Use of Competitive Poster Projects in Freshman and Sophomore Level Classes

Clark T. Merkel, Zachariah Chambers
Department of Mechanical Engineering
Rose-Hulman Institute of Technology

Abstract:
We have been using poster projects in freshman and sophomore level courses as a way to develop our students' design, teamwork, and presentation skills, as well as to reinforce the course concepts. Projects for classes are selected pertinent to the specific course material and are run as a competitive challenge to a number of separate teams formed from the students in each class. The projects require actually building a working prototype of the design and competing against other teams in head-to-head competition. In addition to the project competition, a judged, poster presentation on the project is required which is to demonstrate how their engineering skills were applied to the design and analysis of the project. This paper presents some of the different projects that have been used in our mechanical engineering classes. It also discusses how the projects were administered and discusses the strengths and weaknesses of this type of activity as a learning tool.

Introduction:
What is a competitive poster project? It involves a team design project that culminates with both a poster display of the work completed by the team and a competitive event in which the different student teams compete against other student teams with a prototype of their design and construction. The choice of project can vary from class to class, since the focus of the projects are not interdisciplinary, but are targeted very closely to the material and principles which are to be covered in a specific class. The project is to act as an avenue by which the understanding of principles can be strengthened and at the same time allow an open-endedness to create the opportunity for a worthwhile design experience. It should be complex enough to include several of the conceptual principles together, so that the students will need to separate out the problems into a set of smaller tasks. Because the project will also involve actually building a prototype, the project should be simple enough that a team of students with average construction skills will be able to put together a workable prototype. While students generally find the opportunity to actually build a project exciting, the addition of making this into competition makes it even better. The promise of competition tends to draw out even more effort in the majority of students. The grand finale of the project occurs during the final week of the term, when the posters are displayed and judged, and the teams pit their prototypes against each other in competition.

The educational objectives of a poster project include:
--to create a simple focused design experience at a lower class level.

--to foster and nurture teamwork skills in the students.
--to reinforce course content and principles.
-- to allow students to explore construction tools available within the department.
-- to have students get exposure to problems that may not be well defined or have more than one answer.
-- to continue to hone their communication skills by practice.
-- to breath a sense of fun and excitement into the class.

One of the pitfalls for projects with students at this level of development is that they tend to get focused on planning and building on one idea too quickly. They don't always explore other options thoroughly and seem to be more interested in the hands-on building of the project rather than on the modeling and analysis of it. It's as if the building of the project is an end in itself. This type of behavior underplays the more important role of the design steps in the project. After all, the design process is the real reason we are doing the project in the first place.

One reason to expand a regular design project to a competitive poster project is to put more of the focus back on the design process. By incorporating the poster presentation as a well-defined and legitimate part of the project, more focus is returned to the design, analysis, and communication side of the project. This emphasis is reinforced by allocating the majority of the project grade to the poster presentation and not to a successful prototype. It is suggested that around 80% of the grade be allocated to the poster presentation, 15% to the prototype and competition, and 5% to the ability to participate and work effectively as a team. The poster presentation is to be a platform where each team is to demonstrate that they have done a complete and thorough job with their design and analysis.

The type of information which can be included in the poster presentation are details such as

-- team name and team members
-- pictures and/or drawings of the design and prototype.
-- specifications that describe the design
-- a complete analysis using the applicable course principles as they apply to the project.
-- testing data which has been generated to determine the performance of the prototype and how well the data matches the model.
-- a list of steps that explain the design and construction tasks performed to arrive at the final design.
-- a list of safety rules that apply to constructing or operating the prototype.
-- specific requirements to find such quantities as predicted run-times, model strength, or energy efficiency.

Putting together a poster that shows this quantity of information clearly, and in a way that is pleasing to the eye, requires careful planning and layout. Students will need to use a mix of language, graphic, and numerical analysis skills to create a robust poster.

The typical team design experience will occur over a time frame of several weeks, usually scheduled toward the end of the term. During this time the instructor is expected to provide enough structure and definition of the project to keep the teams moving toward their design goal. At a freshman or sophomore level, it is not unusual for students to have difficulty breaking down large problems into smaller more manageable tasks. The more structure you chose to provide at this point will make the design process, and the tasks they need to complete, run more smoothly. The goal is provide the students with a strong enough push so that they will have their design completed with an adequate amount of time left to build their prototype and do a thoughtful job putting together their poster presentation.

During the final week of the term, a contest between the teams' prototypes and a poster competition can be held. The posters are usually displayed along a departmental hallway for judging approximately a day before the prototype competition. This helps generate interest outside of the class and promotes attendance at the contest the next day. The requirement of participation in a final competitive event sets a very definite deadline for the conclusion for the project.

