ME 398  Engineering Design  
Winter 2:00 – 3:20 pm TTH  
Tech M128 (Tuesday)/Ford ITW (Thursday)

Course Description:  The course provides an experience in the creative aspects of design from project definition to ideation to functional prototypes. Industry sponsored projects are carried by student groups. Throughout the 10-week period, students will have the opportunity to experience the entire process of design, including defining product specifications, developing creative design ideas, evaluating design concepts based on engineering analysis, describing the detailed design using CAD drawings, and building physical prototypes to demonstrate feasibility. Former students in this course won various product design awards, such as the international design competition based in Germany and the Margaret and Muir Frey Memorial Prize for Innovation and Creativity at Northwestern University.

Instructor:  Dr. Wei Chen, A216, (847) 491-7019, weichen@northwestern.edu  
http://ideal.mech.northwestern.edu/  
Office hrs:  Tuesday & Thursday 4:00-5:00 pm or by appointment

TA:  Paul Arendt, B111, 491-5066, paularendt2012@u.northwestern.edu

Required Textbook and Reading:
  *(Readings are very important for this course. Please visit the book website at [www.ulrich-eppinger.net](http://www.ulrich-eppinger.net) for additional learning resources).*
- Lecture notes and additional reading materials posted on blackboard.
- Design notebook (see pg. 4 for description)

Reference Books:

Prerequisite:  Senior or graduate standing, or approval of instructor

Grading (Total: 1200 points):
- Design Specification and Product Goal (1/18)  50
- Conceptual Design Presentation (2/3)  100
- Mock-up/Rough Prototype (2/3)  50
- Written Exam (2 Quizzes)  150
- Dissection and Contextual Analysis Report (2/8)  100
- Detailed Design Documents (2/24)  150
- Final Design Oral Report (3/15)  100
- Peer Evaluation (3/17)  150
- Final Design Written Report (3/17)  100
- Final Prototype Evaluation (3/15)  100
- Professors' Grade (project and lecture participation)  50
- Design Notebook (collected periodically)  100
Notes on grading:
1) Grades are based primarily on PERFORMANCE and secondarily on effort. Specific grading criteria are provided for each assignment. Note that grading is largely subjective in this course, unlike most engineering courses. To ensure fairness, instructor will decide grades with the inputs from TAs, sponsors, and any other faculty advisors who might be involved.
2) On certain submissions (design specification and detail design documents), 70% of the point value will be awarded upon initial completion of the assignment. The assignment may be corrected and re-submitted within a specified period for the remaining 30% of the grade. If the project is not re-submitted, the grade for the initial submission will be used for 100% of the grade.
3) Not taking the shop training course will result in a penalty of losing 50 points.

Course Schedule

Overview
- **Week 1** – Team forming & project selection
- **Week 2** – Meeting with client and identification of project specifications
- **Weeks 3 to 5** – Conceptual design, Shop training
- **Weeks 6, 7** – Detail design
- **Weeks 8, 9** – Fabrication and improvement
- **Weeks 10, 11** – Final report & presentation

Course Calendar

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<tr>
<th>Date</th>
<th>Topics</th>
<th>Assignment Due</th>
<th>Readings</th>
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<tbody>
<tr>
<td>W1</td>
<td>T: 1/4 Introduction</td>
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<td>Ch 1</td>
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<td>Th: 1/6 Design Process</td>
<td>Project selection</td>
<td>Ch 2-3</td>
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<td>W2</td>
<td>T: 1/11 Identifying Customer Needs, Product Specification</td>
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<td>Ch 4-5</td>
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<td>Th: 1/13 Meeting with Client</td>
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<td>W3</td>
<td>T: 1/18 Conceptual Design</td>
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<td>Ch 6-7</td>
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<td>Th: 1/20 Conceptual design tools/Project planning</td>
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<td>Ch 16</td>
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<td>W4</td>
<td>T: 1/25 Product Dissection (lab session)</td>
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<td>Ch 9</td>
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<td>Th: 1/27 Contextual Analysis/Design for Manufacture</td>
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<td>Ch 11</td>
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<td>W5</td>
<td>T: 2/1 Team meetings</td>
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<td></td>
<td>Th: 2/3 Conceptual design oral presentation</td>
<td>Oral Presentation/Mockup</td>
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<td>W6</td>
<td>T: 2/8 Team meetings</td>
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<td>Th: 2/10 Detail design and performance evaluation, Quiz 1</td>
<td>Dissection report due</td>
<td>Ch 12</td>
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<td>W7</td>
<td>T: 2/15 Team meetings</td>
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<td>Th: 2/17 Quality Engineering</td>
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<td>Ch 13</td>
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<td>W8</td>
<td>T: 2/22 Team meetings</td>
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<td>Th: 2/24 Design for Safety (guest lecture)</td>
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<td>W9</td>
<td>T: 3/1 Team meetings</td>
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<td>Th: 3/3 Patents and Intellectual Property, Economics</td>
<td>Detail Design Document Due</td>
<td>Handout</td>
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<td>W10</td>
<td>T: 3/8 Team meetings</td>
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<td>Th: 3/10 Ethics, Quiz 2</td>
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<td>Ch 14, 15</td>
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<td>W11</td>
<td>T: 3/15 Final Presentation (3-5 pm)</td>
<td>Prototype due</td>
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<td>Th: 3/17 Final Report due</td>
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Notes: To actively participate in class discussions, it is very important to read the assigned chapters **BEFORE** the lecture.
Goals of Design Projects:
A primary component of this course is a real design experience. Students will work in teams of 4. During the course of the quarter several written and oral assignments related to the design project will be due. The goals of the design project are listed below.

