

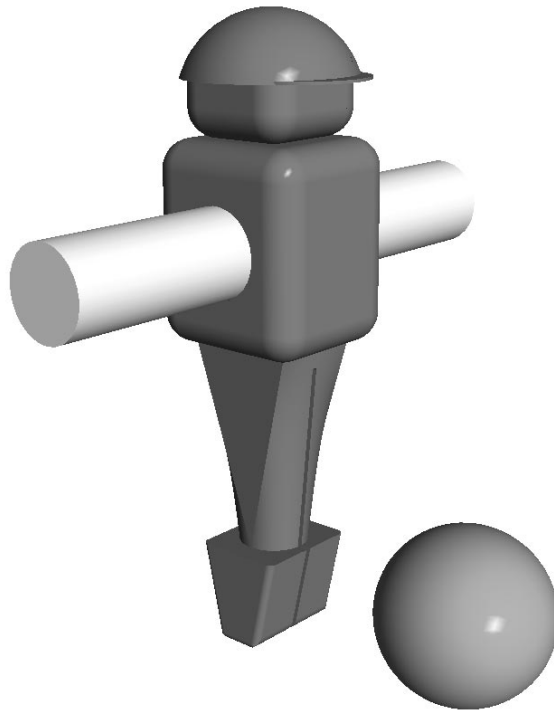
Design Contest
ME72 Engineering Design Laboratory
Fall Term, 1998
Syllabus

Professor: Erik Antonsson
Office: 323 Thomas

Instructor: Curtis Collins
Office: 325 Thomas

12 Units (3-8-1)
3 hours class: **Tue 10:00 am, Thur 10:00 am, Thur 2:00 pm**, 306 Thomas
8 hours lab/shop
1 hour home work

Web Site: <http://www.design.caltech.edu/Courses/ME72/>



- **Syllabus, week by week:**

1. **29-Sep, Tue** Brief Class Meeting. Handouts.
What is Design? The Design Process.
Functional Requirements and Constraints.
1-Oct, Thur Models of the Design Process,
Discussion of FR's and C's.
Introduction to the Design Contest.
1-Oct, Thur Introduction to the M.E. Shop.
M.E. Shop use and safety.
2. **6-Oct, Tue** Structured Methods of Pahl and Beitz,
Design Axioms, Set-Based Design. Continue FR's and C's.
8-Oct, Thur Introduction to Motors and Transmissions.
Power Transmissions: Motors and Impedance Matching.
8-Oct, Thur Power Transmissions: Belt/Pulley Drives, Belt Tensioning Devices.
3. **13-Oct, Tue** Methods for Generating and Evaluating Design Alternatives:
Brainstorming, Delphi Method, Method 635.
15-Oct, Thur Design Reviews.
15-Oct, Thur Design Reviews
4. **20-Oct, Tue** Discussion of Devices from a previous year.
In-class demonstrations: Silicone, Gear alignment.
22-Oct, Thur Pugh Charts, QFD, Introduction to Taguchi Methods.
22-Oct, Thur M.E. Shop.
5. **27-Oct, Tue** Bearings and Shafts.
29-Oct, Thur Gears: Involutometry and Spur Gears.
29-Oct, Thur Helical, Worm and Bevel Gears, Epicyclic Gear Trains.
6. **3-Nov, Tue** Videotape of previous ME72 Design Contest(s).
Design Productivity Videotape(s).
5-Nov, Thur Design Reviews.
5-Nov, Thur Design Reviews.
7. **10-Nov, Tue** Quality Philosophy (Robert Pirsig).
Brainstorming applied to the Contest Device.
12-Nov, Thur Quality, FMEA.
12-Nov, Thur M.E. Shop: Device Prototype Due.
8. **17-Nov, Tue** Couplings, Hooke's and CV-Joints, Clutches and Brakes.
19-Nov, Thur Contest Discussion.
19-Nov, Thur M.E. Shop: Device Function Test.
9. **24-Nov, Tue** Contest Discussion/Preparation.
24-Nov, Thur Thanksgiving Vacation, No Class.
10. **1-Dec, Tue** Preliminary Contest, M.E. Shop.
3-Dec, Thur Device Size and Weight Test, Beckman Auditorium.
3-Dec, Thur Final Contest: **2:00 pm**, Beckman Auditorium.