To give a better picture of what is involved in the poster projects that we have used, three different poster projects are discussed in this paper. They have been used in freshman and sophomore level mechanical engineering classes. These projects include a torch powered ball bearing lift used for an introductory thermodynamics course, a rat trap race car used with a dynamics course, and a optimal race track design project that was used for a mechanical engineering computer applications course.

Ball bearing lift:

The topics covered in an introductory thermodynamics course include such concepts as heat and energy conservation, entropy production, exergy, closed and open systems, simple cycles, and efficiency. An appropriate choice for a poster project was to focus on the problem of how do you get useful mechanical work when you have energy available from a thermodynamic source. For this project, each student team was given a propane canister, a torch nozzle, a striker, a 3/4" ball bearing, and a banana. (The banana was a whimsical afterthought meant to add a touch of fun by an eccentric instructor.) They were given the task of using the purely thermodynamic energy of the burning torch to raise the ball bearing through a height of 36 inches and to deposit it in a specified container (a funnel mounted on a tripod). Only the chemical energy released by the burning torch could be used to cause the resulting motion of the ball bearing. In addition, they were to try and accomplish this feat in as short a period of time as possible.

Each team was to brainstorm and come up with possible designs to accomplish this feat. Additionally they were to use their newly acquired background in thermodynamic principles to explain and attempt to quantify how the system transfer of thermodynamic energy to mechanical energy was accomplished. This particular class was being taught during a five week summer session, which made an extensive design process more difficult because of the compressed schedule. The project concept was introduced during

week 2 to allow the students start thinking about possible design options. To move the design process along quickly, each team was expected to pick one of their possible designs during week 3 and focus on how they could make it work. They were to use their thermodynamics knowledge to improve the functionality of their chosen design. This was capped with the building of their design and the competition during the final week.

The poster presentation for this project was to include drawings and/or pictures of their design, a full explanation of the design's functionality, and an explanation of how the thermodynamic energy was converted to mechanical energy. Other information was to include an analysis of any mechanical forces that may be part of their design, any testing done to measure the performance of the prototype, and calculations to find the thermal efficiency of their system. Figure 1 shows one example of the posters students created.

The competition rules were set up to allow each of the four teams two attempts to perform the required feat. The order of competition for the first round was selected randomly. The completion times found in the first round were used to specify the order of the teams in the second round, the fastest team going last. While the overall goal was to be the quickest design to raise the ball bearing, each team was also trying to pass minimum performance goals. The performance goal at the extreme lower end was to create any type of perceptible motion by the prototype. The top level performance goal was to successfully complete the design feat. The level of performance their prototype reached was used to determine small portion of their project grade.

For this class there were four teams of three or four students each. The four teams ended up using three different methods to perform the feat: a closed pressure vessel which built up steam pressure to fire the ball bearing as a projectile (used by two teams) a rotary steam engine with pulley system, and an ice melting system used to cause relative mass displacement. Of these four, three were able to successfully raise the ball bearing through the required distance. Figure 2 show one example of the pressure vessel designs being used during the competition.

In hind sight, there were several difficulties with this project. First, the short session made it very difficult to spend the proper amount of time on design considerations. The students were asked to simply pick one concept quickly and attempt to make it work. More focus was given to getting the prototype to work, than careful planning. Secondly, the analysis of the models was quite inexact. There were significant difficulties being able to determine just how much heat from the propane torch was being delivered to the apparatus and how much was lost to the environment. Finally, compared to other projects, there was a greater need for safety consideration with this project. Use of chemical fuel, open flame, high temperatures, hot metal, and pressurized vessels created more opportunity for someone to get hurt. Fortunately, no one was harmed during this project.

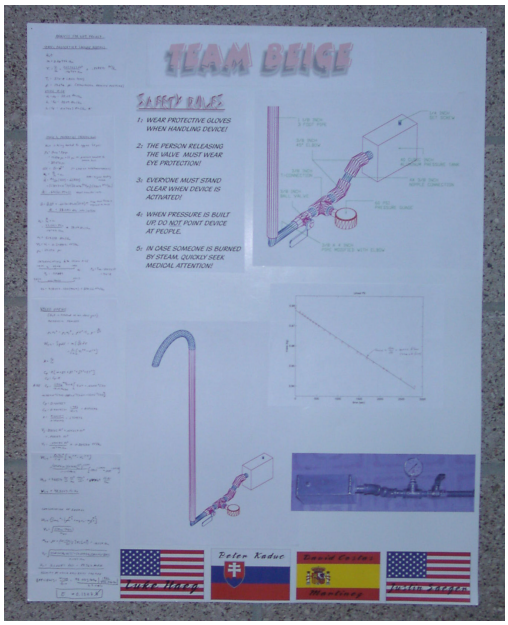

Figure 1. Thermo Lift Poster

Figure 2: Thermo Lift

Rat trap race car project:

