

ME 382: INTRODUCTION TO DESIGN
Fall 2008
Covell 221 for Lectures and Rogers 228 for Design Studio

Instructors

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Teaching Assistants

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Class Hours

Lecture: MWF 12:00 - 12:50 PM (Section 001), 1:00 - 1:50 PM (Section 002)
 Design Studio: TR 8:00- 9:50 AM, 10:00-11:50 AM, 12:00- 1:50 PM, 2:00-3:50 PM

Text

The Mechanical Design Process, Third Edition, David G. Ullman, McGraw Hill

Course Objective

The objective of this course is to provide a team project-based, hands-on discovery experience of developing prototype products through a well-organized engineering design process including planning, problem definition, concept design, product design/realization, and testing. Design processes and methods are introduced through the Lectures; the processes and methods are applied in a design project in the Design Studio. Achieving the course objective will be measured through how well the students attain the following course learning outcomes.

Course Learning Outcomes

By the completion of this course, students must demonstrate the ability to:

1. Apply Gantt Chart techniques to identify project deliverables and make a 10-week work plan for a small-scale engineering design team project
2. State and illustrate the quality function deployment (QFD) method by using QFD to define an open-ended engineering design problem
3. Generate and evaluate conceptual design solutions using functional analysis and prototype testing given a design problem definition
4. Produce a product that meets functional requirements
5. Produce a product with originality, regulatory, and aesthetic considerations
6. Perform as part of an engineering design team

Design Project – MARS ROCKS

This is the project developed by American Society of Mechanical Engineers (ASME) for the 2009 ASME Student Design Competition. A design problem description is available at the website:

http://www.asme.org/Events/Contests/DesignContest/Student_Design_Competition.cfm

An additional rule is being added to the contest for this course. The maximum that can be spent on off-the-shelf parts is \$100/team. All prices are fair-market-value. New parts or components are considered at the price you paid for them. If there is a widget in your little brother's toy box you want to use, then its value on E-bay or other auction must be used.

Grading

Grading will be based on:

- 25% - individual homework
- 20% - individual design notebooks
- 20% - product development report (teamwork)
- 10% - design reviews (teamwork)
- 15% - field test results (teamwork)
- 10% - subjective evaluation (teamwork)

Total 100%

Each of the graded items is described below.

I. Individual Homework (Document A1-A26, see VI for their descriptions)

Due the Monday following the assignment at the beginning of class. The homework you turn in each week will be a photocopy of the individual entries in the design notebook; it is your responsibility to make sure that the photocopy is readable. The sequence of doing homework and record keeping in design notebook is: you read the material and do the assignment as part of your record keeping in your design notebook; then photocopy the assignment parts as homework to turn in. Your name and group number must be on each homework.

Note: You turn in the homework on Monday and, during your lab on Thursday you discuss the topics and reach team agreement on the results. Documentation of the team agreement becomes part of the team's Product Development Report (see III for description).

II. Individual Design Notebook

You are required to keep a permanently bound 8.5" x 11" design notebook for use in this course (this is a common practice for professional engineers in many industrial companies). All work concerning the design project will be entered into this notebook. The entries may include all individual homework, design ideas and reflections, teamwork discussion/results, design studio exercises, sketches, tables, and other contents that are closely related to the design project. Your name and group number must appear on the cover of your design notebook. Every page in the notebook must be numbered in ink at the beginning of the term. No pages can be removed and each page must be dated and initialed when used. In other words, everything you do on the project is included in the notebook. It is suggested that you use a spiral bound quadrille notebook and staple in pages as needed.

Each notebook will be collected at the end of the term and graded on the number of "quality entries" it contains. Typical examples of a quality entry include: a significant sketch or drawing of some aspect of the design; a listing of functions, ideas, or other features; a table such as morphology or decision matrix; or a page of text. Entries that are unintelligible are not "quality entries".

Note: do not use your design notebook for recording lecture notes. The lecture notes will not be counted as entries.

Notebook grading will be:

- grade of 100% for 60 or more quality entries
- grade of 95% for 55-59
- grade of 90% for 50-54
- grade of 85% for 45-49
- grade of 80% for 40-44
- grade of 75% for 35-39
- grade of 70% for 30-34
- grade of 65% for 25-29
- grade of 60% for 20-24
- grade of 55% for <20

Note that padding is obvious and not counted!

