ME 398 Engineering Design
Winter 2016, 2:00 – 3:20 pm TTH
Ford, ITW Lecture Room

Course Description:

ME 398 is the capstone course in Product Engineering for the Mechanical Engineering, which provides an experience in the creative aspects of design from project definition to ideation to functional prototypes. During this time, 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 multiple physical prototypes ranging from feasibility demonstration to full Alpha-level functional prototypes.

Prerequisites: Senior standing, or approval of instructor.

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Teaching Assistant:
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Required Textbook and Reading:

- *Product Design and Development*, Ulrich and Eppinger, McGraw Hill/Irwin, 6th edition, 2015**.**
- Lecture notes and additional reading materials posted on Canvas.

Reference Books:

- *The Mechanical Design Process*, David G. Ullman, McGraw-Hill, 3rd edition, 2003.
- *Product Design: Techniques in Reverse Engineering and New Product Development*, Kevin Otto and Kris Wood, Prentice Hall, 2001.

Outline of Assignments and Grading:

Assignment	Total Points 2500
Team Assignments	
Weekly Status Reports (9 reports; 50 pts each)	**450**
Online Documentation	**100**
Individual Assignments	
Professors' Grade (attendance, participation, project management)	**250**
Peer Evaluations (2 evaluations; 50 pts each)	**100**
Final Exam	**100**
Design Documentation Notebook	**100**
Contextual Analysis Assignments (Individual Prep - 25 pts; Pre-lab - 25 pts)	**50**
Team Document Deliverables	
Product Design Specification (2 submissions; 100 pts each)	**200**
Product Design Document	**150**
Product Archeology Lab Report	**100**
Quarter 1 Final Report	**200**
Team Presentations	
Needs & Conceptual Ideas Presentation	**100**
Critical Systems Prototype & Concept Mock-up Presentation	**100**
In-Class Design Presentations (3 presentations, 50 points each)	**150**
Prototypes	
Conceptual Mockups	**100**
Integrated Critical System & Full Product Mockup	**250**

Details on these assignments may be found in the course deliverables outline.

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, instructors will decide grades with the inputs from TAs, sponsors, and any other faculty advisors who might be involved.

2) All deliverables will be graded for the team (unless otherwise noted as an individual assignment). Each team member will be assigned the same grades for these materials. Professors' Grade and Peer Evaluations are considered in the final grade.

Course Topic & Presentation Schedule

Week	Date	Lecture Topics	Readings	Lecturer
1	6-Jan	Course Introduction, Client Projects & Project Intros, Project Selection (Outside of Class)		Beltran / Gatchell
	8-Jan	Team & Project Selection, Intro to Design Process, Project Management / Baseline Project Planning, Teamwork	U & E - Read chapters 4 & 18; scan chapters 1 & 2.	Gatchell
2	13-Jan	Design (Con't), Opportunity Assessment, Needs Identification & requirements, Intellectual Property	U & E - Read chapter 3 & 5; scan chapter 16.	Gatchell
	15-Jan	Quality Function Deployment, Marginal & Ideal Specifications, Competitive / Non-Comp Benchmarking	U & E - Read chapter 6; access and read Hauser and Clausing, The House of Quality, Harvard Business Review, May-June 1988.	Gatchell
3	20-Jan	Design for X (Mfg., assm, qual, robust), Contextual Analysis, Topics Presentation I – Identification of Needs and Specs.	U & E - Scan chapters 11, 12, & 13.	Gatchell
	22-Jan	Concept Generation, Ideation, Concept Selection	U & E - Read chapters 7 & 8; Ullman - Read chapter 7; Read Girotra et al., "Idea Generation and the Quality of the Best Idea", Management Science, April 2010	Gatchell
4	27-Jan	Functional Decomposition (3D printer, Med Device, Quik-grip)	Otto & Wood - Read chapter 5	Chen
	29-Jan	Product Architecture & Dissection, Topics Presentation II-Functional decomposition	U & E - Read chapter 10; Otto and Wood - Read chapter 6	Chen
5	3-Feb	Product Archeology - In Shop Activity		All
	5-Feb	**Needs & Conceptual Ideas Presentation**		All
6	10-Feb	Technical Communication & Presentation, Presenting Data, Research, & Concepts, Critical Systems Identification	Shwom - Read chapter 10	Beltran
	12-Feb	Back-of-Envelope Calculations, Modeling (Quik-Grip), Feasibility Analysis, Specification Types (Power, Flow, Energy est), Modeling		Beltran
7	17-Feb	Technical Communication & Presentation, Presenting Data, Research, & Concepts		Beltran
	19-Feb	Design for Safety / Reliability, Cost Analysis, Meeting Engineering Requirement, Bill of Materials		Crispin Hale
8	24-Feb	Detailed Design, Prototyping, Prototype Manufacturing - Planning and Execution, Purpose of a Prototype		Beltran / Chen

	26-Feb	Failure Modes Effects Analysis, Part Analysis, Failure Methods		Beltran / Gatchell
9	3-Mar	DOE, Performance Testing	U & E - read chapter 15. Ullman - read chapter 10.	Chen
	5-Mar	User Testing, Industrial Design		Gatchell
10	10-Mar	Performance Evaluation, Optimization	U & E - read chapter 17. Ullman - read chapter 9.	Chen
	12-Mar	Critical System Prototype & Product Mock-up Presentation		All
Finals	17-Mar	Quarter 1 Design Report		All
	19-Mar	EXAM		All

N.B. To actively participate in class discussions, it is very important to read the assigned chapters **BEFORE** the lecture.