The project chosen for a sophomore class of dynamics was the commonly used rat trap race car. Students were given a standard rat trap and instructed to design and build the fastest vehicle they could to race a distance of thirty feet, starting from rest, along a smooth, tiled floor. The vehicles were to be powered by the spring mechanism supplied with the trap. Students were allowed to cut away part of the base and remove nonessential hardware, but were not allowed to tamper with the spring or staples. They were not allowed change the winding of the standard spring. Any additional parts they chose to add to the vehicle would be allowed as long as it didn't provide any additional potential or kinetic energy sources. After designing and building their race cars, they would compete in a double elimination tournament down the departmental hallway during the final day of class.

The poster to be completed for this competition required a description of the function and dynamic analysis of the vehicle. The students were to consider and display principles involving energy analysis, force analysis, acceleration analysis, and vehicle specifications (mass, length, width, height, horsepower, etc). A required part of the poster was to specify and show calculations for the predicted thirty foot sprint time, which was to be based on a dynamic analysis, not on time trials. Additional requirements included a picture or drawing of the vehicle design, team name and a list of team members, and a list of at least five safety rules the team generated for working and using their vehicle. Posters were to be displayed in the department hallway starting at noon on the day prior to the competition and continuing to noon following the competition. All posters were judged on the quality and completeness of the design as well as the clarity and readability of the poster. An example poster is shown in Figure 3.

The race competition was conducted using two vehicle heats in a double elimination tournament. Each team was guaranteed at least two races. In addition to the teams attempting to win their individual heats to progress through the tourney, they were also trying to meet individual performance goals that would be used to determine a portion of their project grade. The minimum performance level was to have designed and built a car that they could set at the starting line (wheels were required). The top performance level was to complete at least two runs in which the vehicle traveled the entire 30 foot distance. Figure 4 shows one race in progress.

Of the seven teams that completed during this class, five produced cars that successfully completed the top performance goal. The two teams that didn't perform well, failed for quite different reasons. One team completed the design process but made poor choices during the construction process and built a car that ran poorly. The last team had difficulty working together as a team and ran out of time to complete the project. While we want all teams to succeed, having teams that fail can also be a good tool if the students can examine the failure and understand why the difficulties occurred.

Many teams also struggled with the analysis of their projects. They had greater than anticipated difficulty applying their dynamics background to the relatively simple vehicle designs. This can be improved by providing a very structured process to help them break the design problem down into individual tasks and concepts.

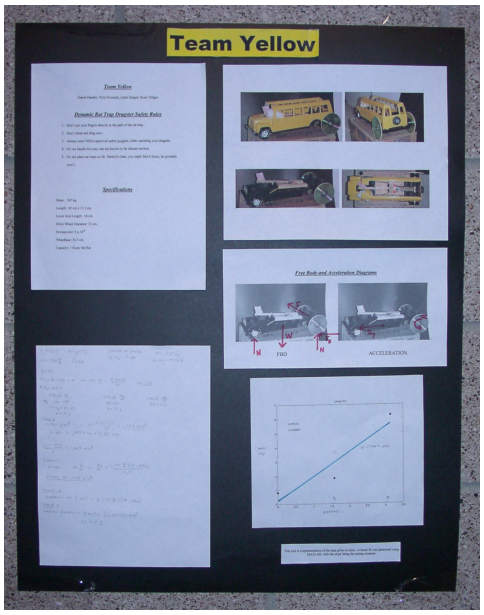

Figure 3. Rat Trap Poster

Figure 4. Rat Trap Race

Optimal race track design:
A race track design poster project at first glance seems like an unlikely choice for a computer applications class. However, this project offers a number of different concepts that can be linked to the numerical methods and coding applications that mechanical engineering students will cover. The first activity with this project occurred the second day of class when the students ran an experiment and recorded a number of different time trials of a test car on a test track. The track used for this test consisted of a ramp section (4 ft drop over 8 ft run) attached to a long horizontal section of track. The time it took for the test car to reach each of eleven different positions along the track was measured by use of stop watches and recorded. Each of four different class sections took nine trials each to create a data base of 36 different test runs, with time readings at each of the eleven positions.