Your final entry in the design notebook will be at least one-page or more to reflect your design process, product performance, teamwork, your contest experience, and what you have learned from it. This is required.

III. Product Development Report (include Documents B1-B4, see VI for description)

This is a self-contained, well-written report summarizing the design process and team project. This file contains the TEAM results of the design process and product. Document B1-B4 must be included in this report. It is highly recommended that each team keep a single file of the team results along the product development process from earlier on during the term. At the end of the term the team will refine this file into a Product Development Report. The complete report should contain at least the following:

- Executive Summary (a picture of your product is required)
- Introduction
- Team results for the 32 items listed on the previous pages.
- Discussion of prototypes and final design including photographs
- Evaluation of field test
- Conclusion

The Product Development Report will be graded on its completeness of all the above items, clarity of explanation/justification/discussion on your design decision for each step, and writing quality. Due time: 11am, December 8th, 2008, at ROG418. An example Design Report Format can be found on the Blackboard. You do not need to follow this, but it gives some good ideas.. The grading template for the product development report is:

ME 382 Design Project: Product Development Report Grading Sheet	
Team Number _____	Date _____
Executive Summary	(max 2) ____
Introduction	(max 1) ____
Problem Appraisal	(max 4) ____
Conceptual Design	(max 4) ____
Product Design	(max 4) ____
Drawings	(max 4) ____
Discussion of Prototypes	(max 3) ____
Evaluation of Field test	(max 2) ____
Conclusion	(max 1) ____
Team Grade Total (max 25)	_____

IV. Subjective Evaluation

The subjective evaluation will be performed by the evaluation team from 12:00 - 5:00 PM on Thursday, December 4th, 2008. All the teams must place their products in Rogers Hall 228 by 12:00 PM. The grading template for subjective evaluation is:

ME 382 Design Project: Subjective Evaluation	
Team Number _____	Date _____
Craftsmanship (3)	_____
Compliance (2)	_____
Originality (2)	_____
Aesthetics (2)	_____
Simplicity (1)	_____
Team Grade	Total (max 10) _____

V. Field Test (announced broadly and open to general public)

The field test (ME382 Design Contest) will be held at 6:00 PM Thursday, December 4th, 2008, at Milam Auditorium. The teams can pick up their products at Rogers Hall 228 at 5:00 PM and transport them to Milam. Grading will be based on how your team places with first place receiving 100% and last place 60%. This event is open to the public.

VI. Description of the Required Design Process Documents

A. Documents that will be assigned as **individual homework** and thus be part of the notebook. Specifics about the Assignment are on Blackboard in the folder labels "Homework Assignments". Many can be completed using pre-formatted templates. These are labeled with a * and are in the Templates Blackboard folder.

i. Project Appraisal and Preparation Phase

Week 1: Planning the Project

- A1. Task Titles, Objectives of each Task, Deliverable and Metric for each Task, Personnel Required for Each Task, Time Required for Each Task, all part of Project Plan Template *
- A2. Schedule of Tasks
- A3. Team Contract * and Personal Problem Solving Dimension *

Week 2: Understanding the Design Problem

- A4. Description of Customers
- A5. Customer's Requirements
- A6. Weighting of Customer's Requirements
- A7. Competition's Benchmarks Versus Customer's Requirements
- A8. Engineering Requirements
- A9. Competition's Benchmarks Versus Engineering Requirements
- A10. Engineering Targets

ii. Conceptual Design Phase

Week 3: Concept Generation

- A11. Functional Decomposition
- A12. Function-Concept Mapping/Morphology *

A13. Sketches of Overall Concepts

Week 4: *Concept Evaluation*

A14. Technology Readiness Assessment

A15. Go/no-go Screening

A16. Decision Matrices to Determine Best Concepts

A17. Analysis, Experiments and Prototypes Supporting Concept Evaluation

iii. Product Design Phase

Week 5: *Product Generation*

A18 Analysis/Experiments and Prototypes – Test Report*

A19 Usable Off-the-Shelf Products (COTS)

A20. Shape Development Driven by Function (Individual Layout Drawings)

A21. BOM*

Week 6: *Product Evaluation*

A22. Comparison to Engineering Requirements (cancelled)

A23. Functional Changes Noted- Change Order *

A24 Analysis, Experiments and Prototypes Supporting Product Evaluation (cancelled)

A25. Design for Assembly Evaluation DFA*

A26. Cost Evaluation – Plastic Part Cost Calculator*, Metal Part Cost Calculator*

Week 7: *Product Evaluation Continued*

A27. Analysis of tolerances

A28. Analysis of failure potential

B. The following **team documents** are done by the team and are a part of the **product development report**. They are not counted as part of the design notebooks.

