards (briefly summarize; include technical, societal and economic constraints)

3. Prototype Design Summary (summarize the process used to design prototype and the results of that process)
4. Build and Test (describe the building and testing procedures; include results and modifications)
5. Prototype Demonstration (summarize results of the in-class demonstration; present and discuss the results that your team achieved and briefly discuss your observations of the other demonstrations; specifically note any observations/conclusions that you can make regarding design choices and their effects on performance). Remember to include and discuss the results from the in-class demonstration including **the energy efficiency of the system that you calculated using data collected during the demonstration.**
6. Recommendations (present recommendations for improving the design for "commercial development;" specifically, based on (5), what design changes do you recommend based on your demonstration and your observation of the other demonstrations?)
7. Appendices (include detailed budget, receipts for purchases, recalculations, sketches and drawings, progress reports, figures and tables that are not embedded in the text)

Team Design Project Final Report Grading Rubric

		Weight	Points (1-10)
Introduction	Design problem clearly defined	0.1	
Completeness	All required report sections are included; materials submitted as earlier progress reports that are included as appendices are briefly described in text and clearly located in appendix; incomplete or weak progress report information is sufficiently improved in the appropriate sections of the final report	0.5	
Demonstration	Process and results of in-class demonstration are clearly described	0.2	
Recommendations	Brief; potential improvements are discussed that would enable wide scale production and implementation	0.1	
Appendices	Extra materials well organized, appropriate, and easy to interpret	0.2	
Professional presentation and communication, Mechanics	Text, graphics, drawings and tables neat and generated with appropriate computer tools; Tables, figures, drawings, calculations are used appropriately and effectively	.3	
Organization, Focus	Logical flow of material between sections that aligns with basic design process; Purpose of report overall, and each section, clearly defined; Reasonable number of section headers to guide reader	.3	
Grammar, paragraphs, spelling	Sentence structure concise and appropriate for technical communication No spelling, tense or plural/singular agreement errors	0.3	

Total points: (max 20)

Team Design Project Overall Grading Procedure
(descriptions apply to max positive or negative points)

A. Group Assessment: The product of 0.75 and the sum of point allocations for deliverables 1 through 6 _____(maximum 75 points)

B. Individual Assessment (25 points; points assigned based on peer evaluation and at the discretion of the instructor)

Team member contributed at or above average for the group _____ (maximum 25 points);

orTeam member did not do anything _____ (minimum of $-1\times$total of A. Group Assessment, so that project grade = 0);

or somewhere in between the above _____ (between -75 and 25).

C. Project Grade = Score for A + Score for B

_____ (maximum 100 points)

ES 110 Engineering & Society – Fall 2012
Group Design Project

Team Design Project Self-Evaluation and Peer Evaluation Form

This form must be completed in confidence at the completion of the project by each team member on the project team, and submitted with the project in individually signed and sealed envelopes.

Please rate the contribution toward the team project of each team member in your group **including your own**. Provide a score between 0 and 10 for each member and then elaborate on what particular each member contributed. Feel free to write additional comments at the bottom of the form.

Estimated Time Required To Complete Project (hours): _____

Time You Actually Spent on Project Tasks (hours): _____

Group: _____

Name	Score (0 – 10)	Contribution to the Project

Comments on team contributions/performance:

_____

_____

_____

_____

Signature and Date: _____

Name (print): _____

Another Brick in the Wall

Submitted by: Irving Oppenheim
Carnegie Mellon University
ijo@andrew.cmu.edu

12-100 Introduction to Civil and Environmental Engineering **Spring 2012**

Project 1. "Another Brick in the Wall"

Schedule

Distribution of project description	February 1
Timing studies for wall construction	February 8 (scheduled 20 minutes/group)
Submission of individual exercize	February 13, 2:30 PM
Submission of group bid document	February 15, 11:30 AM
Wall construction	February 15 and 17
Presentation of oral reports	February 22
Submission of written reports	February 29, 5:00 PM

Introduction

This project is an exercise in construction planning and scheduling. Your group is a construction company bidding on a project for Pink Floyd Properties; Professor Oppenheim is the President of Pink Floyd and Tim Lam (tglam@cmu.edu) is the Project Manager. Your group must choose a construction plan, prepare a cost estimate and schedule for the project, and then execute the construction. To generate the cost estimate your group must determine the tasks needed to complete the project, the sequence and durations of those tasks, the schedule of those tasks, and the material quantities. Remember that some tasks cannot be started until other tasks are completed (one task must precede the other), whereas some tasks can proceed in parallel. The construction schedule must be submitted as a Gantt chart prepared using Microsoft Project; the Gantt chart will identify when tasks are scheduled to start, when tasks are scheduled to end, and when the entire project will end.

From this project, you will learn some of the important aspects of construction planning and management. This project has four parts:

1. Determine cycle times for the tasks during a practice session.
2. Generate and evaluate alternate construction plans, select your proposed plan, and submit the cost estimate and schedule (the bid document) for your plan.
3. Perform the construction, competing against your own predicted schedule.
4. Conduct further study to determine if you would revise your schedule were you to repeat the project.

Problem Description

The project your group will bid and construct is a brick wall, depicted in Figure 1. It is nominally 64 inches long, equivalent to eight bricks positioned end-to-end, 8 inches thick, corresponding to two wythes of brick, and approximately 16 inches high, corresponding to six courses of brick. The owner (Pink Floyd Properties) wants the wall to be built at lowest cost, and requires that the project be completed within a specific time limit. As with any construction project, you will provide the owner with a sealed and confidential bid document that states how much it will cost and how long it will take to build the wall. The owner has obtained engineering estimates of the cost and time required for the construction process, which will not be revealed to the bidders, and the owner expects that all responsive bids should be near those estimates. In any event, you will be required to execute the project according to your own schedule and specifications.

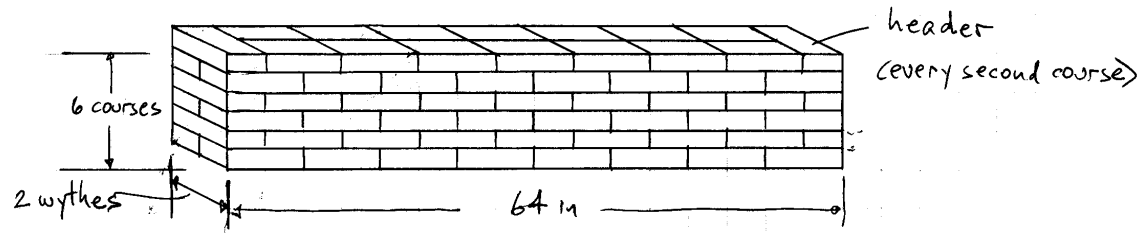


Figure 1. Sketch of wall (NTS; not to scale)

The wall must be solid; you cannot leave out any bricks or blocks. Within each wythe the bricks must be staggered, meaning that the vertical joints (properly termed the head joints) should not line up; in masonry terminology, this means that you cannot use a "stacked bond" but must use a "running bond." The two wythes must be interconnected by at least two header bricks in every second course of brick. These features are pictured in Figure 1.

Use of Microsoft Project 2010

In this activity you will use Microsoft Project 2010. That software program is installed in BH 140E, in Wean, and in the West Wing Collaborative clusters. Handout 4, together with the lecture on February 1, will introduce you to that application.

Resources – Materials

Two brick suppliers compete for your business. Local zoning authorities have established weight limits for trucks, permitting only a particular number of bricks per load. There may also be headway constraints, establishing a minimum time interval between pickups. The first supplier is Grant Building Supply and they are located near PH 101. For many years Grant has been the only local supplier, but now competition has entered the local market. The second supplier is Lee Products, and they are located near PH 107A, which is closer to the construction site. When all things are considered, it may not be immediately evident which supplier is less expensive.