Deliverables and Prototype Due Dates

Week	Date	Weekly Team Tasks	Document / Prototype/Presentation Deliverables
1	6-Jan 8-Jan	Project Selection, Assignment of Roles, Weekly Team Meeting Time Selection	
2	13-Jan 15-Jan	Needs Research, Client Site Visit / Interview, Brainstorming Conceptual Ideas	
3	20-Jan 22-Jan	Needs Research, PDS V1 Work	Topics Presentation I
4	27-Jan 29-Jan	Needs Research, Contextual Analysis Assignment (Individual), Mock-up Prototype	Product Design Specification V1 Contextual Analysis Document (Individual), Topics Presentation II
5	3-Feb 5-Feb	Presentation Prep & Mock-up Prototype, PDS V2 Work, Product Archeology Pre-lab (Individual)	Product Archeology Pre-lab Report **Conceptual Mockups,** Needs & Conceptual Ideas Presentation
6	10-Feb 12-Feb	PDS V2 Work, Critical Systems Identification, Product Archeology Lab Report	Product Design Specification V2
7	17-Feb 19-Feb	Critical System Prototype, Product Design Documentation	Product Archeology Lab Report, Topics Presentation III
8	24-Feb 26-Feb	Critical System Prototype, Product Design Documentation	
9	3-Mar 5-Mar	Presentation Prep, Product Design Documentation, Integrated System Prototype	Product Design Documentation
10	10-Mar 12-Mar	Presentation Prep, Integrated System Prototype, Quarter 1 Design Report	**Integrated Critical System & Mockup,** Critical Systems Prototype & Concept Mock-up Presentation
Finals	17-Mar 19-Mar	Quarter 1 Design Report	**Quarter 1 Design Report**

Team Guidelines & Formation

Teams will be formed and project assigned following the client presentations. A survey instrument will be distributed to students in the class following our first meeting, in which each student will rank all projects in order of preference.

Each team must comprise the following:

- 4-6 members;
- One or more members who are proficient in Computer-Aided Design (CAD) using one of the CAD packages available at NU
- One or more members who are with Co-operative Education or Summer Internship experience;
- Preferably at least one person with no Co-op/Intern experience.

Each team is expected to be self-governing; members are expected to assume ownership of their projects. This involves organizing and running the meetings with your instructor and client.

In-Class Topics Presentations

The In-Class topics presentations are "mini-presentations" intended to demonstrate your teams understanding of the concepts and methods taught in class lectures. These presentations will require that your team communicate a specific step or tool in the product design process, and apply that step/tool to your product.

These presentations will be short and informal, and will be delivered only to the course faculty and staff. Details on the presentations are given in the course deliverables outline.

Weekly Team Meeting Requirement

Following the formation of teams, each team is required to establish a weekly meeting time for a minimum of 2 hours. This will serve as the "lab" for the course, during which your team will have a dedicated time period for this class. During this weekly meeting, a course instructor will be present, and will review your weekly status reports with your team.

Prior to each meeting, you are required to submit the following:

1. Weekly Status Report – 24 hours prior to meeting
2. Meeting Agenda – 1 hour prior to meeting

Responsibility for writing the status report, creating the agenda, and running the meeting should be shared equally by the team. All members of the team will be evaluated for the weekly meeting based upon their preparation, understanding of the project, meeting organization, and professionalism (e.g., being punctual).

Outside of this weekly team meeting, you should be in continuous and frequent communication with your team. You should expect to meet multiple times in addition to this required weekly meeting.

(Please note that this course should be of the highest importance in your schedule, and take precedence over any non-academic activities.)

Weekly Status Reports

Teams are expected to submit a weekly progress report 24 hours prior to each weekly meeting, detailing what work each member has contributed since the last meeting and what next tasks are planned. This template is included in the course deliverable outline. The report should be emailed to the faculty members in charge, the TA, and all team members.

Peer Evaluations

The Participation/Attendance grade will largely be based on a peer evaluation survey. This survey will ask each student to evaluate their team members with regards to contributions to the final project and teamwork. These evaluations will only be read by the instructors.

Students will evaluate the contributions of their team members during weeks 6 & 11.

Online Documentation & Design Notebook

Each student will be required to maintain a notebook for all product design work, which will include all sketches, notes, and design ideas--essentially everything that is handwritten regarding the design project (not the lectures). 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.

In addition, each team will be responsible for maintaining an online document repository of all electronic documents created for this course. This will be evaluated at the end of the course, and should be well maintained with clearly labeled sections and folders.

Details for both the notebook and online documentation are given in the Course Deliverables Outline document.

Goals of Design Projects:

The principal component of this course is a real design experience in which student work within teams to solve open-ended, under-defined design challenges. The goals of the design project are listed below.

Primary Goal – Design Experience:

- Needs and specs - identify needs and create design specifications
- Project planning - integrate Gantt, PERT and RAM charts into a design process
- Conceptual design - brainstorming, generating novel alternatives
- Mock-ups - build mock-ups of the device to showcase its appearance, structure, or function
- Detailed design - design on paper, create solutions to meet specifications
- Design optimization - evaluate design, optimize design
- Prototyping - physical realization of the design
- Redesign - evaluate design and revise; embrace the iterative nature of prototyping