An ECE Capstone Design Experience

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The capstone design experience in the Department of Electrical and Computer Engineering at Western Michigan University is a two-semester sequence of two courses, the first of the two (**ECE Design I**) being a 2 credit course while the second (**ECE Design II**) is 3 credits. Students must have senior status and permission of the department chair to enroll in the sequence. In the first course, students form design teams, identify a project topic, produce a design project proposal and are instructed in topics relating to engineering professionalism. During the second course, the design teams, following their proposals prepared in Design I, implement their design project, evaluate it for compliance with their original specifications, create a project report and orally present their results at a public, formal, day-long, college wide "Conference on Senior Engineering Design Projects".

ECE Design I

ECE Design I is a two credit course and formally meets twice a week in a class room format. To be admitted to the course, each student completes a written application for admission. Using the application as a basis, the student is interviewed by a departmental academic advisor. Based on the interview, the advisor recommends admission or denial to the course. The advisor's recommendation is sent to the department chairperson who makes the final decision.

The course has two major goals. The first is to provide experience in engineering design through the process of establishing specifications for a design project, developing a design concept, testing the validity of the concept with mathematical and physical models and composing a design proposal for subsequent implementation of the proposed project. The second goal is to introduce students to various aspects of engineering professionalism.

First course, Design I, of the two course sequence

This first of the two design courses is divided into two broad segments. One of these addresses activities and topics associated with engineering design, the design process and creation of a project proposal. The other addresses engineering professionalism issues.

Engineering design segment of the Design I course

There are a number of milestones in the engineering design segment. Design teams must be formed. A project topic must be selected and, optionally, a project sponsor found. The project topic must be evaluated and approved and the design must be initiated. Faculty advisors for the design teams must be identified and selected. First, second and final drafts of the design proposal must be created and evaluated.

The task of selecting team members and finding a project is assigned at the first meeting of the class and must be completed within six weeks of the 15-week semester. Team size is specified at 3 students plus a team or two of either two or four persons should the class size not be evenly divisible by 3. Students are allowed to form their own teams and are encouraged to include a mixture of both electrical engineering and computer engineering students. The course instructor functions as a clearinghouse for students by publishing and maintaining a list of students seeking team partners. The instructor intervenes in the process only in cases where students cannot resolve any untoward circumstances.

To assist in finding projects, the course instructor solicits projects and maintains a list of "Potential Senior Design Projects". These projects are usually obtained from sources within the local industrial, professional and academic communities. Each potential project has a brief description and a contact person. Many of these sources have previously sponsored senior design projects and would like to do so again. Others sources are new or have a one-time project. Student teams are encouraged to explore the projects on the list and evaluate and select one appropriate for their team and for the design course's requirements. Students are also encouraged to find their own sponsored projects, are given general information on how to find such projects and often do so. Self-sponsored projects are discouraged but if they meet project requirements are allowed.

What are the requirements that a project must meet to be acceptable? To answer this question, the students are provided with two guidelines. The first, given below, is a rather qualitative guideline given in the form of an "Ideal Senior Design Project" description. Note that while it is qualitative in some parts, it recommends that the project have both a hardware and a software component, it allows projects that have only a hardware component and prohibits projects that have only a software component. The prohibition of exclusively software projects has both philosophical and an experiential basis.

The Ideal Senior Design Project

An ideal ECE Senior Design Project would include the following characteristics.

It would be a project that would require the development of a component, product or system that has potential for satisfying a real need. What is a real need? Here, a real need would be one that had been identified/encountered by a practicing engineer employed by a local firm where the firm would be in the business of designing, developing and/or manufacturing engineering components, products or systems. Further, the firm would be willing to sponsor the project.

Sponsorship would include the following:

- The firm would provide project team members with periodic access to a firm engineer(s). The engineer(s) would be available to provide the team with direction, counseling and advice.
- The firm would provide the team with access to and use of their facilities and engineering services for the purpose of fabrication, development, and testing of the project hardware and software.
- The firm would provide funding for project components and other miscellaneous expenses.