Resources – Labor

Your team will require two different types of workers: truckers and masons. Truckers have the task of loading bricks at one of the suppliers and delivering them to the laydown area at the job site. Masons have the job of taking those bricks from the laydown area, moving them as needed on the job site, and laying them in place in the wall. Work rules limit masons to carrying no more than 6 bricks at a time. The pay scale for trucker is different than that for masons. Each trucker and each mason is paid for the time duration of their shift. For example, trucker A might start at t=0.0 min and end the shift at t=8.0 min, trucker B might start at t=3.0 min and end the shift at t=9.5 min, and mason C might start at t=4.0 min and end the shift at t=11.0 min. Trucker A would be paid for 8.0 min, trucker B would be paid for 6.5 min, and mason C would be paid for 7.0 min. A trucker or a mason cannot split their shift, but a worker can complete one shift as a trucker, pay a $50.00 training fee, and then work another shift as a mason. Your group has four people[1] in it, and you must decide how many workers to use. One trucker and one mason? Two truckers and one mason? Two truckers and two masons? Your company operates its own trucks

[1] If your group has only three people in it, you can draft a TA to become the fourth worker.

(which look like buckets) and your workers must begin and end their shift at the jobsite where your construction office is located, at the laydown area. Your bid price should be the total cost that you estimate, plus 10% to represent your profit. On February 8 you will practice the three individual tasks (truck cycle to Grant, truck cycle to Lee, mason cycle) to obtain the cycle times.

Other Constraints

Construction is often performed on sites that offer limited area for storage; in this project, there may be a constraint on the number of bricks that can be stored in the laydown area at any time. Moreover, truck drivers are not permitted to run, which would be the equivalent of speeding, and therefore only a walking pace is permitted. Police will be patrolling! (Masons are not permitted to run either, by union rules.) The job site, laydown area, and brick-source areas have been laid out, and you can only place bricks on those prepared areas. The clock stops when the wall is completed and all workers have returned to the construction office, at the laydown area.

Cycle Times (Productivity data)

On February 8 your group will have a 20-minute slot in which you are to practice the three different work cycles. You are to obtain an average time for each cycle, and you must use those three cycle times for project planning. (For planning purposes, you may make an engineering decision to round up, adding a small margin in your cycle times as protection against unforeseen delays, and as protection against a penalty for failing to finish on schedule.) You cannot use different times for different group members. When you execute the project you will not have a time manager, and you will not be able to adjust your work to the clock. Your group should therefore fill in the following blanks, and show these times in your reports.

Trucker, laydown area to Grant, load, return, and unload _____ seconds

Trucker, laydown area to Lee, load, return, and unload _____ seconds

Mason cycle, laydown area to wall site, masonry work, and return _____ seconds

Material Unit Costs, Labor Wage Rates, and Site Information

The wall must conform to the dimensions specified. It will be constructed from brick, available to you at the two locations specified. In order to estimate the cost of the structure to be built, you have to compute the costs of the materials in the structure and estimate the cost of the labor to build it. The material and labor unit costs, as well as site information and project restrictions, are summarized below.

This project will consider three different geographical settings. Groups 1 through 5 will use one set of unit costs and zoning restrictions, groups 6 through 10 will use a second set, and groups 11 through 16 will use a third set.

Unit Costs and Zoning Restrictions for Groups 1 through 5

The jobsite is an open, undeveloped industrial park in the western part of the country. The distance between the jobsite and the two supply locations is great, which we will simulate physically by tripling the travel distance, requiring the trucker to make an extra trip on each leg. (That is, the trucker goes jobsite to supply location, back to jobsite, back to supply location, and only then picks up the material. That same trucker then goes to jobsite, back to supply location, back to jobsite, and only then delivers the material.) Brick costs are high in this part of the country, because the materials are not manufactured nearby and must be shipped in from afar.

Contract Requirement:

Project Time Limit	13:30 (min:sec)

Material Costs:

Brick, Grant Building Supply	$0.85/unit
Brick, Lee Products	$0.75/unit

Labor Costs:

Mason	$7.20/min
Truck Driver	$4.20/min

Zoning Restrictions:

Maximum Truck Load (Grant)	8/truck
Maximum Truck Load (Lee)	8/truck
Minimum Truck Headway (Grant)	None
Minimum Truck Headway (Lee)	None
Maximum Storage at Laydown Area	No limit
Maximum Mason Load	6 bricks

Unit Costs and Zoning Restrictions for Groups 6 through 10

The jobsite is a crowded inner city location on the East Coast, severely limiting the storage at the laydown area. Brick costs are high, because the supply locations have high real estate costs. The masons are unionized, and the mason load (the number of bricks placed in one mason cycle) is less than in other parts of the country.

Contract Requirement:

Project Time Limit	12:00 (min:sec)

Material Costs:

Brick, Grant Building Supply	$0.80/unit
Brick, Lee Products	$0.70/unit

Labor Costs:

Mason	$7.20/min
Truck Driver	$5.40/min

Zoning Restrictions:

Maximum Truck Load (Grant)	6/truck
Maximum Truck Load (Lee)	8/truck
Minimum Truck Headway (Grant)	40 seconds
Minimum Truck Headway (Lee)	40 seconds
Maximum Storage at Laydown Area	8 bricks
Maximum Mason Load	4 bricks

Unit Costs and Zoning Restrictions for Groups 11 through 16

The jobsite is in the midwest. Material costs and labor costs are relatively low.

Contract Requirement:

Project Time Limit	11:00 (min:sec)

Material Costs:

Brick, Grant Building Supply	$0.60/unit
Brick, Lee Products	$0.50/unit

Labor Costs:

Mason	$7.20/min
Truck Driver	$4.20/min

Zoning Restrictions:

Maximum Truck Load (Grant)	6/truck
Maximum Truck Load (Lee)	6/truck
Minimum Truck Headway (Grant)	None
Minimum Truck Headway (Lee)	40 seconds
Maximum Storage at Laydown Area	20 bricks
Maximum Mason Load	6 bricks

Project 2 Grading

Individual Scheduling Exercize (due 2:30 PM, February 13)

In the first part of this project your group must select four alternate construction plans, and in the two group submissions (the Bid Document and the Final Report) your group must explain why those particular alternatives were selected for study. Each member of the group must also, as an individual, study one alternative and generate a cost estimate and a project task schedule, and you must submit your individual scheduling exercize, in the form of an individual report, by 2:30 PM on February 13. The task schedule must include an activity precedence table and a Gantt chart produced using Microsoft Project. Your report on your individual scheduling exercize will be worth 20 points toward your individual score on Project 1.

Bid Document (due 11:30 AM, February 15)

Your group must analyze and discuss the four different alternatives that were studied, choose one as the basis for your bid, and then document that alternative in your bid document, which is to be submitted by 11:30 AM on February 15. Your submission, with the grading sheet as its cover sheet, must present the "as-bid" information: the total cost for the project, the work breakdown for each task, and a detailed task schedule. The task schedule must include an activity precedence table and a Gantt chart produced using Microsoft Project. This part of the document must be short and concise; the task schedule will be used for field inspection purposes by the owner's representatives. You must also include a brief description of each alternative, perhaps a paragraph in length, a cost and time estimate for each alternative, perhaps best represented in a table, your justification for the alternative you chose to bid, as well as the detailed cost and time breakdown for your bid. The bid document will be worth 20 points.

