

ME 14 Final Project Guidelines

(Preliminary Version)

1 Overview

The goal of the final project is to give students a reasonably complete experience with the design process from initial concept to prototype. As discussed below, the final projects will fall into one of the following three categories:

- A *preapproved* project that is chosen from a list of projects. These projects have all been successfully attempted by previous ME 71 students. However, there are enough creative ways to approach these projects that there is ample room for your own innovation.
- A *self-selected* project that is chosen by you or your team members. Note that the project cannot have a potentially harmful use or application, and it must follow the spirit of the Caltech honor system.
- A *sponsored* project that is chosen from a small list of projects. These project concepts are “sponsored” by outsiders who seek to have students build a prototype. As we have discussed in class, a prototype is meant to answer a question, and to reduce uncertainty.

Note that the final projects are not meant to be competitive in nature. First, you must choose the category that best suits your interest and schedule. Second, you need to determine the number of members in your “design team.” Generally, we encourage people to work in teams of two. Group projects involving more than two students are allowed with our consent. The quality and scope of the group projects should be proportional to the number of students involved.

2 Final Project Time Schedule and Deliverables

Here is a quick summary of the major events that need to occur in the Final Project schedule. Details on each event and deliverable can be found in the following sections.

- *Preproposal: May 23, 2014, 3:00 pm.*
 - A description of your project, its goals, and the final “product.”
- *Preliminary Design Review: May 27, 2014*
 - Like the transmission PDR, you will meet with course instructors and T.A.s to review your project plans and designs.

- *Major Project Piece Fabricated: June 4, 2014* (demonstrated to JVD or class T.As. by 5:00 pm)
- *In-Class Project Update: June 6, 2014.*
 - You will *briefly* present your project to the class, the status of your project's progress, and your plans to wrap up your project.
- *Final Project Submission: 5:00 pm on Friday, June 13, 2014.* Note: the shop is very likely to be closed from 9:00 am-1:00 pm on June 13 for the graduation ceremony.

3 Details on Deliverables

The remainder of this section describes the key deliverables for the final project.

1) Preliminary Project Proposal. The preliminary project proposal is intended to describe your project concept in enough detail so that it can be evaluated for the purposes of project approval. This project proposal will consist of:

- (a) The names of the member(s) of your team. You can also select a team or project name as well.
- (a) A text description of your project and its intended operation.
- (b) A discussion of the overall objectives of your project. This is just the preliminary version of the objective tree (i.e, just the first level or two of the objective tree). What are the principal criteria by which you can say that you have a good design?
- (d) A 3-D perspective sketch of one possible design solution for your project, clearly identifying the major components of the mechanism and their relationship. Dimensions are not required. You may use SolidWorks to produce this drawing, but it can be hand-drawn. Note, you are not committed to using this design alternative for your final design. Accompanying conceptual sketches to describe the operation of your device are a welcome addition.

Please email your project proposal to Melissa Tanner (melissa@caltech.edu), or drop them in the box out side of 205 Keck.

NOTE, the act of submitting a pre-proposal DOES NOT automatically guarantee approval of your final project subject matter. We will notify you of acceptance of your project subject and project scope by 5:00 pm on May 23. You are **strongly encouraged** to discuss your project with the course instructors prior to submitting your proposal. Time will be allotted at the end of class on May 22 to facilitate these discussions.

2) Preliminary Design Review.

You should come prepared to the review with the following documents (which you will leave with the review panel):

- (a) Objectives of your project (in a Objective tree form, or in a list).
- (b) A list of required functions, if that is relevant to your project.
- (c) A list of relevant specifications and constraints for the project's objectives and functions.
- (d) A morphology chart that lists several alternative means to implement the project's functions and objectives.
- (e) A summary of any analysis that you may have done on your project.
- (f) A 3-D perspective sketch of your best candidate solution. A SolidWorks rendering is preferred, but not necessary. Additional sketches will detail your mechanism's operation are very welcome.
- (g) Physical "mock-ups" or prototypes which help the review panel better understand your project goals or proposed solution are welcome.
- (h) A list of the materials required to build your project (e.g., aluminum stock, plexiglass, gears, dowel pins, etc.).

3) Engineering Drawings. Note However, final project parts cannot be fabricated in the machine shop unless you have a drawing for that part.

4) Major Piece Fabricated. At least one major fabricated piece must be demonstrated to John van Deusen or to one of the class T.A.s. They will record your demonstration of the part. You can demonstrate this in the shop.

