

UNIVERSITY OF NOTRE DAME
DEPARTMENT OF AEROSPACE AND MECHANICAL ENGINEERING
AME40463: Senior Design Project – Technology Assistance and Rehabilitation
Spring 2011

A. COURSE OBJECTIVES

This course is the capstone project in the undergraduate mechanical engineering program. One feature of this course is that not everyone will engage in all of the same activities. Your experience will depend upon those aspects of the project upon which you focus. You will be asked to share your experiences with others in the class, so each can benefit from everyone's efforts. The following are the desired learning outcomes for the course.

Learning Outcomes for each student:

1. Contribute to a collaborative team effort resulting in the design and demonstration of a technically feasible and socially desirable product.
2. Assume a major role in the design of a key technical feature or component of the product and be able to effectively communicate your contributions in oral, visual and written form.
3. Demonstrate the effective use of appropriate analytic, numerical or experimental engineering methods in satisfying student Outcome 2.

Desired Outcomes for each design team:

1. Develop a concept for a product.
2. Develop a virtual model and a robust, functional prototype that effectively demonstrates key technical features of the concept.
3. Develop a product that contains embedded intelligence including sensors, actuators and controllers characteristic of contemporary mechanical engineering systems and products.
4. Effectively communicate the concept and its development using various media.

During the course, emphasis will be placed on innovative concepts and prototyping and it is expected that key technical decisions related to the design of the product concept will be supported by engineering analysis. Balancing innovation with the practical constraints imposed by the limited time, experience, resources, facilities and technical support is critical in this project.

B. COURSE POLICIES

GRADING: Your course grade will be determined based both on your performance and that of your team.

- a. Individual deliverables:
Engineering method application and trade study, engineering notebook, presentations, etc. 45%
- b. Team deliverables:
Product concept, prototype, documentation and presentation of results 55%

An individual's credit for team deliverables is determined using information from the peer reviews and instructor assessment. Deadlines have been established for each of the deliverable items and must be strictly observed.

Individual Deliverables: (45% of total)

Design method application memo	5%
Engineering trade study (proposal and report)	15 %
PDR and CDR participation and discussion participation	10 %
Engineering notebook	10 %
Designer reflections	5%

Team Deliverables: (55% of total)

Needs assessment, design specifications, test plan, budget management	10%
Design Documentation:	
- Report (Parts I and II)	20 %
- Display and Video	5 %
Prototype/s	20 %

Grading guidelines will be provided for selected deliverable items and grades will be based upon both content and presentation. It is expected that all work submitted for grading in this course would meet standards appropriate for professional engineering practice. Grades for submitted work will be posted on Concourse.

DESIGN CLASS ATTENDANCE POLICY: The course is scheduled from 9:30 am – 12:15 pm each Tuesday and Thursday. During this time, discussions, presentations, special equipment training, consulting, and other forms of interaction between students, support staff, TAs, clients and the instructor will take place. This is also the time when all students can attend team meetings without schedule conflicts. You are expected to be engaged in AME40463 activities from 9:30 am – 12:15 pm on scheduled class days. Each Tuesday and Thursday morning you should meet in Rm. 212 Stinson-Remick Hall at 9:30 a.m.. Beginning on Jan. 25th each team will share progress and issues (Preliminary Design Reviews – PDR) during the Tues. studio sessions. You will be provided with a schedule of presenter assignments and, on occasion, specific issues to be discussed. Beginning on Thursday, Jan. 27 and each Thursday thereafter, each team will meet for approximately 30 minutes with the instructor to discuss team-specific issues. Schedules for these sessions will be provided. Each student is allowed to miss, without official University excuse, a total of 4 class sessions (this is a 4-credit hour course). Additional unexcused absences will result in you being dropped from the course. It is therefore important that you schedule any other professional or personal activities with this policy in mind. **Please make every effort to arrive on time for the studio sessions**, as repeated or excessive tardiness will be considered an absence.

PROJECT SCHEDULING, DELIVERABLES and TIME EXTENSIONS: You will be provided with a number of deadline dates for both individual and team deliverables. Please note that in almost every case, you and your team can complete and submit these deliverables before the deadline date. The Public Poster Display and Prototype Demo (Apr. 19) and the Critical Design Review (Apr. 28) are the only fixed-deliverable dates. Any other deliverable can be submitted early. No required submission will be accepted late without an official University excuse.