Wall Construction (February 15 and 17)

Timekeepers will control the two supply locations, and truckers must identify their group number and name to receive clearance to receive each load of bricks. The construction activity will be worth a total of 10 points. Five points are earned for completing the project within the prescribed time limit. Five points are assigned for project quality; lack of quality would include irregular brick placement in the wall, accidents during construction, bricks placed outside the laydown or job site (cardboard) areas, speeding tickets, and so on. Five points are awarded by comparing the cost and time of your actual construction to that of your bid and to that of the engineer's estimate. The scoring process is relatively complex; it will depend upon whether your bid is near the engineering estimate, below the engineering estimate, or above the engineering estimate, and if your completed project is below, near, or above your own bid. The purpose of this scoring system will be discussed in class, and you should refer further questions to the Project Manager (tglam@cmu.edu).

Final Report (due 5:00 pm, February 29)

The final report should be prepared following the outline given on the attached grading sheet, which is to be used as the cover page for the report. Your construction work will be monitored by timekeepers, and you will receive the as-built data for your project from which you will calculate

the actual cost and duration. In this final report, you must discuss your reasons for choosing a particular alternative, and provide the details of this alternative; you must then discuss in detail what happened during the construction process. This should include a discussion of any accidents, confusion, or anything that was not anticipated in your planning. What was your completed cost, and how was this cost computed? What was your completed construction time? How did your completed timeline compare to what you predicted? (You should include one Gantt chart for the original bid and another Gantt chart for the completed project, both using Microsoft Project). If your cost and timeline were different from those predicted, why do you think they were different? Moreover, you should return to the study of alternatives; if you were to submit a new bid, how would it be different? Make appropriate changes in your cycle times, choose and evaluate additional alternatives, and present an updated bid for the "next" construction project. The report must include a Table of Contents with the items listed on the grading sheet. The final report is worth 50 points.

Oral Reports, Groups 1, 2, 6, 7, 11, and 12 (February 22)

This semester, each group will make a verbal presentation of one project. The six groups listed above are designated to present oral reports for Project 1. You should describe the overall project, the alternative plans considered, the key aspects of your bid, and the performance of your group in meeting cost, schedule, and quality objectives. Every member of the group is required to speak, and the presentation should be organized and developed by the whole group. The presentation must be between 6 and 8 minutes in length. PowerPoint presentations are required; submit your PowerPoint files via the digital drop box in Blackboard by 11:00 AM on the day of the presentation.

12-100 Introduction to Civil and Environmental Engineering **Spring 2012**

Project 1. "Another Brick in the Wall"

Grade Sheet for Individual Scheduling Exercize (20 pts) **Due February 13, 2:30 PM**

Group Number: ____ Name: _____

Description of alternative being studied	5 points	_____
Describe, in words, the alternative for which you are providing a schedule; outline, in words, the three other alternatives that your group is considering; tabulate the cycle times you (and your group) are using		
Detailed cost estimate	5 points	_____
Detailed schedule	10 points	_____
Gantt chart - activity precedence table - duration of each task - critical path highlighted - chart properly presented - chart shown on one page - legends etc. properly labeled		
TOTAL	20 points	_____

12-100 Introduction to Civil and Environmental Engineering **Spring 2012**

Project 1. "Another Brick in the Wall"

Grading Sheet for Bid Document (20 points) **Due February 15, 11:30 AM**

Group Number: ____ Members: _____

_____

_____

_____

Alternatives 10 points _____

Describe the possible alternatives that were considered
-tabulate the cycle times your group is using
-explain the engineering reasons for the alternatives that you selected to study
-briefly describe the specific characteristics of each alternative
-summarize the time and cost estimates

Detailed cost estimate of selected alternative 5 points _____

Explain or discuss why the alternative is economical

Detailed schedule 5 points _____

Gantt chart
- activity precedence table
- duration of each task
- critical path highlighted
- chart properly presented
- chart shown on one page
- legends etc. properly labeled

TOTAL 20 points _____

12-100 Introduction to Civil and Environmental Engineering **Spring 2012**

Project 1. "Another Brick in the Wall"

Final Project Report (50 points) + Construction (10 points) **Due: February 29 5:00 PM**

Group Number: ____ Members: _____

_____ _____ _____

REPORT GRADING

General			
	Title page; neatness, table of contents	3 points	_____
Introduction		7 points	_____
	Objective. Describe the purpose of the report		
	Description. Describe the items addressed		
	Describe the role of team members		
	Describe the organization of the report		
Narrative description of construction project			
	(when?, what?, where? and how? the different stages of the project were conducted).	10 points	_____
Actual project cost and schedule		10 points	_____
	Detailed cost estimate (breakdown of materials, time, labor, unitary costs and final cost)		
	Detailed schedule (Gantt chart using MS Project)		
Discuss differences between estimated and actual		10 points	_____
	Table comparing times and costs (breakdown of materials, time and labor, unitary costs and total final cost for estimated and actual)		
	Discussion of differences		
New Project Bid			
	New cost estimate (breakdown of materials, time and labor, unit costs and total cost as estimated and as actually constructed)	5 points	_____
	New schedule (Gantt chart using MS Project)	3 points	_____
	Final conclusions	2 points	_____
REPORT TOTAL		50 points	_____

CONSTRUCTION GRADING

Completion within time limit	5 points	_____
Project quality	5 points	_____
CONSTRUCTION TOTAL	10 points	_____

Backwater Blues

Submitted by: Irving Oppenheim
Carnegie Mellon University
ijo@andrew.cmu.edu

12-100 Introduction to Civil and Environmental Engineering **Spring 2012**

Project 3. "Backwater Blues"

Schedule

Distribution of project description	April 9
Signup for (April 18) time slots	April 11
In class activity, measuring dissolved oxygen	April 18
Sampling	April 18-23
Submission of group interim report	April 25, 2:00 PM
Lake testing	April 25
Presentation of oral report	May 2
Submission of group final report	May 4, 5:00 PM

Introduction

Your group has environmental engineering responsibilities for the Allegheny National Forest, and you report to Aniela Burant (aburant@andrew) who is the chief engineer. With much fanfare, over Ms. Burant's protests, the legislature permitted the Happy Carrot Health Food Store, of Greenwich Village, to open small food processing plants on five pristine lakes within the forest. The company produces natural, organic, vegan, green, macrobiotic foodstuffs such as soups, and the legislators and news media thought it was a perfect example of environmental ethics. However, shortly after the plants started operating, there was a massive die-off of fish in all five lakes.

It was determined that the byproducts discharged into the lakes, although natural and organic, consumed most of the dissolved oxygen (DO) and left none for fish respiration. Your group is to take DO measurements in one particular lake and then predict whether that lake will be sufficiently reaerated to be restocked with fish on April 25. You will study the mathematical model (a first-order differential equation) used by environmental engineers to predict reaeration, and the laboratory methods or field methods used to measure DO. You must make various engineering judgments about your data, and other judgments about tradeoffs you encounter within your decisions. The five lakes are assigned to different groups as follows:

Table 1. Group Assignments

Lake name	Groups
Cathedral Lake	1,7,5,13
Electric Lake	2,8,10
Iceberg Lake	3,9,14
Lonesome Lake	4,11,15
Lost Lake	6,12,16

On April 18 your group will receive instruction in measuring DO in a water sample using a Hach AccuVac test kit. Between April 18 and 23 your group will have the opportunity to sample (measure) the DO in your lake. From those sample data you must predict the DO concentration in your lake on April 25, when the lake is to be restocked. Unfortunately, the powers-that-be did not learn their lesson about the risk of great fanfare, and they have scheduled live television coverage of the restocking process. A further die-off remains a possibility, and your engineering expertise and judgment is needed to minimize the possible embarrassment.