The ideal project would have both hardware and a software component. (Note: Projects with only a hardware component are acceptable. Exclusively software projects will not be approved)

The ideal project would be one that required a result (final product) near the “Proof-of-Concept” end of the spectrum rather than near the “Ready-for-the-Consumer” end of the spectrum.

The following is a description of a project that was completed by an ECE design team and that met most of the criteria of an ideal project.

> Request for proposal: A **portable test station** for use in production line testing heating/cooling air handling modules (AHM) of automobiles for specification compliance. Each module has an electric motor and switches that need to be tested for proper motor displacements, motor currents and switch closures. In use, the **portable test station** would be attached to an AHM and perform its testing as both moved down the production line. When retrieved at some point down the line, the **portable test station** would indicate a pass or fail test result via an alphanumeric display and/or indicator lamps and/or an audio signal. The portable test station must be able to store the test procedures and specifications for a variety of different motors and must have controls that allow a human operator to readily switch between these test procedures. The **portable test station** must be capable of being reprogrammed with test procedures/specifications for new motor designs. The **portable test station** must occupy no more space than a typical laptop computer and it is expected that it would have a 12 or 16 button keypad and a LCD display for user interaction. The **portable test station** should have a self-contained power supply, which is capable providing power not only for itself but also to operate the motors of the AHM under test. The power supply should be rechargeable and must have a life of at least one "worst case" 8 hour shift between recharges.

The second guideline identifying acceptable design projects is more quantitative. At the end of the first six weeks of the course, each design team must submit an "Application for Project Topic Approval". The details of all that is required in this document are shown in Appendix I and serves to tighten the tolerance on acceptable projects. As prescribed there, the team must provide a well-written description of their proposed project and a clear explanation of the need it will fulfill. The team must also provide a set of specifications for the project, preferably quantitative, and an initial design-concept for the project. Further, they must show how and give evidence that their design concept will indeed meet the projects specifications. They must also provide evidence that their design team has the necessary credentials to reasonably meet the project's design challenges and must provide the results of a relevant a literature search for their project. They also are given the opportunity to indicate preference for a faculty project advisor in the application. This preference is one of the factors that the ECE department chair uses in assigning an ECE department faculty advisor to each team. The assigned advisor will advise the team throughout the balance of the Design I course and for the full duration of the Design II course.

Each team's Application for Project Topic Approval is evaluated by the course instructor and by the department chairperson and is accepted, rejected or returned to the team for modifications. Projects are seldom rejected since students are given the opportunity and encouraged to consult regularly with the course instructor about their project topic selection progress throughout the six-week process. However, there is occasionally a team that fails to exercise due diligence and their application is rejected or returned for improvement. In the case of rejection, the instructor assigns the team a project topic.

The next milestone in the project part of the course, following topic application approval, is creation of a Design Project Proposal. This is done primarily under the guidance of the team's faculty advisor and is paced by a schedule of proposal draft submissions. A first draft, a revised draft and a final formal draft are required. The first draft of the proposal is due at 8 weeks into semester, the second draft at 10 weeks and the final draft at 12 weeks. Each draft must show significant improvement over the prior draft. The requirements that the proposals must meet are defined by the criteria in the "EVALUATION CRITERIA FOR DESIGN I PROJECT PROPOSALS" form shown in Appendix II. This form, based in part on the ABET statement describing engineering design, identifies approximately 45 criteria and is structured so that a user may respond by checking and circling items from lists. The design teams use the form as a checklist for items to include in the proposal. Faculty advisors use it to evaluate the drafts of the project proposals and to provide feedback to their design teams of needed improvement in the next draft. As indicated on the form, advisors are asked to assign a letter grade for the proposal work to each team member for only the final draft. This grade is 40% of the grade for the whole course.

The criteria in the form are grouped into the following categories.