COMMUNICATIONS AND COMPUTER POLICY: You are responsible for archiving and maintaining your Team's information and data. Concourse will serve as the basic information source for this course. Email will be used sparingly to provide updates or respond to questions. If your team decides to develop a public website to publicize your efforts it must comply with University requirements for content.

DESIGN STUDIOS: During this project you will have access to two studio spaces: Rm. 212 Stinson-Remick and B-19 Fitzpatrick. The use of 212 S-R is subject to the guidelines imposed by the facility director, Ms. Natalie Gedde. This is a spared-space facility and individuals and teams must follow the guidelines provided to use this space. The AME Undergraduate Design Studio, B-19 Fitzpatrick Hall, will be available for your use whenever Fitzpatrick Hall is open. Each team will be allocated a workspace that includes storage, meeting, and fabrication spaces. It is the responsibility of every member of this class to make sure that the equipment in this facility is used in a safe and responsible fashion. The room is equipped with a combination lock. Please don't provide the combination for this lock to students who are not in this course and do not prop the door open. Additional guidelines for the use of the studios and schedules for availability of the prototype fabrication equipment will be provided during the course.

SPENDING, COST ACCOUNTING and EQUIPMENT ACCOUNTABILITY: Each Team will be allocated up to \$500 for development of their design concept. Additional funds may be available under special circumstances but ONLY with written, advanced authorization. Each team will have available for their use a number of pieces of issued equipment and tools. Guidelines and procedures for spending and record keeping will be provided. It is expected that all of the issued equipment will be inventoried and repackaged in the same manner as it was provided and returned in the same condition as issued. Each group will develop their own process for resource tracking and provide an update at the PDR.

PROTOTYPE CONSTRUCTION AND SAFETY: The machine tools in B-19 are available for your use as are limited tools and facilities in S-R. The lathe, band saw, vertical mill, and grinder will be available at limited times and may only be used under the direct supervision of appropriate personnel and only if you have been certified on their use. 2-D CAD/CAM work-cells will be available, but class members must be certified in their operation prior to use. Safety glasses **MUST** be worn whenever operating any of the equipment in B19. You must also wear hard-soled, closed-toe shoes and appropriate clothing when using the machine shop portion of the Design Studio. You must clean up the work

area after using any of this equipment. **Unauthorized use of any of the equipment or facilities or violation of posted safety regulations will result in dismissal from this course.** Your safety and the safety of those around you are the primary considerations. The prototype as well as all other equipment or supplies purchased from the resources provided by the University remain the property of the University of Notre Dame.

INTELLIGENT SYSTEMS AND AUTOMATION LEARNING LAB POLICY: ISALL is located in room 358C of Fitzpatrick Hall and is open Monday-Friday from 8:00 to 4:30. You may work in ISALL any time during these hours, but be advised that technical support staff is available only during regularly scheduled class hours on Tuesday and Thursday and at certain other specific times, which will be posted on the lab door. ISALL is managed by Mr. Brownell who will provide additional information on equipment and services.

AME MACHINE SHOP POLICY: The AME machine shop will be available to provide limited support. Mr. Hluchota, the AME Tool and Die maker, will be available for approximately ½ hour for consultation during the weekly design studio sessions. Mr. Hluchota will post his available times. Students are not allowed to use equipment in the AME Cushing shop at any time, though Mr. Hluchota may assist you by performing special tasks if time and resources are available.

CLIENT INTERACTIONS: Each group will work with an off-campus client. All interactions with the client must be conducted in a professional manner and at the client's convenience. The level of interaction with the client will depend upon the client's availability and interest. If you have any questions or concerns related to your team's interaction with your client, contact your instructor immediately.

CODE OF HONOR POLICY: All work submitted in this course must be the work of the student or students submitting the work. Students should be careful to properly cite the sources of ideas and other information that they submit if they are not their own, original work. Collaboration and team effort are keys to success in the course, but there are various items (e.g. engineering notebook, individual trade study, etc.) that must be the work of the individual engineer and submitted information must be the student's own or carry citations to the source. If you have any questions about the appropriateness of a collaboration or citation for an information source, ask prior to submitting the work.