April 11: Signup for time slots

On April 11 your group must sign up for a 20-minute time slot on April 18, when you will learn to make DO measurements. Therefore, you must communicate with your group members in order to co-ordinate your schedules and to establish your preferred time slots.

April 18: Training session, measuring dissolved oxygen

A number of different methods can be used to measure dissolved oxygen, and many products (laboratory equipment, field equipment, chemical test kits, and so on) are marketed for that purpose. We will use the Hach AccuVac test kit, in which the water to be sampled is drawn into a magic vial which is originally a sealed and evacuated (vacuum) volume. The vial is submerged in your water sample, you break its tip (underwater!), and it takes in the water without admitting any air. The vial contains chemicals which cause the resulting solution to change color and thereby indicate the DO concentration. The test kit includes a color disc with which you match the color in your vial to read the DO concentration. (People who are blind or color-blind will be excused from this particular exercise.) The quoted measurement range is 0-15 mg/L, with a "smallest increment" of 0.2 mg/L. At your training session each member in your group will be given a vial with which to make a measurement. In each test it might be instructive for every group member to practice reading the color disc; do you all get the same reading? In your session it will be interesting to compare the measurements from the four different vials.

Project Objectives

Your group has two objectives in this project. The first objective is to predict the DO concentration in your lake on April 25 when the grand restocking is scheduled at 2:30 P.M. The second objective is to study and comment on the expected fish mortality, with possible alternatives. Each of these two objectives involves a number of interrelated engineering tasks.

For example, the prediction of DO concentration will include the following steps:

- Your group will be provided with only five vials for DO measurement. When should you take your first measurement? When should you take your second measurement? When should you take subsequent measurements?
- What do your data indicate? Do you have confidence in interpreting those points? Real data may refute your expectations, and may be contrary to careful theories that we teach you. If such questions emerge, do you have possible remedies?
- At some point, can you extract a reaeration constant? Can you predict the DO concentration on April 25? Do your predictions change within the sampling period?

Regarding fish mortality, you have a justified concern that the political appointees managing this event may not properly quantify the implications, and your group is asked by the chief engineer to study the question and, if appropriate, to make some suggestions. The study of fish mortality may include the following steps:

- Regrettably, there is a mortality rate in this process while you wait to stock the lake. For your particular lake, does this tradeoff suggest stocking the lake early?
- There is another, more dramatic, mortality as the fish are transferred into the lake, which varies with the DO concentration. For your particular lake, does this tradeoff suggest that Ms. Burant should postpone stocking this lake?
- Do the circumstances suggest revising the plan, perhaps stocking some lakes but not all?
- Is a fish die-off a bad thing, or might there be benefits to it?

Dissolved Oxygen and Reaeration

Water contains dissolved oxygen, which is necessary to support aquatic life. The solubility of oxygen in water (the saturation concentration of DO) will vary with temperature, with the presence of other chemical species in the water, and so on. For example, the saturation concentration is 14.6 mg/L at 0 ^{o}C, 10.1 mg/L at 15 ^{o}C, and 7.6 mg/L at 30 ^{o}C. In this project you are to assume that a DO concentration of 8.7 mg/L represents saturation.

Different life forms (from bacteria to plants to fish) demand DO, as do biological waste products, as do some chemicals, as do (in this case) some byproducts of food processing. In this instance that last category appears to have consumed much or all of the available DO. The topic of biological oxygen demand is treated in engineering courses in water quality and water chemistry, but we will adopt a much simplified view of the topic in this project.

A natural body of water will reaerate after its DO is temporarily reduced. You will assume that reaeration is best described mathematically by the first-order differential equation described in Handout 10. The reaeration constant, k_r, is typically influenced by surface area, flow rate, turbulence, temperature, and so on. For example, a well-respected environmental engineering text (Masters and Ela, *Introduction to Environmental Engineering and Science*, Prentice Hall, 2008) summarizes reaeration constants for bodies of water, such as a range of 0.10-0.23 day^{-1} for "backwaters" or a range of 0.46-0.69 day^{-1} for "large streams of normal velocity." (These typical constants, and their units, are discussed in Handout 10.) However, in this project you cannot use any such information, and your estimate of the reaeration constant must be based totally on your measured data.

The discharge from the Happy Carrot processing plant may have consumed all DO, creating a dead lake with a DO concentration near zero. In the recovery process, some finite amount of time (perhaps many days) might elapse during which oxygen is consumed as rapidly as it enters the water. That is, the DO concentration may stay near zero (may remain "on the floor") before measurable reaeration begins. Figure 1a shows the expected reaeration curve, observed after the DO has been driven partway down, but Figure 1b shows a two-part reaeration curve that might apply to your lake. Therefore, your group must decide whether your lake is described by Figure 1a, for which you must find the reaeration constant k_r, or by Figure 1b, for which you must find both the date on which reaeration begins, t_r, as well as the reaeration constant, k_r. Your decision is likely to be made much more difficult by the inherent scatter in real data and by your limited opportunity to acquire data.

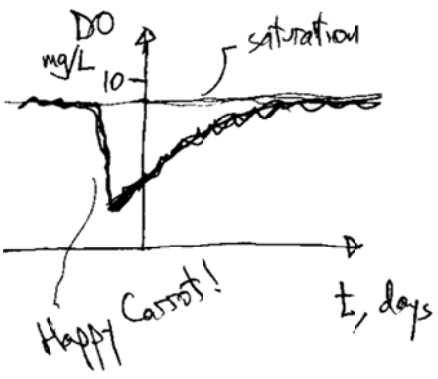


Fig. 1a. Reaeration after partial depletion

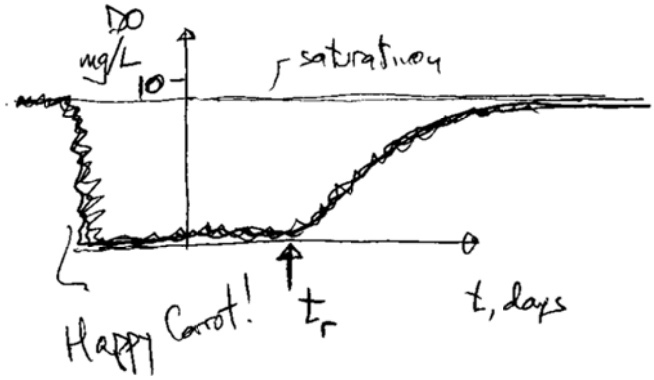


Fig. 1b. Reaeration after total depletion

Fish Mortality at Hatchery and during Fish Stocking

(This is fictional, but is introduced to enable your group to discuss some engineering choices.)

Fish hatcheries have been ordered into action, to provide 12,000 fingerlings of each of three species. All 36,000 fingerlings will be ready on April 23. However, a fisheries manager now points out that the fingerlings have a mortality rate of 1% per day, so fish will die in the days between April 23 and 25. If you have confidence that your lake should be stocked on April 23, you can make that recommendation by email to the chief engineer (Aniela) but it must be received prior to 6:00 PM on April 22, in order to schedule the early stocking the next day. You must accompany that recommendation with your prediction of the DO concentration on April 23, as well as your regular prediction of the DO concentration on April 25.