• **Contest Device Schedule and Milestones:**

Week	Date	Day	Time	Milestone
1	29-Sep	Tue	10:00 am	Zeroth Assignment given.
	1-Oct	Thur	10:00 am	Written Contest Materials distributed. FR's and C's Assignment given.
	1-Oct	Thur	2:00 pm	Pick up "Bag of Junk".
2	6-Oct	Tue	10:00 am	
	8-Oct	Thur	10:00 am	3 Alternatives Assignment given. Mockup Assignment given.
	8-Oct	Thur	2:00 pm	Zeroth Assignment Due . FR's and C's Due .
3	13-Oct	Tue	10:00 am	
	15-Oct	Thur	10:00 am	Design Review (bring Notebook and Mockup).
	15-Oct	Thur	2:00 pm	Design Review (bring Notebook and Mockup). 3 Alternatives Due [5%]. Mockups Due [5%]. Begin building Prototypes of key elements. Begin Fabrication of Device.
4	20-Oct	Tue	10:00 am	Engineering Analysis Assignment given.
	22-Oct	Thur	2:00 pm	Prototype of 1 key (working) element Due [10%]. Continue Fabrication.
5	27-Oct	Tue	10:00 am	Engineering Analysis Assignment Due [5%]
	29-Oct	Thur	2:00 pm	Continue Fabrication. Begin Testing and De-Bugging.
6	5-Nov	Thur	10:00 am	Design Review (bring Notebook and Device).
	5-Nov	Thur	2:00 pm	Design Review (bring Notebook and Device). Continue Refinement, Testing and De-Bugging.
7	12-Nov	Thur	2:00 pm	First Complete Device Prototype Due [7%]. First version fabrication complete. Continue Refinement.
8	19-Nov	Thur	2:00 pm	Device Function Test [8%]. Size and Weight Test . Continue Refinement.
9	25-Nov	Wed	5:00 pm	Devices Impounded for Thanksgiving Break.
10	30-Nov	Mon	8:00 am	Impounded Devices Returned.
	1-Dec	Tue	10:00 am	Preliminary Contest: M.E. Shop. 30 Second Set-up Time Test .
	3-Dec	Thur	10:00 am	Device Size and Weight Test in Beckman Auditorium. Devices Considered Complete. Device Construction to Cease.
	3-Dec	Thur	1:30 pm	Contestants Assemble in Beckman Auditorium.
	3-Dec	Thur	2:00 pm	Final Contest: Beckman Auditorium.
11	8-Dec	Tue	5:00 pm	Contest Evaluations Due .
	10-Dec	Thur		Device Grading. [40%]

- **Office Hours:**

If there is sufficient interest, Curtis Collins and I will maintain office hours for questions and consultations. Hours to be arranged. Curtis, the Teaching Assistants and I will also hold “shop hours”, hours when they will be available in the shop to answer questions and provide advice. Hours to be arranged.

- **Shop Hours:**

The M.E. Shop will be open from 8:00 am to 5:00 pm Monday through Friday. The Shop will be open during the lunch hour. The Shop will be closed to ME72 students during ME72 class times. During approximately the last 3 weeks of the class, the M.E. Shop *may* be open from 8:00 am to 8:00 pm Monday through Thursday, and from 8:00 am to 5:00 pm on Friday.

- **Shop Machine Sign-ups:**

The M.E. Shop staff have instituted a sign-up procedure to schedule time on the lathes and mills in advance. Please refer to the sign-up sheets in the entry-way to the shop for rules and details.

- **Design Reviews:**

We will hold two design reviews during the term. One on Thursday of the third week and one on Thursday of the sixth week. On these days the two hours of class meeting time will be divided up into 10 minute (or so) time slots, one per team, to meet with the instructor. These meetings are an opportunity for the instructors to provide guidance and advice to the students on the progress of their design. These meetings are not intended to be the only opportunities to meet with the instructor, but rather to ensure that a minimum of two meetings occur between each student and the instructor. (Other meetings can be arranged as needed or desired.)

Each student should be sure to bring his or her design notebook to the design review. Additionally, at the first review, the student should bring his or her 3-Alternatives assignment and Mockup. At the second review, the student should bring his or her Device (or as much of it as is completed).

- **Teams**

You will be required to work and compete in teams of two.

The class will be divided into two groups at the beginning of the term. You are free to select as your teammate any student *not* in your group. Any student who does not have a teammate by Tuesday of the second week of class will be assigned one.