C. PROJECT REQUIREMENTS

The projects will focus on the design of electro-mechanical devices in two related areas: 1) applying assistive technology that creates greater access to employment for people with disabilities, 2) assisting in the rehabilitation from temporary or permanent debilitating medical conditions. Each project team will be paired with a specific client who has identified a general need in one of these two areas. Working with that client, the teams will identify specific opportunities and work to develop a desirable, feasible and viable product to address that opportunity. Their efforts will be assessed based upon their application of sound engineering design practice, the successful demonstration of a functioning prototype and a determination by the client of the potential to meet the identified objectives for the device.

Each Team must:

1. Develop a set of engineering design requirements that are developed in response to a specific need.
2. Develop the conceptual design for a product that satisfies their stated engineering design requirements.
3. Develop effective documentation to communicate the form, function, and performance of the product. The design must be based upon sound engineering modeling, analysis, simulation, and prototyping. The documentation should include engineering justification and address key issues such as performance, fabrication, and assembly. All documentation must be able to be archived and distributed in a digital format.
4. Demonstrate and document the use of appropriate-resolution virtual (CAD) models of the prototype including a complete assembly, subassemblies and in-house fabricated components.
5. Fabricate a functional prototype to demonstrate the feasibility of key aspects of the product. The prototype will be evaluated against the engineering design requirements and evaluated by the clients.
6. Present the results of this concept development project in a formal Critical Design Review at the conclusion of the project.
7. Follow established procedures for maintaining and returning all issued equipment, follow safety guidelines, and follow cost accounting guidelines.

D. PROJECT SCHEDULE OVERVIEW AND PRIMARY MILESTONES

Project Schedule - Primary Milestones

18 Jan	Project kick-off meeting
21 Jan	Designer Reflections begin – Individual comments submitted weekly via Concourse
25 Jan	Weekly Preliminary Design Reviews begin (PDR)
1 Feb	Team's Customer Needs Assessment NLT
8 Feb	Individual design method application memo NLT Team's Target Design Specifications NLT
22 Feb	Team's Concept NLT
22 Feb	Individual engineering trade study proposal NLT
8 Mar	Individual engineering trade study report NLT Mid-term peer review
5 Apr	Team Design Project Report – Part 1 NLT Prototype Testing Plan and Performance Evaluation Criteria
14 Apr	Prototype Performance Testing NLT
19 Apr	Public Poster Display and Prototype Demonstration DUE
22 Apr	Electronic Submission of the AbilityOne Network Design Challenge Report – NLT*
28 Apr	Critical Design Review (CDR) and video DUE
3 May	Design studio check-out Engineering notebook DUE Final design documentation: Team Design Project Report - Phase I(revised) and Phase II NLT Peer review and Personal contributions DUE

E. DETAILS ON SELECTED DELIVERABLES

Additional details on the course/project deliverables will be provided during the semester and posted on Concourse.

Selected Individual Deliverables: (These are **NOT** all the individual deliverables):

1. **Due Friday, 21 Jan:** Designer Reflections – Each student is asked to submit weekly reflections on the design process and the product they are developing. Brief, regular reflection on your activities and decisions will assist you during the process. A series of questions will be posted in the Assessments section of Concourse each week. Your response to the reflection questions will be required by 5:00 p.m. on Friday and the following week's questions will be provided at that time. You will receive a participation grade on this element of the project.

2. **Due Friday, 8 Feb:** Design Method Application Memo – Each student will develop a 1-page engineering memo and associated “powerpoint” presentation (4-page limit) material demonstrating the application of a specific design method to some aspect of the concept selection phase of the project. The team members should coordinate their selection of methods and applications so that there is no duplication of effort within the team. Methods can be selected from those

used in AME30362 or other sources if approved by the instructor PRIOR to submission. The memo and presentation will require a peer review and revision PRIOR to submission (details to be provided). The memo should complement, not duplicate, the presentation materials. Use the memo to provide the insights and comments that you would provide during an oral presentation of the slides. (Both hardcopy and electronic submission)

3. **Due Tuesday, 3 May:** Individual Engineering Design Notebook - Details on the notebook are provided in this handout. Notebooks will be briefly reviewed and feedback provided periodically during design studio sessions. Each student should bring his/her notebook to every class session, and it should be available for evaluation at anytime during those sessions. (Hardcopy OR electronic submission depending upon media used.)