Someone also produces data regarding the one-time mortality rate as fish are stocked into a lake, as a function of DO concentration. The data are incomplete, and they vary among the three species, but they are presented to your group because they may imply some fish mortality in the lake for which you have responsibility. (Note: this problem is *not* characterized by a normally distributed random variable. If you choose to address with this question, you have only these data and your judgment to guide you.) The available mortality data are summarized as follows:

Table 2. Fish mortality at stocking

Species	DO for 10% loss	DO for 5% loss	DO for 1% loss
Dogfish	6.5 mg/L	7.1 mg/L	7.7 mg/L
Slimeheads	5.1	5.8	6.5
Weasleys	6.3	6.9	7.3

April 18 – April 23: Lake Sampling

Like many real world problems, your group will have only limited data upon which to base your analysis and your decisions. Sampling times will be announced for six dates, April 18 through April 23, and you have resources to take no more than five DO measurements. When should you schedule your sampling? You should consider possible strategies and their implications. For example, if you sample early and often and get a clear indication of reaeration at a rapid rate, it might lead you to recommend early stocking of your lake on April 23. However, if you sample early, on multiple occasions, and your measurements are all near zero, then reaeration has not yet started and you might not have enough samples left to obtain the reaeration constant. Your group must consider the implications and develop a plan.

April 25: Submission of Group Interim Report (due 2:00 PM)

You must present your predicted DO concentration in a report on April 25 by 2:00 PM, before the 2:30 ceremony when the official measurement will be made by the chief engineer and the scheduled restocking will occur. This report must contain your discussion and recommendations, including suggestions for a different schedule or different strategy for restocking. This report is to be complete, addressing everything you have discussed in your group. However, it is an interim report because at the time you submit it you will not have seen the "final" DO measurement and you will not have had the overview of all five lakes. Your final report will then incorporate all additional information (including the fish mortality) that emerges on April 25.

April 25: Lake DO Measurement and Fish Stocking

As noted above, at 2:30 on April 25, with news media present, the chief engineer will officially measure the DO concentration in all five lakes and will preside over the fish restocking. Your group may be called upon to assist in the cleanup of dead fish.

GRADING

Aniela Burant (aburant@andrew.cmu.edu) is the co-ordinator for Project 3 and will be responsible for scheduling the activities and for grading the projects. For all questions of project interpretation, scheduling, and grading, please communicate with Aniela using email.

April 25: Group Interim Report

You must submit your engineering calculations analyzing the lake assigned to you within your group. Your report must include graphs showing the raw DO data collected and describe this behavior in context of Fig. 1a or 1b in this handout. Explain how you chose your sampling schedule. In addition, show the analysis (graphs, equations) used to determine the reaeration constant for your lake. You must also include the calculation of the predicted DO on April 25.

May 4: Group Final Report

Your group must submit a final report that documents the overall project; it must contain an executive summary, an introduction, problem statement, content, discussion, conclusions, and so on. The report must present the results of your laboratory tests. Your report must describe, fully, the behavior of your lake, and must contain discussion of how your predictions compare to your observations. You must provide calculations for the fish die-off. Make recommendations for when to restock your lake. Then compare all five lakes and explain your recommendations on which lakes to stock and when to stock them. You should also comment on uncertainties in your measurements and your predictions. The reports should be prepared using the format specified on the attached grading/cover sheet.

Comments on Final Report Grades

Poor reports most often result from a lack of co-ordination and effort. All members of your group are collectively responsible for the completeness, accuracy, and consistency of your report. Simply dividing up the effort amongst the group members, and then waiting for the pieces to arrive (often at the very last minute), is not recommended. Please take pride in your work.

May 2: Oral Reports from five groups

This semester, each group will make a verbal presentation of one project. Groups 5, 10, 14, 15, and 16 are designated to present oral reports for Project 3. You should describe the overall project, the technical approach, and the performance of your group's structures. Every member of the group is required to speak, and the presentation should be organized and developed by the whole group. Presentations should be interesting and informative to a class of first-year students; humor is encouraged. PowerPoint presentations are required. The presentation must be between 6 and 8 minutes in length.

12-100 Introduction to Civil and Environmental Engineering Spring 2012

Project 3. "Backwater Blues"

Grading Sheet for Group Interim Report due: April 25, 2:00 PM

Group Number: ____ Members: _____

_____

_____

_____

Executive summary	10 pts total		
	Organization and scope	5 pts	___
	Quality of writing	5 pts	___
Introduction	10 points total		
	Describe the problem	6 pts	___
	Describe the organization of the report	2 pts	___
	Describe the role of each team member	2 pt	___
Data Collection	15 points total		
	Describe the DO test method	2 pts	___
	Explain your data collection schedule	5 pts	___
	Present raw data collected	5 pts	___
	Discuss uncertainties in data collection	3 pts	___
Data Analysis	25 points total		
	Explain the behavior of your lake (Fig. 1a or 1b)	5 pts	___
	Present and explain the reaeration rate analysis	8 pts	___
	Present calculations to predict DO on April 27	7 pts	___
	Discuss uncertainties in the DO prediction	5 pts	___
	Present calculations for fish die-off	10 pts	___
Discussion and Conclusions	20 points		
	Recommend when to restock your lake	10 pts	___
	Overall summary	5 pts	___
	Conclusions and recommendations	5 pts	___
	TOTAL	80 points	_____

12-101 Introduction to Civil and Environmental Engineering Spring 2012

Project 3. "Backwater Blues"

Grading Sheet for Group Final Report due: May 4, 5:00 PM

Group Number: ____ Members: _____

_____

_____

_____

Executive summary	10 pts total		
	Organization and scope	5 pts	___
	Quality of writing	5 pts	___
Introduction	10 points total		
	Describe the problem	6 pts	___
	Describe the organization of the report	2 pts	___
	Describe the role of each team member	2 pt	___
Data Collection	15 points total		
	Describe the DO test method	2 pts	___
	Explain your data collection schedule	5 pts	___
	Present raw data collected	5 pts	___
	Discuss uncertainties in data collection	3 pts	___
Data Analysis	35 points total		
	Explain the behavior of your lake (Fig. 1a or 1b)	5 pts	___
	Present and explain the reaeration rate analysis	8 pts	___
	Present calculations to predict DO on April 25	7 pts	___
	Discuss uncertainties in the DO prediction	5 pts	___
	Present calculations for fish die-off	10 pts	___
Discussion and Conclusions	30 points		
	Compare 4/22 results to predictions	5 pts	___
	Discuss insights gained from testing	5 pts	___
	Recommend when to restock your lake, and compare and make recommendations for all 5 lakes	10 pts	___
	Overall summary	5 pts	___
	Conclusions and recommendations	5 pts	___
TOTAL	100 points		_____

Bridge Over Troubled Waters

Submitted by: Irving Oppenheim
Carnegie Mellon University
ijo@andrew.cmu.edu

12-100 Introduction to Civil and Environmental Engineering **Spring 2012**

Project 2. "Bridge over Troubled Waters"

Schedule

Distribution of project description	February 29
Signup for time slots	March 2
Testing of wood and string specimens	March 7
Submission of individual analysis report	March 21, 2:30 PM
Truss construction	March 22-26
Testing of bridge structures	March 28
Presentation of oral report	April 4
Submission of group final report	April 11, 5:00 PM