- Project Need and Description
- Elements of the Design Process
- Use of the Engineering Method
- Additional Factors

The proposals that satisfactorily meet these criteria will have the project completely designed, i.e., every component (e.g. ICs, transistors, micro-processors, resistors, inductors, SCRs, LCDs, RAMs, PLDs, motors, actuators, sensors, transducers, PC boards, enclosures, etc.) will be selected and sized, circuit configurations will be determined, schematic circuit diagrams will be drawn, dimensioned drawings of mechanical parts, if appropriate, will be included, software flow charts will be completed and software will have been written. A Critical Path network to guide the projects timing and allocation of resources will also be included. All that should remain for the final semester (Design II) is implementation and fabrication of the physical system and software, followed by testing and design revisions cycles. While proposals seldom meet all of these criteria, we've found that striving to achieve these criteria generally result in proposals that help guide the teams to a successful design implementation during the second of the two-course sequence.

While the teams are preparing their Project Proposal, the formal class meetings are, in part, devoted to instruction in the following engineering design topics.

- The Engineering Method
- Identifying and establishing project needs
- Establishing, developing and writing design specifications
- Developing design concepts
- Testing the validity design concepts with physical and mathematical models
- Feasibility: physical, economic and design team compatibility

- Human factors
- Intellectual Property (patents, copyrights, trademarks, service marks, etc.)
- Engineering Design Methodologies
- Project Planning including the Critical Path Method (CPM) and Program Evaluation and Review Techniques (PERT)

For most of these topics we us the textbook Design of Devices and Systems, by Middendorf & Engelman, Marcel Dekker, 1998, and have found it to be very effective. We supplement this with readings from Scientific American, The Wall Street Journal (case studies) and numerous other publications.

Engineering professionalism segment of the Design I course

A indicated above, the majority of this first of the two courses is devoted to engineering design issues and the related tasks associated with Project Proposal production. We do however, devote significant time to ethics and to professional engineering registration.

Our anchor for exploring ethics is a videotape product of the National Institute for Engineering Ethics of the National Society of Professional Engineers entitled Gilbane GOLD. Gilbane GOLD is a dramatization about an ethical dilemma that involves environmental engineers, consulting engineers, engineering management, engineering professional organizations and the ratings driven new media. It serves to stimulate discussion and bring about a heightened awareness on the part of our students about ethical issues. In addition, real cases involving engineering ethics are studied. These include the Kansas City Hyatt Regency Walkway Collapse, the Bjork-Shiley Heart Valve failure and the Chernobyl Nuclear Power Plant failure. Finally, the role of the IEEE in engineering ethics is reviewed and the IEEE code of ethics is presented and discussed.

Professional engineering registration is addressed by reviewing the steps one must take to become registered, the credentials one must have at each step of the way and the benefits of registration. Also, the arguments for and against P.E. registration as they frequently appear in IEEE, ASEE and trade journal publications are presented and discussed. Students are encouraged to pursue registration and to take the fundamentals of engineering examination soon.

In addition to focusing on the above topics, the students are required to attend three formal ECE department seminars spaced throughout the semester. The speakers for these seminars are invited and are drawn from the local industrial, professional and academic community. They include design engineers from local companies, patent attorneys, attorneys involved in personal injury cases resulting from failed engineering systems, owners of local engineering firms, deans of engineering, ECE program graduates who have been employed as engineers for a number of years and many others. Our intent is that these seminars are informative about contemporary engineering issues, serve as another example of the role of engineering in our society and hopefully they will contribute to the development of the professional engineering stature of our graduates.

Grading for the Design I course

The grading for ECE Design I has three components. The components and their weights are:

1. project proposal 40%
2. proposal preparation and classroom assigned homework 15%
3. examinations and quizzes 45%

The course instructor is responsible for items 2 and 3 and the faculty advisor, assigned to advise the team at week 8 into the course, is responsible for item 1. The overall grading is thus distributed over two faculty members and about 1/2 the course grade is attributable to the project proposal and its preparation.

Second course, ECE Design II, of the two-course sequence

The second of the two design courses (ECE Design II) is a 3 credit hour course (the first is 2 credits). ECE Design II is somewhat less structured than ECE Design I. It meets formally in a classroom setting only 5 times throughout the semester and 3 of those times are to attend the ECE seminars mentioned above. The tasks that must be completed by the students are as follows. Note that all but one of the tasks require teamwork.