4. **Due Tuesday, 3 May:** Individual Peer Review and Personal contributions – This is a multi-step process that will be discussed during the semester. Near the end of the project, each engineer will prepare a written statement detailing their contributions to the team's efforts. These will be shared with the members of the team and the each will prepare their end-of-semester peer evaluation. A draft of the peer evaluation form is included in this handout (note: some details may change prior to submission). Review this form at the beginning of the semester to assist you in understanding some of the important issues that will be used by your peers to evaluate your contributions. In order to receive your grade in this course, you must submit this document by the required due date. (Hardcopy, non-electronic submission) [**Note:** a confidential, mid-term peer review will also be submitted. The mid-term review will not influence your course grade.]

Selected Team Deliverables: (These are **NOT** all the team deliverables)

1. **Due Tuesday, 27 Jan.:** Preliminary Design Review - Each Tuesday during the studio session the project teams will participate in preliminary design reviews (PDR). Each group will be given the chance to share progress and issues of concern. All are expected to participate in the discussions and provide collaborative assistance to each group. During the even-numbered PDRs the group should also present: 1. an updated project plan (Gantt chart), 2. a summary of the time invested to date for each member of the group, 3. categorized spending to date and 4. updated project budget plans. (All material presented during the PDR should be submitted as a single .pdf via email the instructor)

2. **Due Tuesday, 1 Feb.:** Team Customer Needs Assessment - Each team will prepare a formal engineering memo (limited to 2 pages) and associated "powerpoint" presentation (to be used as part of the PDR for this date) describing their understanding of the customer and design challenge. This document should describe the customer's needs and opportunity/challenge provided for this class of products and current products available to meet the all or part of the anticipated needs for the product. The memo and presentation will require a review by all the team members PRIOR to submission and their signatures indicating their endorsement of the content and presentation. The memo should complement, not duplicate, the presentation materials. Use the memo to provide the insights and comments that you would provide during an oral presentation of the slides. (Both hardcopy and electronic submission)

3. **Due Tuesday, 8 Feb.:** Target Design Specifications - Each team will prepare a formal engineering memo (limited to 2 pages) and associated "powerpoint" presentation (to be used as part of the PDR for this date) detailing the quantitative, target design specifications for their product. The specifications **MUST** be quantitative and based upon the customer's needs and wants and they will be used to guide the development of the design. They will also be used later in the project to evaluate the effectiveness of the design. The memo and presentation will require a review by all the team members PRIOR to submission and their signatures indicating their endorsement of the content and presentation. The memo should complement, not duplicate, the presentation materials. Use the memo to provide the insights and comments that you would provide during an oral presentation of the slides. (Both hardcopy and electronic submission)

F. ENGINEERING DESIGN NOTEBOOK

This important individual deliverable item represents a continuous journal of your activities on this project. It should be EITHER a hardbound notebook (permanent or spiral bound but NOT snap-ring binders) OR it can be developed in an all-electronic format (e.g. using a notebook, tablet or laptop computer) and if developed in this form it will be submitted

as a single .pdf document. Its purpose is to document the development of your product from your perspective and to help you record your activities, contributions, and rationale for the decisions that you or your team made.

Some guidelines you should consider:

You should include on each page of the notebook the **date of the entry and sign each page** as you make entries in the notebook. The book should document thoughts or ideas you and your colleagues develop. The notebook may include items such as written text, sketches, flowcharts, timetables, vendors, part numbers, or any other useful information. Include anything you think will be of value: ideas and thoughts related to the product or the project, preliminary calculations, notes from team meetings, notes from phone conversations (vendors, etc.) along with name and numbers, notes from a test of a prototype, "taped/pasted in" emails, letters, "napkins with scribbles", etc. Notebooks are frequently used to date when inventions were conceived. You may tape information initially written elsewhere onto pages within the book, but the contents of the book must not be able to fall out. You may fill more than one book, and they should be numbered sequentially. You do not need to "tape" into the notebook information that has been recorded or "published" in other forms such as the design methods application, engineering trade study, etc. The notebook should represent the notes used to develop those studies. These notebooks will be graded and will be part of your individual evaluation.