This data base of car position and time would reappear throughout the term and be used repeatedly in homework assignments, programming assignments, and in-class examples. Some of the related activities included:
-- use of finite difference calculations to find velocity and acceleration of the car.
-- calculation of statistical measures for the 36 data sets.
-- calculation of the best fit through a set of points to give a position versus time function.
-- calibration of a differential equation model giving velocity and time versus position.
-- calculations showing how changing track shape changed the run times.
-- writing code to demonstrate how data may be read from a data file in Matlab.
-- comparison to models created in Working Model.
-- creation of a website using HTML to disseminate project and race information.
The process of collecting the original data also made the students aware of other problems that could occur, or that they might want to avoid to produce consistent runs when they reached the point of actually building their own design track.

While the data used from these runs proved useful for many of the classroom assignments and demonstrations, the actual poster project the students would be assigned to complete would be to design a track with the shape to give the shortest time for the car to travel through a given horizontal distance while dropping through a given height. A model of their final design was to be completed by the students prior to construction. In fact, they would be required to build their physical test track to match the shape of the model they came up with. As part of the material covered in the class, a model for a car on a track would be created and simulated numerically using an Euler method and Matlab coding. Additionally, Working Model would be used to study the effect of different track shapes on the car travel time. Students would be required to use one of these methods to generate a predicted run time for their final track. Using these tools, along with behavior they saw at the original test trials, they would find a design to provide an optimal and consistent run-time along the track.

About one week prior to the competition date, students who had completed the design phase would be given a little toy car, two pieces of vinyl siding (for track) and structural material to support their track (a 4' x 8' piece of plywood). Tools and space were made

available for the construction. They were to construct their prototype track to match the shape of the optimal design model they settled upon.

In addition to the poster and prototype competition, this project also required completion of a team project website. This course included an HTML component, so students were required to post information about their project design, analysis, testing, and construction. Each student on the team was to be responsible for authoring at least one page of the website. The poster the team was to create was required to take information off the developed website. If it wasn't on the website, they weren't suppose to include it on their final poster. Information that was to be included on the website, as well as the poster, included the shape of their final design, a mathematical analysis of their design, and the process decisions which explain how they arrived at the final design. Additional information was to include team name and team members, a list of their safety considerations, and any other work or information they had gathered to show they had performed a thorough job on their design. Essentially, the poster presentation was to summarize their website information, which was to describe their design and their design process.

Each of the eight teams in the four class sections competed in their own in-class competitions. The top two teams from each section advanced to an intrasectional competition later that same day and had a run off to determine the course champion. In addition to competing against the other teams, each team was also trying to perform up to their predicted run time. The portion of their project grade allocated to the competition was divided between their best run time performance and their ability to predict the performance from their model. As with the other projects, the communication aspects (the poster and website) accounted for the majority of the grade.

While many teams successfully created a number of computer models of different track shapes, on their actual constructed track they had stability problems due to steep drops or sharp changes in direction that had not been accounted for in the models. These also created for a fairly large spread of different run times since the runs were not uniform. Teams that designed tracks with smooth, gradual drops generally produced consistent runs that were within 10% or 15% of their predicted run time.

Administrative concerns:
After selecting and defining a project, the major job of the instructor turns out to be an administrative role. The better you can define the scope of the project for the students the better they will feel able to complete the project. To discuss some of the time concerns, a suggested schedule is given below for running a project over a ten week session.

Day 1: Introduce the project as an item on the syllabus, but only in a very general sense. Indicate the type of project that will be completed and that it will be performed as a competitive team project. Details for the project will be given during the second half of the term.

Week 4-5: Set up project teams. Using randomly selected teams seems to work better than allowing the students to group themselves. They already have groups they tend to work with and have already established who the leaders and followers are. Random selection will make it easier to reestablish different roles within the groups. Setting up teams earlier in the term, can leave a team undermanned should they lose members due to students who may drop the class. Over the next 1 to 2 weeks use a variety of group or team assignments as homework and/or in-class team building activities to allow the team to learn how the work together. The activities should be designed to force the members to develop dependence upon each other. You should also schedule at least one activity which shows them how to take a large task and break it down into individual tasks, which may be assigned to individual team members to complete. During activities it is suggested that the members assume roles that they are to perform when meeting as a team. The roles the students should play should be rotated from assignment to assignment. Roles that we have adopted include coordinator, record keeper, resource holder, devil's advocate, and scheduler/timer.

Week 6: Present the teams with a detailed and formalized description of the project. Include a clear time line for what and when key aspects of the project are to be completed. Include a set of rules by which the project, poster, and competition will be held or graded. Include a copy of the team evaluation form that they will be expected to complete on their team members. Now is a good time to ask each member to evaluate themselves using the form on how well they perceive themselves to be contributing to the team. One of the first activities might include generating a list of safety rules to follow while working with the project and the completed prototype.