1. Prepare a formal project abstract for the program of college wide Conference on Senior Engineering Design Projects to be held at the end of the semester.
2. Meet weekly with project advisor
3. Prepare and deliver individual (rather than team) biweekly progress reports for advisor and sponsor.
4. Implement/build/fabricate the design as planned in the project proposal
5. Carryout testing and redesign as necessary
6. Compose a first draft, a revised draft and a final draft of a report for the project
7. Present project results orally at the formal Conference on Senior Engineering Design Projects held during the last week of classes.
8. Deliver finished project and a copy of the final report to the project sponsor.

The team members themselves are responsible for managing the project including the assignment of tasks to individual members and for picking their own leader. Since the teams completed a critical path network for the project in the first course, many decision related to these issues will have already been made. When problems with cooperation, equal shouldering of the loads and etc. do arise, the teams are encouraged to resolve the problems themselves. If they cannot, the faculty advisor will intervene as necessary but will the reminder that the team, as a whole, will be graded on the overall project results. The team's charge is to successfully complete the project, even when teamwork problems are encountered. In extreme cases, where the group is unable to resolve issues, each team member will be asked to complete a peer evaluation on each of the other team members in the group. A copy of the form used for this is given in Appendix III. This evaluation provides the project advisor with additional information that might be used in assigning individual grades to the team members.

The highlight of the course as well as the event that typically causes high stress is the final oral presentation in a public and formal format at the Conference on Senior Engineering

Design Projects. Our college devotes considerable resources to this daylong event inviting all sponsors, interested parties and even the press. A special class is held to instruct the students on how to prepare for this event. As part of this class, a copy of the "Oral Project Presentation Evaluation Form" that faculty will use at the presentations is reviewed. A copy of this form is shown in Appendix IV. Students are encouraged to structure their presentation to the evaluation form. Also, students in the first course of the sequence are required to attend the conference so that they may observe the teams a semester ahead of them in their delivery of their oral reports. This provides them an opportunity to become familiar with what they will be doing a semester hence and helps prepare them for their own oral presentations.

The following factors are used in grading the projects and the weight assigned each is at the discretion of the faculty advisor of the project.

X - Outcome factor based upon the degree of completion of the project, quality of the finished product and how well the end product meets the specifications stated in the proposal.
Y - Oral report factor based on the oral presentation of the project.
Z - Written report factor based on the final project report.
V - Discipline factor based upon resourcefulness, results of weekly meetings and reports, and uniformity of effort with respect to time.
P - Individual participation multiplier representing the degree of participation of the individual student in the project.

The structure of the ECE Capstone Design Experience presented here has evolved over the last 12 to 14 years through a process of assessment, reflection and continuous improvement. During this period we have constantly sought input from and listened to our critics (primarily our students) as well as the occasional admirer. Whenever problems have arisen, we've evaluated them and made changes to reduce or eliminate them in the next cycle or cycles of the courses. While the current state of the two courses is generally given good marks by our students, other departments in the colleges and by our accreditors, we continue to remain vigilant for new problems and to the principle of effecting continuous course improvement.

Summary

The Electrical and Computer capstone engineering design experience at Western Michigan University is based on a sequence of two senior level courses, Electrical/Computer Engineering Design I and II. In the first of the two courses, student design teams are formed, a design project is selected, a design proposal is developed for the project and topics related to engineering design and professionalism are reviewed and studied. The major activity of the second of the two courses is implementation of the design proposal developed in the first course and the presentation of results of the design at a formal design conference.

Appendix I

ECE DESIGN I APPLICATION FOR PROJECT TOPIC APPROVAL

TEAM MEMBERS: ____

PROJECT TOPIC: _______________________________________ Submission **Date:** ________

A. As a group, on attached sheets **with all text typed and double spaced:**

(DIVIDE THE APPLICATION INTO THE FOLLOWING SECTIONS)

1) Give a several page **DESCRIPTION** of your project. Include in this description the **NEED** that this project is to satisfy. Obtain help in preparing the final draft of **this section** from the university's Writing Center. **BE SURE** to have the Writing Center (WC) tutor send her/his report of your help session to the course instructor. Make a WC appointment early.