Introduction

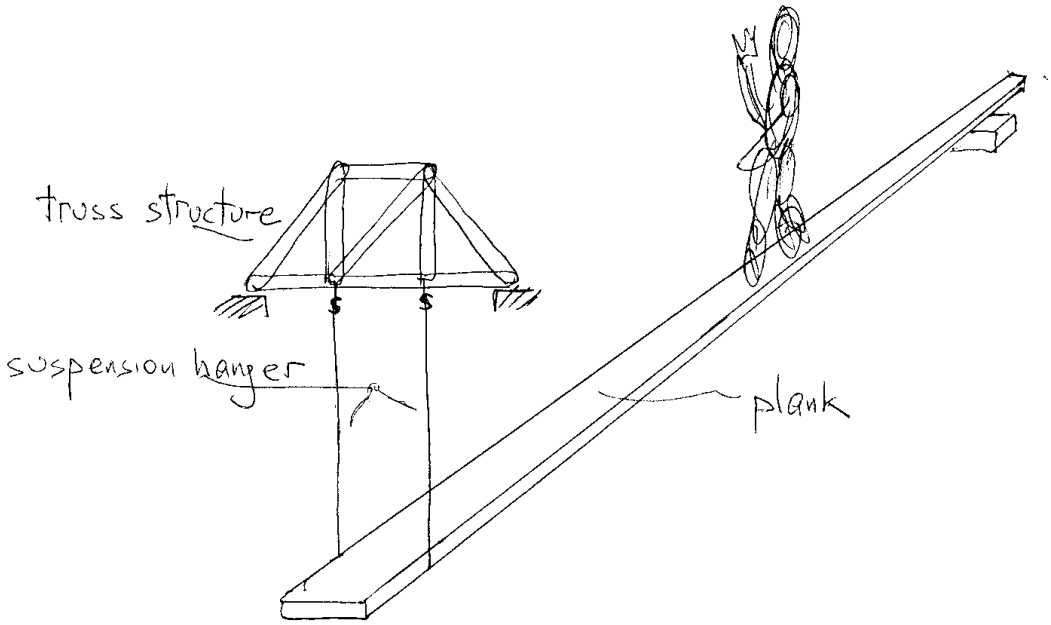


Figure 1. Bridge construction, employing a truss structure, a suspension hanger, and a plank

This project involves structures that bridge horizontal spans to support a load, and in doing so several major topics within structural mechanics will be introduced. In this instance, three different structures are involved. Your instructor (weighing 180 lb) will walk along a plank (weighing roughly 40 lb) that spans a distance of 10 ft, north-south. At its south end the plank will be supported on blocks, but at its north end it will be suspended from a truss structure; you will design the suspension hanger, using cables that resemble kite string, and you will design and build the truss structure, using wood bars that resemble popsicle sticks.

Many bridges are constructed as truss structures, referring to triangulated frameworks that carry loads (applied at their joints) by developing pure tension or pure compression within their bars. This is perhaps the broadest and most recognizable family of major bridge structures. Truss

structures became feasible only when materials (such as steel) were developed that are strong both in compression and in tension, and that can be connected to one another at joints. The principles of force vectors and free body diagrams enable us to analyze such triangulated truss structures, and in our lectures and homework exercizes you will learn to do so.

Some bridges can be envisioned as *beams*, structural members capable of resisting internal *bending moments*. The simplest type of beam is a plank, and this project includes the study of wood planks. The strength of a plank or beam, meaning the load it will carry before it fails, was another of the great problems of antiquity and the renaissance. It was understood that the load at failure would depend upon the span length, the width and depth of the beam cross-section, and the material itself. How can one predict (calculate) the load at which failure will occur? The answer that we use as modern engineers was developed between the 17^{th} and 19^{th} centuries, and is summarized by the principles of internal bending moments, theory of elasticity, and stresses induced by bending which you will learn in our lectures and homework exercizes.

You will also learn relevant principles of statistics and use them to establish engineering information about the wood bars that you will use in your truss and the string that you will use in your suspension hanger. (As for the wood plank along which your instructor walks, you are not responsible for its design, but he is.)

Your group will receive a set of six bar specimens and six string specimens. On March 7, your group will test those specimens to obtain statistics of the bar failure stress and the string failure force. You will use that information to make design choices, and failure predictions, when you design the truss structure and the suspension hanger. Your group will consider four or five alternate truss structures, and on March 21, before class, you will each submit an individual analysis report on one structure. Your group will choose one structure as your best design, and between March 22 and 26 your group will construct that truss structure. On March 28 your structure will be tested, after which you will compare your prediction of its strength to your observation (measurement) of its strength.

March 2: Signup for time slots

On March 2 your group must sign up for a 30-minute time slot on March 7 in which you will test your wood and string specimens, and for a total of 4 hours during the March 22-26 time period in which you will construct your truss structure and your suspension hanger. Therefore, you must communicate with your group members in order to co-ordinate your schedules and to establish your preferred time slots.

March 7: Testing of wood and string specimens

On March 7 your group will perform laboratory tests to find the load at which bending failure occurs in six samples of the wood bars, and in which tension failure occurs in six samples of the string. Data sheets are attached, and they should be used by each of you when you perform those experiments. For each wood bar test you will record the cross-sectional dimensions of the specimen, the span, and the failure load. From each wood bar test you will calculate a failure stress for the wood, and from the set of six tests you will obtain a sample mean and sample standard deviation for the wood failure stress, expressed in lb/in^2. Similarly, for each string specimen you will record the failure force, from which you will obtain a sample mean and a sample standard deviation.

Project Design Objectives

Your design objective is to choose a truss and a suspension hanger, at reasonable cost, that will achieve a target level of structural safety when your instructor walks the plank. The definition of the target level is that the probability of failure in the suspension hanger should be no greater than 5%, and the probability of failure in the most highly-loaded truss member should be no greater than 5%. (In the real world the equivalent probability of failure would be perhaps 0.0001% over the 100-year life of the structure. We have purposely distorted our definition of structural safety in order to have some excitement when we test your structures.) You must calculate the probability of failure for those two particular elements for the worst load case, which occurs when your instructor reaches the end of the plank. You are to calculate the strength of a bar as its cross-sectional area multiplied by the failure stress that you observed in your bending tests; it is understood that the strength of such members would be better estimated using more advanced principles from structural engineering, but for this project you are to use this simpler concept.

It is understood that the strength of the string, the bars, and the joints is not under your control. You will be graded on how accurately you perform the necessary calculations based upon your test data, and not on the success or failure of your particular structure. Most significantly, you will also be graded on your investigation of different structural choices.

If there were perfect understanding of structural behavior, then the objective might be stated as building a structure with minimal cost that achieves the target level of structural safety. However, many issues are uncertain, and in this project you are invited to consider them and discuss how they might influence your recommendation of a structural choice. These conditions are to be considered within your group and discussed in your report. You cannot go outside your group (that is, you cannot go to the instructor or to the TA) to discuss those questions; they are part of your group design exercize.

Truss Design: Geometric Constraints

We keep this problem in 2-D by sandwiching your truss between two sheets of plexiglass in a test frame, like an ant farm. The test frame imposes these geometric constraints on your truss:

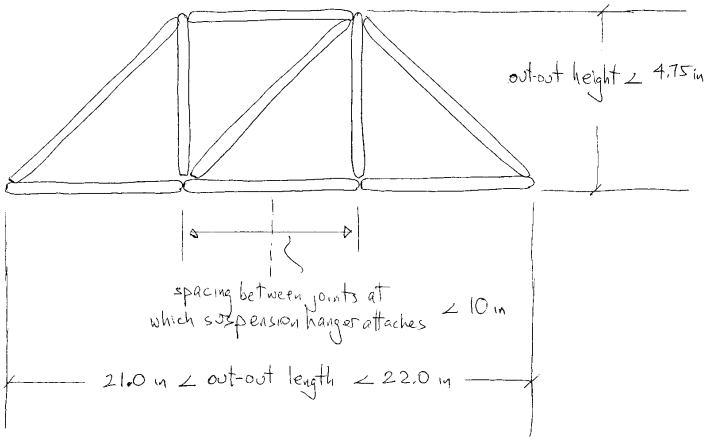


Figure 2. Sketch showing geometric constraints

Figure 2 is only a representative sketch. For example, the bars supplied for this project are roughly 4.5 in long and 0.375 in wide, and it would be impossible to build the truss in Figure 2 with bars of that size. Similarly, Figure 2 does not show how the bars are to be connected.