Week 8-9: Allocate some of the scheduled class time in 10-15 minutes chunks to allow the teams to frequently meet to discuss and plan the completion of their project.

Week 10: Allocate one or two class periods to allow the teams to complete their project. Construction will usually be done away from the classroom, so you should give them some time away from the class. Poster projects will be posted a day before the competition to allow for judging and grading of the posters and to use the posters as a way of promoting the event. On the day of the final competition, draft one member from each team to help run the event. Have a set of assigned roles with specific job descriptions assigned to each role. Common roles to assign depend upon the type of event but can include: starter, line judge, announcer, time keeper, recorder, score keeper, and an event official who will be the final say should there be some unexpected need to clarify a rule of the competition.

Final day of class: Hold an awards ceremony during the final class. Also have students complete an evaluation of their team members. Get feedback from the teams on how the project process might be improved.

Project Documents:
Experience has shown that the more structure and detail you can supply to this process, the more smoothly the events and the design experience will run. Copies of some of the documents used for the projects described in this paper have been included at the end of this paper. These include:

Project description sheets of the three projects: In addition to a detailed explanation of the project and any limitations imposed on the design, you should include any deadlines, times and locations of testing or data collection, a list of supplied and allowed materials, and a description of what is expected for presentation of the poster as well as poster specifications. You should also include the criteria by which the poster and project will be graded.

Poster grading form. Since the posters will be judged while hung along a hallway, having a preprinted grading form helps in their evaluation. A copy of this form should be given to each team to help them make sure their poster addresses each point. Students can also be asked to judge other projects as a way to compare their work to the work of the other teams.

Rules of competition and job assignments sheet. It should include a time schedule for the competition and a clear listing of the basic rules. Include a list and description of each job to be filled by the students during the competition. Leave a sign up space beside each job title for the students to formally sign up to do a particular job. The simple act of having a person physically sign up, increases their sense of responsibility and authority to fulfill that role.

A team evaluation form. Teams are expected to provide assessment and constructive criticism of their own members. Indicate on the form that their evaluation will have some effect on the relative grade received by the members. There should be a statement on the form that indicates the form will be held private and confidential so that the students will be free to give their honest opinions.

A project evaluation form. An evaluation form by which the students may provide feedback on strengths and weaknesses of the project, and to make suggestions for making the experience better.

There are other types of tasks that can fall under your job of administering the project teams. If one of the teams start to malfunction, you may have to step in and try to get them back on task. Not all personalities will work well on the same team, and there will be times when teams will seem to be unable to work together.

You may need to round up resources, materials, or testing equipment needed for construction of the project or for use in the competition.

Each project is a little bit different, and will require just a little bit different work on your part.

Conclusion:

This paper has described one method to add more exposure to design, teamwork skills, and cooperative learning to freshman and sophomore courses in mechanical engineering. While many of these courses are traditionally taught with a strong lecture component, adding a design project with a communication component to enhance and reinforce the principles covered by these classes may be a very positive addition. While it is true, that to make room for these additional activities, some of the material usually covered in the course may have to be removed or at least decreased in coverage, the addition of a project offers development of equally important skills. Additionally poster projects have the side benefit of infusing excitement and fun into the course. Most students actually enjoy the opportunity to build a working model of their design and compete with them. Coupling this with a strong communication component, such as the poster sessions, help keep the focus on the process of design. The poster project couples the exposure to design with the thrill of building a project, and packages it together in a competitive event, which most students find both educational and enjoyable.

Example Document 1:
Detailed Project Description: Thermo Lift Project

Torch Powered Ball Bearing Lift Poster Project:
Your thermodynamic project consists of two parts.

Part 1: Design and build a propane powered lift. The lift is to lift a ball bearing from a point no more than two inches off the ground, upward through a height of at least 36 inches, at which point it is to be deposited into a container provided by the instructor (a funnel on a tripod.) The lift will be successful only if the ball bearing ends up in the provided container. Only the torch's chemical energy is available to power your design. The torch must be securely supported so that it will not tip over during use. You are not allowed to tamper with or modify the torch to give excess heat. You are allowed to build as much of an additional system to harness the energy of the torch's heat and a mechanism to raise the ball bearing. Your project will take part in competitive semifinal and final heats against another team's lift. The goal is to be able to lift your ball bearing faster than the other team.
Competition: Friday, June 22nd at 8:30 a.m.