You can also get find some additional information concerning traditional engineering notebooks at:

http://www.bookfactory.com/special_info/engr_notebook_guidelines.html

Due to the volatility of electronic record keeping, the available software and guidelines for electronic engineering notebooks are less well defined. If you intend to use this notebook to document potentially patentable concepts, it is strongly recommended that you use a hardbound notebook and follow the accepted guidelines for their use. If you want to explore the use of an electric version of this important documentation, you can look at a range of documents on the web that offer advice, purchase special software or develop your own process. Just keep in mind this may affect your intellectual property rights.

Regardless of the approach you adopt, consistent, professional documentation of your efforts during his project are required and should be documented in your notebook.

G. PROJECT SUPPORT PERSONNEL

Instructor:

Steve Batill - batill@nd.edu

360 Fitzpatrick Hall - 631-0601

Office Hours: 3 – 5 p.m. on Monday and Thursday or by appointment or just stop by the office anytime for questions or discussion.

Graduate Teaching Assistant:

Jose Lugo - jlugo@nd.edu

Additional teaching assistants will support activities in the B-19 Design Studio.

Technical Consultants:

Greg Brownell - brownell.1@nd.edu

Intelligent Systems and Automation Lab, 358 Fitzpatrick

Leon Hluchota - Leon.Hluchota.1@nd.edu

AME Machine Shop, 108 Cushing

Rich Strebinger - Richard.B.Strebinger.1@nd.edu

364 Fitzpatrick

CAD/CAM and Rapid Prototyping Systems

John Ott - jott@watt.ame.nd.edu

377 Fitzpatrick

Design Studio Manager

AME40463: Spring 2011 Senior Design Project
Confidential Peer and Project Evaluation

Make a copy of and then complete the evaluation form by hand. Fold and write your name on the outside of the paper and submit directly to S Batill. This form will be submitted twice during the semester: 1) by 9:30 a.m., Tuesday, March 8, 2011 AND 2) by 9:30 a.m., Tuesday, May, 3, 2011.

Review submitted by: _____

This form should be used to provide a confidential, professional evaluation of each member of your design team **including yourself**. This evaluation is a key element in the instructor's evaluation of each individual in the team. Please consider each item carefully. Rate each member of the team in each area, on a scale from 0-10, with a 10 being the highest rating. **THE AVERAGE FOR THE ENTIRE TEAM MUST BE "5" FOR EACH CATEGORY.** You will have to select your own relative merit on that scale, and it is important that you are consistent. At the end of the semester you will also be asked to provide brief handwritten comments about each team member. Submission of this review form is a **course requirement**.

CATEGORY	1	2	3	4	5	6	7	8	9	10	TOTAL
ENGINEER'S NAME (listed in alphabetical order)											
1.											
2.											
3.											
4.											
5.											
TOTAL (=25)											

CATEGORIES:

1. TECHNICAL ABILITY
2. ORAL COMMUNICATION SKILLS: LISTENING AND SPEAKING
3. WILLINGNESS AND ABILITY TO WORK WITH OTHERS IN THE TEAM
4. WILLINGNESS AND ABILITY TO CONTRIBUTE IDEAS
5. ABILITY TO ADAPT TO NEW IDEAS
6. COMPLIANCE WITH TEAM DEADLINES
7. CONTRIBUTIONS TO THE IDEATION PROTOTYPING AND CAD MODELING
8. CONTRIBUTIONS TO PROJECT DOCUMENTATION (REPORTS AND VIDEO)
9. CONTRIBUTIONS TO PROTOTYPE FABRICATION, ASSEMBLY AND TESTING
10. OVERALL LEVEL OF EFFORT

AME 40463 Senior Design Project: Spring 2011

Design Methods Application - Evaluation Criteria

Engineer: _____

Score: _____

Possible Total Rating - 25 pts

1. Organization and Format: (6 pts)
 - a. Engineering memo format and meets length requirement 2 pts
 - b. Appropriately identified sections and subsections in memo 2 pts
 - c. Presentation slides – consistent style and format 2 pt

2. Application of the design method (10 pts)
 - a. Appropriate use of the method 4 pts
 - b. Assumptions explicitly indicated 2 pts
 - c. Results and conclusions appropriate for the method 4 pts