4) In-class Project Update Your team will make a 5 minute presentation with a maximum of 5 slides on the nature of your final project, the current status of your final project, problems you may be having with your project, and your plans to finish your project.

6) Final Project Submission: The final project is due at 5:00 p.m. on the last day of finals (June 13, 2014). Your project should be left at the shop. Your final project submission will consist of:

1. your fabricated device.

2. your “design notebook.” (see below for details)

More details will follow in a separate handout. There can be no exceptions to this due date. Students who do not complete the project by this date will receive a grade based on the portion of the project that is completed at that time. Incompletes may be given for valid reasons, but must be accompanied by a letter from the dean of students explaining why you deserve an incomplete. Students who do not complete the project because of poor planning will not be given the incomplete option.

Because the final project follows very tight deadlines, and because the grading and recording of your various submissions takes some time, it is highly desirable that you turn in photocopies of your submissions and keep the originals for reference.

4 The design notebook

To facilitate grading of the final projects and organization of your efforts, each team member is required to maintain a section in their design notebook that is dedicated to the final project. At the bare minimum, the notebook should catalog the essential information about your project. Preferably, the notebook should also record the significant evolutionary changes in your design. The final contents of the design notebook must include:

- An updated set of drawings showing final dimensions of your completed project.
- A final description of your project. You should note any significant changes from your original concept, and why those changes were necessary. You should discuss both the positive and negative aspects of your design, and how well it met your original objectives. If given more time to work on your project, how would you redesign your solution to improve its “value,” and/or make it easier to produce.

Your notebook should also include:

- any calculations relevant to the design of your project.
- the records of any conceptual exercises that were carried during the design of your project.
- sketches or descriptions that help to describe the thought process behind evolutionary changes in your project.
- “fabrication notes:” notes on issues that arose during the fabrication of your project, and how you solved those issues.

5 Final Project Materials

For your final project, you can use materials that are stocked in the M.E. shop. Some of you will need items which aren't maintained in the M.E. shop. Each student has a budget of up to \$45 to obtain supplies from the central receiving warehouse or from outside vendors. Teams of students can pool this budget for their projects. The cost of any components above the limit will be born by the design team members.

6 List of Pre-Approved Projects

Below are some suggestions for the final project. In each case, you are to design, build, and demonstrate a working device. The projects are loosely stated so as to leave sufficient leeway for individual creativity and initiative.

- **Can Crusher:** Design a human-actuated mechanical device to crush aluminum soda cans for recycling purposes. Quality designs will be visually appealing, require a minimum of human effort, be easy to use, take up a minimum of space, provide thorough and safe crushing of the can, and appear to be durable .
- **Fly-ball Governor:** Before the advent of electronics, the speed of steam powered engines was often regulated by simple mechanical devices, such as the fly-ball governor. As the rotation of the shaft increases, the centripetal acceleration of the rotating masses increases, causing the spring to shorten. The movement of the spring was coupled to a valve so that as the spring shortened, the valve closed, reducing the amount of steam into the engine cylinder, thereby decreasing the amount of power produced by the engine. Design and fabricate a fly-ball governor whose spring will deflect approximately one inch when the shaft is rotating at 360 rpm.
- **Clocks.** Previous classes have made a variety of mechanical clocks, ranging from pendulum/escape mechanism clocks, to water clocks, to rolling ball clocks.
- **Multiple-speed transmission.** Design a transmission for the the drag wheel/motor combination used for the transmission design contest. You must design a transmission that uses at least two different "speeds" (or gear ratios), or a variable speed transmission. The "gear shifting" behavior must be performed automatically by your device. That is, you can not manually change the speed ratio during operation. All of the contest rules will be in effect, except as follows. Because the automatic shifting mechanism may occupy significant space, your device need only fit inside a 6 inch \times 12 inch \times 12 inch volume. The critical 6 inch dimension is defined by the distance between the motor and wheel mounting shafts.

7 Self-selected Projects

Individuals or teams can select their own project concept, subject to the constraints outlined above. Some projects from previous years were:

- Cam operated rock climbing aide;
- one way clutch
- adjustable and collapsible foot stool;
- folding guitar stand;
- sheet music stand;
- a hand-pull golf cart.

Note, **we will not** approve any project which might potentially be used in a way which is harmful, illegal, or in violation of the Caltech honor code.

8 Sponsored Projects

These will be described in an upcoming handout.