Part 2: Your team is to put together a poster that describes the thermodynamic and mechanical function of your lift. Things to consider covering in your poster include energy analysis, efficiency of system, mechanical forces, and specifications (mass of ball bearing, combustible energy of fuel, power out of your engine, length, width, height, etc). You are required to show an efficiency calculation for your system, based on W_{out}/E_{in}.
Other items required are a picture or drawing of your vehicle, your team name, and the names of the team members. A small portion of your poster will include the 5 safety rules generated by your team. Limit maximum size of poster to 3 x 4 feet. Poster is to be posted on walls in corridor outside Trafton 224/225 by 12:00 noon, Thursday, June 21, and will be taken down after 12 noon on Friday, May 4. Winner of the lift time competition will receive an automatic A for the project. All other competitors will be judged on the quality of their poster project and of their engine/lift design.

Poster/project will be judged and graded on the following criteria:
5 points… Inclusion of required elements:
a) safety rules
b) picture or drawing of vehicle
c) efficiency calculation
d) team name and members names.
e) smaller than 3 x 4 feet.
10 points….Thermodynamic analysis: (completeness, correctness, etc.)
10 points.... Mechanical analysis: (forces and energy of lifting mechanism)
10 points…..Neatness (are you messy or not messy)
5 points…..Clarity (is poster well organized, easy to understand, and interpret)
10 points….Vehicle performance based on:
Lifts ball at least 3 ft during a heat..... ...10 pts.
Lifts ball at least 1 ft during a heat..... 8 pts
Makes at least something move or spin....5 pts
Has a built lift mechanism....……....3 pts
Sets downs a lit torch and ball bearing.... 1 pt

Example Document 2:
Detailed Project Description: Rat Trap Car

Dynamic Rat Trap Poster Project:

Your dynamic project consists of two parts.

Part 1: Design and build a small rat-trap powered vehicle. The vehicle is to be powered solely by use of the spring mechanism supplied with the trap. You are allowed to cut away part of the base and remove other none-essential hardware, but are not allowed to remove or modify the spring or stables holding the spring down. Add as many or as few additional parts to transform the spring potential energy into usable kinetic energy.

The vehicle will be used to race in a sprint competition.
Competition will be a double elimination format.
Sprint length: 30 feet starting from rest.
Sprint Location: The corridor outside of room Trafton E 224.
Sprint Time and Date: Friday, May 4th, at 8:00 – 8:50 a.m.

Part 2: Your team is to put together a poster that describes the function and dynamics of your vehicle. Things to consider covering in your poster include energy analysis, force analysis, acceleration analysis, and vehicle specifications (mass, length, width, height, horsepower, etc). You are required to show calculation for a predicted 30 ft sprint time based on your analysis. Other items required are a picture or drawing of your vehicle, your team name, and the names of the team members. A small portion of your poster will include the 5 safety rules generated by your team. Limit maximum size of poster to 3 x 4 feet. Poster is to be posted on walls in corridor outside Trafton 225 E by 12 noon, Thursday, May 3. and will be taken down after 12 noon on Friday, May 4.
Winner of the sprint competition will receive an automatic A for the project.
All other competitors will be judged on the quality of their poster project and design.

Poster/project will be judged and graded on the following criteria:

5 points… Inclusion of required elements:
- a) safety rules
- b) picture or drawing of vehicle
- c) sprint time calculation
- d) team name and members names.
- e) smaller than 3 x 4 feet.

20 points….Dynamic analysis: (How completely, correctly, and accurately do you show force, energy, and motion calculations)
10 points…..Neatness (are you messy or not messy)
5 points…..Clarity (is poster well organized, easy to understand, and interpret)
10 points….Vehicle performance based on:
- Crosses finish line more than 2 races.. 10 pts.
- Crosses finish line in at least 2 races… 8 pts
- Crosses finish line in at least 1 race…. 6 pts
- At least built the car……...3 pts
- Se ts a bare rat trap at the starting line…1 pt

Example Document 3:
Detailed Project Description: Race Track Design

ME123 Team Project
Race Track Design Project
During the quarter, you have been building up your tools that will now allow you to model the behavior of a car rolling down a track. Your team is now going to design a racetrack that will optimize the time it takes for the Lincoln to travel a total horizontal distance of 30 feet starting from a 4 foot height. The only thing you can change is the shape of the track. The starting ramp will be at the same setting as when you took the race data during the second class period. It is set at an inclination of 15 degrees and delivers the car to the track at a height of 4 ft. You are not allowed to change these parameters. What you do between there and the 30 foot mark is up to your team.

The project will involve four components:
a) Design of the optimal track
b) A web site that describes your design and design process.
c) A poster presentation and competition using only information from your website.
d) Construction and participation in a racetrack competition.
The content of each of these four components are discussed in greater detail further on.