Final Product Documentation

B1. Layout Drawings

B2. Detail Drawings of Manufactured Parts

B3. Parts List (Bill of Materials)

B4. Assembly Sequence Instructions (optimized)

The drawings must be signed by the instructor before building.

VII. Design Review During the 4th and 7th week Design Studios you will have a Design Review. At these times you will present your team's effort to date to a panel that consists of Professors Ullman and Tumer, and other professional engineers from the faculty and industry. A Team Health Inventory* will be submitted independently by each team member at the beginning of the Review.

VIII. Teamwork Grade Adjustment Based on Team Evaluation

To make grading of team produced material fair, the team project grades will be corrected for each student with a weighting factor. This factor will be developed through each team member's confidential evaluation of all members in the team. Each member of the team will evaluate every member of the team (including themselves) for the percent of his/her contribution to the team project. The evaluations will be averaged by the instructor to find each student's contribution and the weighting factor made proportional to it.

Teamwork Contribution Evaluation Form

Team Number _____ **Date** _____

Name	Concept (%)	Analysis/ Testing (%)	Building (%)	Report (%)	Total Contribution to Teamwork (%)

ME 382 Class Schedule

Time	Lecture	Reading	Assignment	Lab (including design studio)
Week 1 9/29 – 10/03	Understanding the Design Process; Project Planning; Product Development Team	Chapters 1-5	<ul style="list-style-type: none"> - HW1 (due 10/06) - Get familiar with the product development process - Be a team player - Transit to “Open-ended Problem Solving” practice ahead 	<ul style="list-style-type: none"> - Team composition - Team building exercises - Make an initial team project plan
Week 2 10/06 - 10/10	Design Problem Appraisal	Chapter 6	HW2 (due 10/13)	<ul style="list-style-type: none"> - Understand and define the design problem - Modify the team project plan
Week 3 10/13 - 10/17	Concept Generation Function Decomposition	Chapter 7	HW3 (due 10/20)	<ul style="list-style-type: none"> - Practice visual thinking & sketching skills - Brainstorm on functions and concepts
Week 4 10/20 - 10/24	Concept Evaluation Decision Making	Chapter 8	HW4 (due 10/27)	<p><u>Design Review 1</u></p> <ul style="list-style-type: none"> - Build & Test concept prototypes - Analysis
Week 5 10/27 - 10/31	Product Generation Drawings, BOM	Chapter 9-10	HW5 (due 11/03)	Proof-of-concept prototypes due
Week 6 11/03-11/07	Product Evaluation: Analysis, Design for Manufacture & Assembly	Chapter 12	HW6 (due 11/10)	<ul style="list-style-type: none"> - Test prototype(s) - Analysis - Decide on one prototype for product
Week 7 11/10 - 11/14	Product Evaluation: Tolerance stackup, Failure potential	Chapter 11	HW7 (due 11/17) Team Documents B1 – B4	<p><u>Design Review 2</u></p> <ul style="list-style-type: none"> - Ready-to-build product due on paper - Build & Test product
Week 8 11/17 - 11/21	Product Evaluation: Design for Reliability	Chapter 13	Build & Test product	Build & Test product
Week 9 11/24 - 11/28 (Thanksgiving)	Real World Product Development Examples	Handouts	Build & Test product	Build & Test product
Week 10 12/01 – 12/05	Contest Preview and Post-mortem	None	<ul style="list-style-type: none"> - December 4th, 12:00 p.m., products impounded at R228 for subjective evaluation - December 4th, 5:00 p.m., pick up products at R228 - December 4th, 6:00 pm, Field Test starts, Milam Auditorium - December 8th, 11:00 a.m., turn in <u>Notebooks</u> and <u>Product Development Report</u> together to Prof. Tumer at R418 	<p><u>Field Tests</u></p> <ul style="list-style-type: none"> - Clean up the shop (mandatory)