Each student will be given a bag of junk from which to construct a device that will perform some part of the task outlined in the rules for this year's design contest. It is up to you and your teammate to decide on the functions for your devices, subject to the constraints outlined in the rules. Keep in mind that the majority of your grade is based on the design and fabrication of your individual device. In other words, your device must be independently designed and built, though it must function in collaboration with your teammate.

- **Collaboration Policy:**

While you will be working in teams of two, it is expected that each individual will design and fabricate a functional device.

It is also acknowledged that interaction between teams in the class is highly beneficial. To that end, any conversations, calculations, analyses, ideas and tests may be shared among the teams, but the device design and fabrication must be an individual effort. Note that this collaboration policy does not extend to replicating others' ideas. Occasionally two people will arrive at a very similar solution independently, sometimes one person will see a great idea in someone else's device, and finding no superior alternative will want to incorporate it. This duplication is permissible, however, not encouraged. Competitors usually maintain a high level of secrecy around their device, and blindly copying an idea or strategy may be risky. In many respects, you should treat this design project as similar to an ordinary homework set. It is permissible to collaborate with your classmates and seek the advice of the instructor, TA's, M.E. Shop staff, other class participants, other students, however, the final product must be your own work. If you are concerned about the acceptable limits to collaboration, discuss the situation with the instructor.

Do your own work, and as always, it is best if you use your own ideas and concepts.

- **Textbooks:**

- Strongly Recommended Textbook:**

- Shigley, Joseph E., and Mischke, Charles R. *Mechanical Engineering Design*, 5th edition, McGraw-Hill, 1989,
ISBN: 0-07-056899-5.
(\$100)

- Strongly Recommended Textbook:**

- Magrab, Edward B. *Integrated Product and Process Design and Development*, CRC Press, 1997,
ISBN: 0-8493-8483-4.
(\$65)

- Recommended Textbook:**

- Pahl, G., and Beitz, W. *Engineering Design: A Systematic Approach*, Second Edition. Springer-Verlag, 1996,
ISBN: 3-540-19917-9.
(\$50)

- Recommended Textbook:**

- McKim, Robert H., *Experiences in Visual Thinking*, Second Edition. Books/Cole Publishing Company, 1980,
ISBN: 0-8185-0411-0.
(\$50)

Design Contest
ME72 Engineering Design Laboratory
Fall Term, 1998
Design Notebook

You will be expected to keep a design notebook. This will be a place for you to record your thoughts and design ideas, as well as a notebook for keeping track to things to do, and things accomplished. We want to see your design ideas as they unfold, in sketches and words. We also want to see notes on discussions with your teammate about your design strategies, compromises made, and task divisions if any.

The class this year will be the subject of an in-depth Los Angeles Times article, with a writer and photographer following the progress of the class from start to the final contest. Readers will be interested in learning both about your devices and the process (struggle) by which you arrive at your device. If you are willing, please include in your notebooks journal entries describing your efforts.

The notebook itself can be anything you wish, a conventional $8\frac{1}{2}$ by 11 notebook, a large format drawing pad, a 100 foot roll of shelf paper, etc.

We also want you to keep track of your time, design time, fabrication time, and test/tune/-refine/debug time. The best would be to record your time, as you work. It would be best if you also summarized this information into the number of hours you worked each week in the following format:

Week	Hours per Week				Total
	Class	Design	Fabrication	Debug	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Total					

Remember that this is (now) a 12 unit course, which means that you should put 12 hours per week into it. This is a total of 120 hours for the term. You should also keep this number in mind as you apportion time to design, fabrication, testing/tuning/refining/debugging.

We will also ask for a summary of the number of hours you spent on the course, at the end of the term.

We will want to see the notebook weekly. We will collect them in the Thursday morning class, and return them in the Thursday afternoon class. If you wish to discuss your notebook, or your design, there will be time during the Thursday afternoon class, or during my office hours.

Grading

5% Three Alternatives

5% Mockup

10% Prototype of 1 Key Working Element

By this due date, one key element of one design alternative must be built as a prototype for testing.

5% Engineering Calculations

7% Device Fabrication Complete

By this due date, the first version of your design must be completely fabricated.

8% Device Function Test

By this due date, your device must demonstrate legal compliance with all the contest rules, and must satisfy the minimum performance to successfully compete.