Time Table and Deadlines for Project:
Friday, Feb. 8..... Materials available for construction.
Monday, Feb. 11..... Completion of design with calculated run time.
12:00 noon, Wed, Feb. 13..... Posters to be displayed at site yet to be named.
12:00 noon, Wed, Feb. 13.....Website to be up and running.
Class time, Thursday, Feb. 14.....Completed racetrack required for competition
6:30 p.m. Thursday, Feb. 14.....Final class against class competition
Class time, Friday, Feb. 15.....Team evaluations due.
Morning, Friday, Feb. 15.....Posters to be taken down.

Part A) Car Design:
You are to use Matlab and/or Working model to design a racetrack to give you the smallest possible travel time to cover the 30 foot range. Document the final track shape and the parameters used for your model in enough detail so that others would be able to duplicate your results. You will be expected to use this model to predict a run time. As part of this design process, you should document who, what, and when will complete or work on different parts.

Part B) Website:
Your team will put together a website that describes and explains all aspects of your project. The website will have at least one page for each member of your team. Each page will have a footnote that credits the primary author of that page. Each page should target a focused topic, but there should also be consistent and coherent style from one page to the other. It should have a logical and clear structure to allow the user to comprehend how to move from page to page and where they need to look for the content. Use of a navigation bar is required. It will be graded primarily on content and structure. Very little of the grade will be based on added frills.

Part C) Poster Display:
Your team will take the information presented on your website and put together a poster display which will be posted from noon of the day before the competition through noon of the day following the competition. The poster content is required to include: team name, class and section number, names of the team members, the predicted run-time of your model, and a picture and/or drawing of your design. Additional detail that describes your model and your team design process is encouraged as long as it does not overly clutter and hurt the clarity and legibility of your poster. Only material and content presented on your website is to be used in the creation of your poster. Poster size is limited to a maximum of 12 sq. feet and will be displayed hanging along a hallway yet to be determined.

Example Document 3--continued.

Part D) Race Competition:

Starting on Friday, Feb 8th, the following materials be provided to each team:

One 4' x 8' sheet of 7/16 inch thick plywood

One piece of vinyl siding (This provides two 12 foot tracks)

You are not allowed to use any additional wood or track in your design. The instructors will supply the final flat section of track that will be used to extend your track to 30 ft at the time of competition. Additional tools such as jig saws, saw horses, hammers, hot glue guns will be made available as well as nails, hot glue, and duct tape. Tracks may be built in the Rotz Building. The sectional competitions will also be held in Rotz on Thursday, Feb. 14th. The competition will test your track in two categories: fastest run-time and accuracy of your prediction based on your track's fastest run. The two fastest tracks from each sectional competition will advance to the finals. We will be trying to set up the final competition for Thursday evening in the Union, so there may be an advantage to having some portability to your track design.

Team Evaluation:

A team evaluation form is to be filled out by every member of the team on Friday, the final class day. You are expected to provide serious and honest evaluation of your team's members. These evaluations will be used to adjust grades in the event that there were members who did not function well or participate with the team. Evaluation scores of

0-1.5 will result in two letter grade reductions for the project. Evaluation scores of 1.5 to 2.5 will result in one letter grade reduction for the project.

Project Grading: Your project constitutes 15% of your total quarter grade:

Poster Grade: **(20 points)**

5 points: Inclusion of required elements on poster display:

a) Picture, drawing, and/or schematic of track design.
b) Predicted run-time.
c) Team name, section #, and names of members.
d) Address of project web site.
e) Size of poster must be smaller than 12 sq. feet..

10 points: Description of your track model and your modeling process.

Answer these questions: What design tools did you use? What was the shape of your track? What were the design parameters used? What was your team's design procedure?

5 points: Neatness, Legibility, Clarity (Is the poster easy to read and understand?)

Web-site Grade: (20 points)

5 points: Inclusion of required elements on website:

a) A discussion of your straight ramp model results from Matlab.
b) A consistent style and format must be used across all pages.
c) A screen capture of your final model from Working Model
d) A navigation bar of consistent style on each page.
e) At least one page must be authored by each member of the team.

10 points: Additional content to clearly and thoroughly explain the modeling procedure, work, and construction completed by your team. Please include how the run-time was predicted.

5 points: Ease of use, legibility, clarity, and level of detail used in the website.