Truss Design: Structural Choices

You must choose a truss geometry that satisfies the geometric constraints, that satisfies the structural rules (meaning that it is triangulated, and that loads are applied only at joints), and that is effective and economical at carrying the applied loads. You are to calculate the strength of each bar as its cross-sectional area multiplied by the failure stress information that you obtain from your specimen testing.

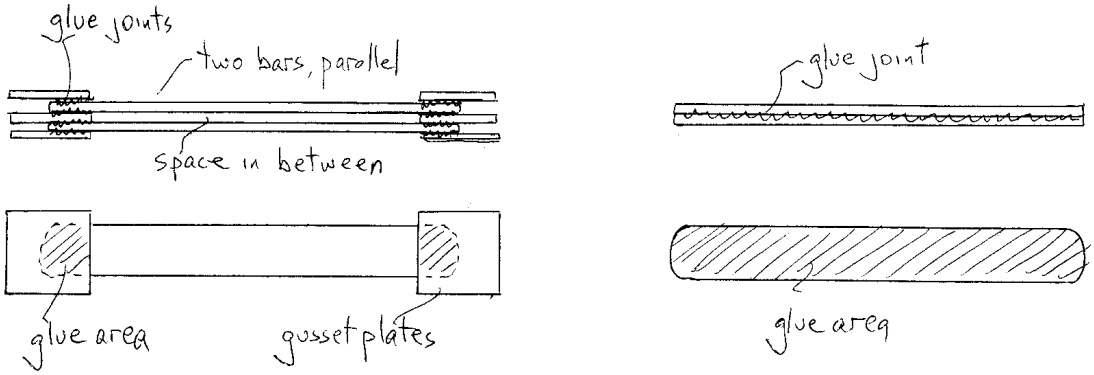


Figure 3. Permissible two-bar member, at left, and an impermissible doubly-thick bar, at right

You have the further choice of building individual members from one or two bars in parallel, but you cannot glue bars together along their whole length to create a doubly-thick bar. Figure 3 shows the difference between a two-bar member (two bars in parallel), which is permissible, and a doubly-thick bar, which is not.

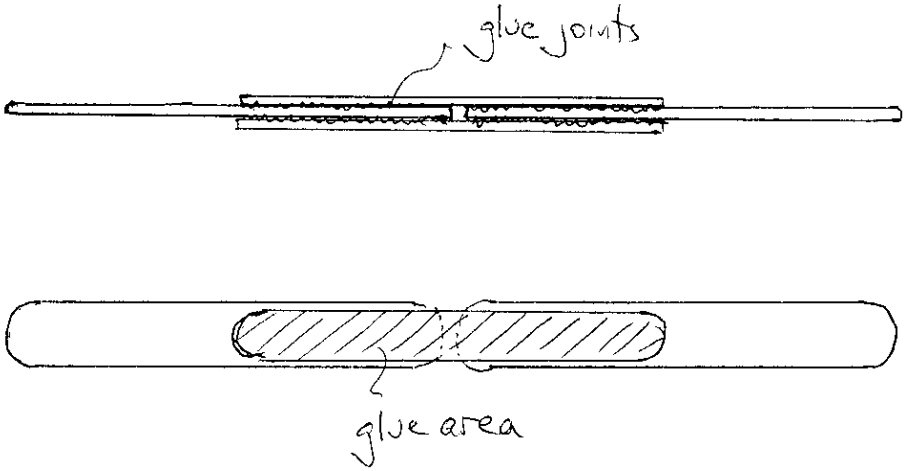


Figure 4. Double-length bar created from four single bars

You have one other choice, termed a double-length bar. You can take four bars and join them in the configuration shown in Figure 4 to create a bar that is roughly 9 in long. It features two bars, one on the front and one on the back, acting as splices to join the two primary bars into one double-length bar. The advantage of the double-length bar is the greater freedom it provides to meet geometric constraints; for example, you could fabricate double-length bars, cut some of them to lengths of roughly 7 in, and then build a truss similar to the one shown in Figure 2. A double-length bar must reduce to a one-bar member at each of its ends, and its strength is calculated as equal to that of a one-bar member. The double-length bar will be more costly, and it may raise other engineering questions for you to consider.

Truss Design: Construction Constraints and Cost Calculations

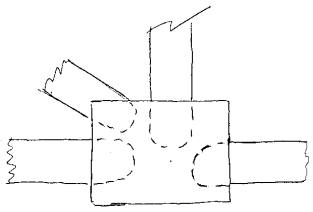


Figure 5. Sketch of gusset plate

Connections at all joints are to be made using *gusset plates*, as sketched in Figure 5. You are not permitted to overlap bars at joints; bars are glued to gusset plates, front and back. Ideally, you want the bars meeting at a joint to be concentric, and you want to have sufficient area for glue contact to each bar. Your structure will rest upon the testing frame at its two support points, and the joints at those two locations should anticipate that condition.

Similarly, the bridge inspectors will hitch their testing slings around the two joints where the suspension hanger is to attach, and the joints at those two locations should anticipate that condition. Those testing slings will terminate in S-hooks. Your suspension hanger will attach to those same S-hooks, and must conform to the dimensions and details presented below in Figure 6. In proper terms, the bridge inspectors will use girth hitches to engage the truss joints, and your suspension hanger will form a basket hitch around the plank.

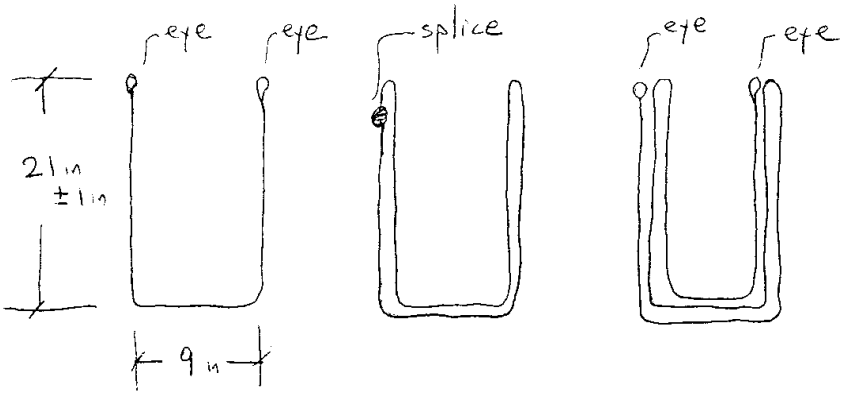


Figure 6. Sample suspension hanger configurations; one-strand, two-strand, and three-strand

Sample suspension hangers are shown in Figure 6, corresponding to one-strand, two-strand, and three-strand examples. Suspension hangers built with an odd number of strands must be fabricated with two eyes (loops), one at each end, as shown. Suspension hangers built with an even number of strands must be fabricated as one long loop with one splice (knot), as shown. These fabrication choices will make the suspension hangers self-adjusting, in terms of equalizing the tension in different strands.

Your basic cost for a bar is $10.00, and your basic cost for each gusset plate is $2.50. If you build a two-bar member, your basic cost will be $20.00 and you will also need additional gusset plates. Your basic cost for a double-length bar is $25.00. If you cut bars to a shorter length, or to achieve a specific end angle, you pay the basic cost for that bar plus $2.00 for each cut that you make. Your cost for the suspension hanger is $5.00 per strand; that is, your cost is $5.00 for the one-strand configuration, $10.00 for the two-strand configuration, and so on.