PRIMARY GOAL - DESIGN EXPERIENCE
- design specification - learn how to create a specification
- project planning - apply PERT or Gannt techniques to a design project
- conceptual design - brainstorming, come up with unique ideas
- mock-up - build a mock-up of the device to show its structure or function
- detail design - design on paper, create a solution to specification
- design optimization - evaluate design and optimize it
- prototyping - make it in machine shop
- redesign - evaluate design and revise

Secondary Goals:
1. Design for X
   - customer focused innovation - consider the end user
   - design for manufacture - make sure it can be made
   - design for serviceability - make sure it can be serviced and repaired (or maybe not)
2. Design Techniques and Issues
   - reverse engineering/product dissection - get ideas and information from similar products
   - quality - know how to make a quality product
   - safety engineering - make it safe
   - economic analysis - make sure it is economically worthwhile to produce
3. Contextual Analysis
   - Global, social, economical aspects of design
   - Sustainability Analysis

Guidelines for Design Projects:
1. Teams shall form by 5:00 pm, Thursday, January 6, 2011. If you are not affiliated with any particular team by this date, you must notify Professor Chen by email and she will assign you to a team.
2. Teams must have 3–4 members.
3. You may choose the members of your team, but there are some restrictions:
   - At least one member of the team must be proficient in Computer-Aided Design (CAD) using one of the CAD packages available at NU (Pro/ENGINEER, UNIGRAPHICS, IDEAS, or SolidWorks)
   - Each team must have at least one person with Co-operative Education or Summer Internship experience and preferably at least one person with no Co-op/Intern experience.
4. Each team must decide on a first, second, and third choice for a project.
5. Teams must submit or email Prof. Chen a written memo of team forming and project selection by 5 PM, January 6 (see instructions in the Project Assignment set).
6. Prof. Chen reserves the right of final approval of team members and project topic.
7. Each team is expected to be self-governing. Each team will meet with Prof. Chen and TA on a weekly basis starting from Week 5. Teams are expected to bring a progress report to each meeting detailing what work each member has contributed since the last meeting and what next tasks are planned. Each team mate should rotate the turn in running the meeting.
   a) A time for the meeting will be scheduled at the beginning of each week.
   b) This meeting should not exceed 30 minutes.
   c) A copy of written agenda is required before the meeting.
   d) All members of the team will be evaluated for the weekly meeting based upon the preparedness, understanding of the project, meeting organization, and incidental items like being on time.
f) Take a full charge of your project. You are expected to run the weekly meeting with Professor Chen and the meeting with your client at major milestones. This is also the opportunity to ask for questions and clarifications of assignments.

8. Anyone needing to communicate with Dr. Chen on any aspect of the project outside of the weekly meeting may do so in two ways:
   a) A brief email.
   b) A visit to the professor's office during regular office hours. Other visits to the professor's office will be by appointment only. Dr. Chen will not be available on T 1-2 or Th 1-2 (before class).

9. Team members will evaluate each others' performance at the end of the course.

10. All detail design drawings are to be done on a computer with a CAD program. There are several options for accomplishing this. You may use Pro/Engineer, Unigraphics, or Solidworks.

11. The oral Conceptual Design Review is to be a presentation of the basic design that will be pursued, why that design was chosen over others, how the design will be implemented and plan for the project for the remainder of the quarter (see instructions in the Project Requirements set). Provide three paper copies of the presentation at the time that you make your presentation.

12. The final written report should be of a length reasonable to fully describe the project. The report will probably be about 15 to 20 pages plus an appendix including the PDS, BOM, and detail design. Samples of reports for past projects are on reserve in the Science and Engineering Library. Turn in 2 copies of the final report. One copy will be kept by the professor. One copy will be given to the sponsoring company or individual.

13. Each team will present oral reports on the project during the final exam week. The length of the presentation will be about 15-20 minutes with an additional 5 minutes for questions. The oral report is a formal report and should include visual aids (PowerPoint or transparencies). Individual grades will be an average of the team grades and the individuals performance. Provide three paper copies of the presentation at the time that you make your presentation.

14. All materials required to be turned in during the quarter (design documents) will be graded for the team. Each team member will be assigned the same grades for these materials.

15. This is a TEAM project. Members of each team should communicate frequently and regularly.

16. On average, each team will receive $250 reimbursement for purchasing materials/parts in prototyping. The materials in NU machine shop are available resources for this class. In many cases, the industrial sponsors are willing to share the cost of prototype.

17. The department fax machine is available to receive faxes at 847-491-3915. Be sure that the fax has both your name and Professor Chen's name on it.

Design Notebook
Each student is required to maintain a "Design Notebook". All work concerning the design project is to be done in the design notebook. This includes all sketches, notes, and design ideas—essentially everything that you write down regarding the design project (not the lectures) should be written down in this notebook. The notebook is a diary of your effort on the project. In practice, design notebooks are important legal documents, and they should be something of which you are proud—it should not resemble a trash bin.

Notebook will be collected periodically during the term and evaluated on the quality of the entries. A quality entry is a significant sketch or drawing of some aspect of the design, a listing of functions, ideas, or features, a table or decision matrix, or a page of text. This information will be used informally by in assessing progress on the project and a student's contribution to the project. Entries must be legible, but this is to be work in progress, not a neat re-copying of work completed. No pages can be removed and each page must be dated and initialed when used. You may want to paste, tape, or staple important team documents into your notebook, but it is not necessary to include documents that are formally required for the course such as the Product Design Specification or Detail Design Documents.

The least expensive way to create a notebook is to buy an 8.5x11 spiral bound notebook. Every page in the notebook must be numbered at the beginning of the term.