Competition (Performance) Grade: (10 points)

Best Run Time:	Closeness of Best Run to Prediction:
under 3 s.....5 points	within 0.2 s.....5 points
under 4 s.....4 points	within 0.4 s .....4 points
under 5 s..... 3 points	within 0.7 s.....3 points
under 60 s.....2 points	within 1.0 s.....2 points
Car doesn't finish.....1 point	within 60 s.....1 point

but team members all make pretend motor sounds during run.

Total Grade: 50 Points: (% of score to individual team members is subject to Team Evaluation Score)

Example Document 4:
Poster Grading Form:

Poster Grading Form:

Team: _____

Members:_____
_____
_____
_____
_____

A) Required Elements: (5 pts)
Safety rules: _____
Picture or drawing:_____
Efficiency calculation:_____
Team names:_____
size less than 3 x 4:_____

B) Thermodynamic Analysis: (out of 10 points total) _____

C) Mechanical Analysis: (out of 10 points total) _____

D) Neatness: (10 points possible) _____

D) Clarity: (5 points possible) _____

E) Vehicle performance (10 points)
based on Lifts ball at least 3 ft during a heat..... ...10 pts.
Lifts ball at least 1 ft during a heat..... 8 pts
Makes at least something move or spin....5 pts
Has a built lift mechanism and engine.....3 pts
Sets downs a lit torch and ball bearing.... 1 pt

Total points:_____(out of 50)

Example Document 5:
Competition Rules and Job Assignments

Rules for Ball Bearing Lift using Propane Torch:

Poster Display:
Poster will be displayed in hallway in Trafton E by Noon, Thursday, June 21 and be taken down after Noon, Friday, June 22. (Look for markers on the wall for location. Tape to attach the poster is available in the ME office.)

Competition:
The project competition will be held starting at 8:30 a.m. on Friday, June 22. It will be held outside, just to the east of Trafton C123 (Look for the orange cones.)

One member of each team will be volunteered to handle assorted jobs to help run the event. Jobs include
1) Announcer: _____
2) Timer: _____
3) Recorder: _____
4) Official:_____
5) Photographer: Instructor_____

Schedule:
8:30 - 8:40 a.m. Project Setup and Volunteer assignment
8:40-8:50 a.m. Safety inspection along with explanation by team describing design
8:50-8:55 a.m. Drawing for order of competition.
9:00 a.m Round 1 competition.

10 minute break

Round 2 competition
(The second round will start with the team which took the longest time in round 1 and end with the team which took the shortest time.)

Teams are allowed to keep the water/steam they used in the first round in their devices, may add more water, or may replace all fluid for their second attempt.
(Burning flame or other heat reservoirs will not be allowed to maintain heat in devices while a team is not competing.)

Following round 2 there will be a prize ceremony
Awards will be given for 1st, 2nd, and 3rd in Best Poster.
1st , 2nd, and 3rd in Competition
and the Best and Most Creative use of a banana in their design.

Example Document 6:
Team Evaluation Form

Team Member Evaluation Form: Team Name: _____

Use the following ratings: 1- Pretty much just watched other members work
2- Contributed some, but not much
3- Actively engaged and participated in process
4- Participated and provided leadership or gave direction to process
5- Pretty much did everything all by themselves
(Evaluations of your team members will be kept private and confidential)

Comment on the contribution of each team member and give them a number rating on the blanks to the right.

Mark Rating on Blanks Below:

Your name: _____ _____ _____ _____
Description of Contribution to team effort: on Poster on Proto Overall

Member name: _____ _____ _____ _____
Description of Contribution to team effort: on Poster on Proto Overall

Member name:_____ _____ _____ _____
Description of Contribution to team effort: on Poster on Proto Overall

Member name: _____ _____ _____ _____
Description of Contribution to team effort: on Poster on Proto Overall

Member name:_____ _____ _____ _____
Description of Contribution to team effort: on Poster on Proto Overall

Example Document 7:
Project Feedback and Evaluation Form
(This is one section of a longer evaluation form that also addressed other programming and applications components taught in the course)

ME123 Course Content Evaluation:

My computer skills prior to taking ME123: expert 5 4 3 2 1 none

My computer skills after completing ME123: expert 5 4 3 2 1 none

.
.
.

Project/Teamwork:

1) the project enhanced my learning experience agree 5 4 3 2 1 disagree

2) the work required for the project at the right level 5 4 3 2 1 too much/little

3) The skills I was taught prepared me for the project clearly 5 4 3 2 1 not at all

4) the use of teams enhanced my learning experience agree 5 4 3 2 1 disagree

5) the use of teams was used at the right level 5 4 3 2 1 too much/little

6) The method of grading team assignments was fair 5 4 3 2 1 unfair

General comments about the project and teamwork requirements.

.

.

.