All joints must be of equal overall thickness for the test frame to maintain your truss in 2-D. If all of your members are one-bar members, then all of your joints will be uniform in thickness, consisting of the bar thickness and two gusset thicknesses. However, if you mix one-bar members with two-bar members, then your joints will be of different overall thicknesses. You must then add plates (from the gusset plate supplier) to act as *spacer plates* to maintain a uniform overall thickness. Spacer plates are provided at no cost, but you must correctly determine the number that you will need, you must correctly indicate them on your truss drawing, and you must use them only as a spacers and not to transmit forces at the joints.

February 29 – March 21: Truss Calculations

One subtask within this project is to perform a truss analysis using the method of joints, to determine the force in each member under the design loading. Your group will use the results of those analyses to compare different truss configurations, and then to design the members in the truss that will be tested. Your group should choose four (or five) possible truss configurations, and then each group member must independently analyze one truss. Your individual analysis report is due on March 21, and you must keep a copy to share with your group. In your individual analysis report you only need to produce the table of forces in all members. You need not perform the member design, or make the statistics calculations, or choose an overall design.

In order to complete a truss analysis using the method of joints, it is necessary that your truss be statically determinate and (in the parlance of structural engineering) "simple." For a 2-D truss supported at its two ends, that condition will be satisfied if one uses triangles and if the number of joints, j, and the number of bars, b, satisfies this relationship:

$$2j-b=3$$

This is a simplified version of a deeply insightful observation offered by the great physicist James Clerk Maxwell.

March 21 – 26: Truss Design Finalization and Truss Construction

Your group must then choose a truss, finalize its design, and construct it; you must also design and construct your suspension hanger. All construction must be done in the Au lab, under the supervision of course TAs. The truss construction materials are wood bars, precut gusset plates, and wood glue. Binder clips will be provided to clamp the joints while the glue dries. Your group must schedule a total of 4 hours to perform the construction; you will be permitted to request 2 additional hours, for a total of 6 hours, but that is the upper limit. You are not permitted to build a truss, test it, and then build a second truss.

March 28: Testing of Bridge Structures;

On March 28, with a break for ice cream, we will test the 16 structures. You should bring a camera, and you are to collect data to review the overall statistics of structural failure. You are expected to discuss those observations in your final report.

GRADING

Yujie Ying (yying@cmu.edu) is the co-ordinator for Project 2 and will be responsible for scheduling the activities and for grading the projects. For all questions of project interpretation, scheduling, and grading, please communicate with Yujie using email.

March 21: Individual Analysis Report

You must submit your engineering calculations analyzing the truss assigned to you within your group. Your report must include a sketch of the truss with its dimensions, the calculations (including all necessary FBDs) for the reactions and for the method of joints, and the table summarizing your results.

April 11: Group Final Report

Your group must submit a final report that documents the overall project; it must contain an executive summary, an introduction, problem statement, content, discussion, conclusions, and so on. The report must present the results of your laboratory tests, and it must give an engineering description of your truss structure and your suspension hanger. Your report must describe, fully, the behavior of your structure, and must contain your discussion of how your predictions compare to your observations. You must discuss what you learned by watching the performance of the structures built by the other groups. The reports should be prepared using the format specified on the attached grading/cover sheet.

Comments on Final Report Grades

Poor reports most often result from a lack of co-ordination and effort. All members of your group are collectively responsible for the completeness, accuracy, and consistency of your report. Simply dividing up the effort amongst the group members, and then waiting for the pieces to arrive (often at the very last minute), is not recommended. Please take pride in your work.

April 4: Oral Reports from five groups

This semester, each group will make a verbal presentation of one project. Groups 3, 4, 8, 9, and 12 are designated to present oral reports for Project 2. You should describe the overall project, the technical approach, and the performance of your group's structures. Every member of the group is required to speak, and the presentation should be organized and developed by the whole group. Presentations should be interesting and informative to a class of first-year students; humor is encouraged. PowerPoint presentations are required, and the presentation must be between 6 and 8 minutes in length.

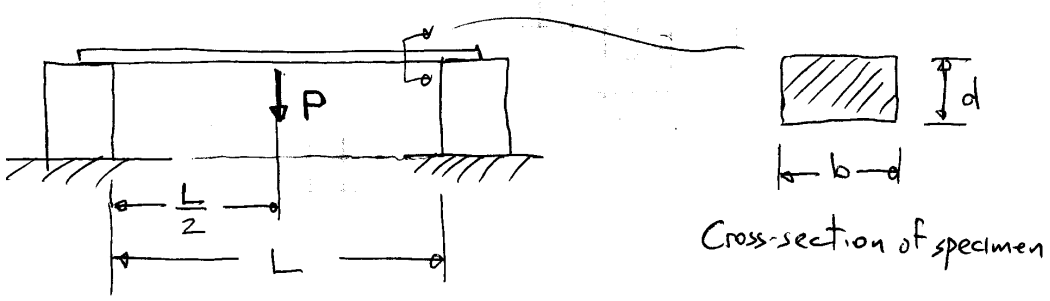
12-100 Introduction to Civil and Environmental Engineering

Project 2: "Bridge over Troubled Waters"

Group Number: ____ Name : _____

Data Table for Testing of Wood Specimens

Test	L [in]	b [in]	d [in]	P [lb]	$S = bd^2/6$ [in^3]	$M_{center} = PL/4$ [lb·in]	Failure stress ($\sigma_{failure}$) = M/S [lb/in^2]
1							
2							
3							
4							
5							
6							



Sample mean of the failure stress: _____ lb/in^2

Sample standard deviation of the failure stress _____ lb/in^2

12-100 Introduction to Civil and Environmental Engineering

Project 2: "Bridge over Troubled Waters"

Group Number: ____ Name : _____

Data Table for Testing of String Specimens

Test	Tension failure force, [lb]
1	
2	
3	
4	
5	
6	

Sample mean of the failure force: _____ lb

Sample standard deviation of the failure force _____ lb

12-100 Introduction to Civil and Environmental Engineering Spring 2012

Project 2. "Bridge Over Troubled Waters"

Grading Sheet for Individual Truss Analysis due: March 21, 2:30 PM

Group Number: ____ Name : _____

Truss analysis

Sketch of truss geometry, with dimensions	4 points	_____
Calculation of reactions	2 points	_____
FBD and equilibrium for first joint analyzed	2 points	_____
FBD and equilibrium for all other joints	10 points	_____
Table of analysis results, clarity	2 points	_____
TOTAL	20 points	_____

12-100 Introduction to Civil and Environmental Engineering Spring 2012

Project 2. "Bridge Over Troubled Waters"

Grading Sheet for Group Final Report due: April 11, 5:00 PM

Group Number: ____ Members: _____

_____

_____

_____

Executive summary	10 pts total		
Organization and scope		5 pts	___
Quality of writing		5 pts	___
Introduction	10 points total		
Describe the problems		6 pts	___
Describe the organization of the report		2 pts	___
Describe the role of each team member		2 pt	___
Member strength	10 points total		
Present strength measurements		2 pts	___
Present statistical analysis of data		3 pts	___
Present calculations for structural safety		5 pts	___
Structural design	35 points total		
Identify and discuss alternatives considered		5 pts	___
Engineering description (incl. sketch) of truss		5 pts	___
Present truss calculations		5 pts	___
Describe member design and construction choices		5 pts	___
Summarize structural safety calculations		5 pts	___
Provide tabulated truss cost		10 pts	___
Discussion and Conclusions	15 points		
Report results of testing		2 pts	___
Discuss insights gained from testing		3 pts	___
Overall summary		5 pts	___
Conclusions and recommendations		5 pts	___
TOTAL	80 points		_____