40% Contest Device:

10% Overall Concept

This is the overall idea of solving the design problem: e.g., wheels or tractor or airplane or catapult, string-drive or belts, etc.

10% Details

This category is for evaluation of the details of the design: e.g. how are the joints and fasteners designed, how are the bearing mountings designed, etc.

10% Execution

The grade for execution primarily relates to fabrication. How you implemented the concept(s) and details you designed: e.g., did you learn how to drill a straight hole, turn a diameter, and mill a flat surface, or does your device look as if it was whittled out with a pen-knife, etc.

10% Planning

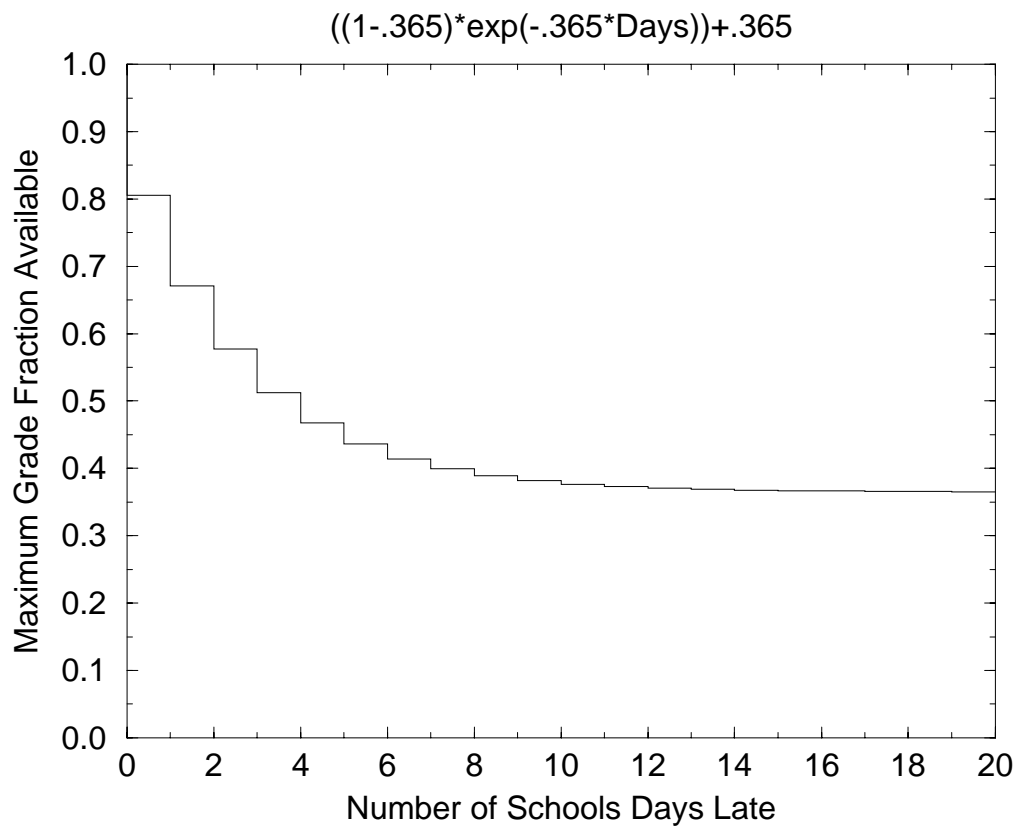
In addition to meeting the milestones (above), this category evaluates your ability to have planned ahead, especially with regard to leaving enough time to build and test, modify and tune your design, as well as practice using it. Note that meeting regularly with the instructor(s) (usually by attending class) is the *only* way that your planning can be evaluated. If you don't show the instructor(s) what you are doing during the term, he will have to guess at your planning, a process that usually results in a low grade.

10% Design Notebook

10% Design Process and Collaboration

This category evaluates how well you coordinated with your teammate to meet the size and weight constraints, and the functional requirements of the task. It also evaluates how well you learned and practised the material from class concerning suggestions for the process of engineering design. For example, did you seriously consider several alternative designs, or did you adopt the first solution that occurred to you.

100% Total



Penalty-free extensions for homework assignments must be arranged in advance with the Professor or Instructor. In the absence of a pre-arranged extension, the maximum possible fraction (M) of the credit available for an assignment will be reduced according to the following formula:

$$M = ((1 - .365) \exp(-.365D)) + .365$$

where D is the number of School Days the homework is late.