3. Engineering Memo (10 pts)
 - a. Complements and supports the presentation materials 4 pts
 - b. Provides insights and conclusions to support the results 4 pts
 - c. Concise with appropriate use of terms, units, etc. 2 pts

4. Presentation Materials (10 pts)
 - a. Quality of graphic content 2 pts
 - b. Quality of written content 2 pts
 - c. Effectiveness of graphics in describing method and results 3 pts
 - d. Effectiveness in written content in describing method and results 3 pts

Evaluator's Comments:

AME40463 Senior Design Project: Spring 2011

Engineering Design Notebook - Evaluation Criteria

Engineer: _____

Score: _____

Possible total score - 40 pts.

Use and Presentation: (20 pts)

1. Consistent entries (10 pts)
 - a. Multiple entries every week during the project (10)
 - b. Entries on Tues/Thurs every week during the project (8)
 - c. Multiple entries for most weeks (some weeks missing) (6)
 - d. Entries on Tues/Thurs (some weeks missing) (4)
 - e. Irregular use with significant gaps in entries (2)
2. Professional presentation (5 pts)
 - a. Consistently neat and well organized (5)
 - b. Irregular or marginal quality of presentation (2)
 - c. Consistently poor presentation (0)
3. All entries signed and dated (5 pts)

Content: (20 pts)

1. Engineering content (5 pts)
 - a. Consistently used to record the technical issues (5)
 - b. Irregular or marginal use to record technical issues (2)
 - c. Not used to record the technical issues (0)
2. Organizational material and meeting or discussion notes content (5 pts)
 - a. Consistently used to record the organizational issues (5)
 - b. Irregular or marginal use to record organizational issues (2)
 - c. Not used to record the organizational issues (0)
3. Useful and effective sketches and schematics with explanations (10 pts)
 - a. Effective, consistent use of drawing/sketches to illustrate ideas (10)
 - b. Consistent use of drawing/sketches – many incomplete or confusing (7)
 - c. Inconsistent use of sketches (4)
 - d. Very limited use of illustrations (2)
 - e. Sketches not used to document design development (0)

University of Notre Dame
Spring 2011

	Mon	Tues	Wed	Thur	Fri
JAN		18 ^{First Class Day}	19	20	21
	24	25	26	27	28
	31				
FEB		1	2	3	4
	7	8	9	10	11
	14	15	16	17	18
	21	22	23	24	25
	28				
MAR		1	2	3	4
	7	8	9	10	11
	14	15	16	17	18 BREAK
	21	22	23	24	25
	28	29	30	31	
APR					1
	4	5	6	7	8
	11	12	13	14	15
	18	19	20	21	22 EASTER
	25	26	27	28	29
MAY	2	3	4 ^{Last class day}	5 ^{study day}	6 ^{study day}
	9	10	11	12	13 EXAMS
	16	17	18	19	Senior Week

AME40463 – Spring 2011 - Project Gantt Chart

Major Task OR Milestone	W1 1/18	W2 1/25	W3 2/1	W4 2/8	W5 2/15	W6 2/22	W7 3/1	W8 3/8	3/12 3/20	W9 3/22	W10 3/29	W11 4/5	W12 4/12	W13 4/19	4/24	W14 4/26	W15 5/3		
Project Kickoff	X								B R E A K W E E K						E A S T E R				
Customer Needs Assessment			<input type="checkbox"/>																
Design Method Memo				<input type="checkbox"/>															
Target Design Specifications				<input type="checkbox"/>															
Team Concept						<input type="checkbox"/>													
Individual Trade Study Proposal						<input type="checkbox"/>													
Individual Trade Study Report								<input type="checkbox"/>											
Mid-term peer review								<input type="checkbox"/>											
Team Design Report - Part I													<input type="checkbox"/>						
Prototype Test Plan													<input type="checkbox"/>						
Prototype Performance Tests														<input type="checkbox"/>					
Poster Display and Demonstration																X			
AbilityOne Report Submission																	<input type="checkbox"/>		
Critical Design Review and video																		X	
Design Studio																			
Team Design Report - Part I and II																	<input type="checkbox"/>		
PDRs		X	X	X	X	X	X	X		X	X	X							
		1	2	3	4	5	6	7		8	9	10							