2) List the project's **SPECIFICATIONS** (quantitatively where possible). Explain and discuss each. Then, describe and discuss your current **DESIGN CONCEPT** for the project and include an explanation of how it satisfies each of the specifications. Draw sketches illustrating your current vision of the concept's hardware. Use block diagrams an/or flow charts to illustrate its functional parts and organization and the information flow and processing in your design concept.

3) Based on your current Design Concept, give an enumerated list of those ***items that YOUR team plans to design***.

4) Make a table that lists the categories of technologies that will be required by the project **and** of the ECE courses that provide preparation in these technologies, e.g., ECE 420 Power Electronics, might be listed for a project requiring "power electronics technology". Then, **show** (in the same or a different table) that the team has collectively taken, and mastered with a **C grade** or better, or by experience (include appropriate substantiating documentation in attached resume), the course work necessary to master the project's technologies. For example, if the project might require micro-controller technology, at least one team member must have mastered ECE 451. **Include copies of resumes and current transcripts of all team members in an appendix**. The resumes should show that the team members have the necessary credentials to successfully complete the project.

5) Research your project and/or your design concept and/or its parts via a literature survey/search. Start at Waldo's Science Reference Library. Briefly describe your search/survey and present its results. Be specific. List each significant information item found, summarize your findings for that item and give the **complete reference** for the source of the information. Note that at least 10 items are expected.

6) Indicate whether this project will be sponsored and, if so, by whom and at what level, e.g., advice from company engineers, money for components, Caribbean cruises for successful completion, etc.

B. Submit **TWO** copies of the "Application".

C. Optional: Faculty advisor preference. __________ Did you discuss this with the faculty person? Yes No

[ ] Approved **[ ] Rejected** **[ ] Needs modifications**

________________________, ______ ________________________, ______

Course Instructor Date Department Chairperson Date

Assigned Advisor ________________________________

Appendix II

EVALUATION CRITERIA FOR ECE DESIGN I PROJECT PROPOSALS

The following are a set of questions partially based on the ABET statement describing Engineering Design. **Students**: use the criteria as a guideline in preparing your proposals. **Advisors**: use the form to evaluate your team's proposal drafts by making appropriate entries. Please complete and return a copy to the course instructor. A proposal grade (A, BA, B, CB, C, DC, D, E) for **each** team member **is required only for the final draft.**

PROJECT TITLE ____DRAFT No. 1 2 Final

TEAM MEMBERS AND (GRADES) ________________________________(_____) ;

_____________________________(_____);___________________________(_____);

_____________________________(_____). ADVISOR ___________________DATE______

I) **Project need and description** (On graded **Yes/No** responses, please circle appropriate number if the response is not clearly **Yes** or **No**)

A) Does the proposal contain a clear and concise description of the project?
Yes 10 9 8 7 6 5 4 3 2 1 0 **No** (circle)

B) Is the need that the system, component or process is being devised to meet clearly and concisely stated?
Yes 10 9 8 7 6 5 4 3 2 1 0 **No**

II) **Elements of the Design Process**

A) Have appropriate qualitative and quantitative objectives and specifications been established and clearly stated for the system, component or process? **Yes** 10 9 8 7 6 5 4 3 2 1 0 **No**
If so: what proportion are quantitative? ____%
What proportion are qualitative? ____%

B) Has a **physical feasibility** study been completed? **Yes** 10 9 8 7 6 5 4 3 2 1 0 **No**

If so, was it primarily qualitative or quantitative? Qualitative____ Quantitative____

C) Has an **economic** (dollar cost) **feasibility** study been performed? **Yes_____ No_____**

If so, was it primarily qualitative or quantitative? Qualitative ______ Quantitative______

D) Is there evidence of a **synthesis process** in the proposal, i.e., were a number of solutions developed, any or all of which might lead to a workable solution of the originally stated need?
Yes 10 9 8 7 6 5 4 3 2 1 0 **No**
If so:
a) were the tentative solutions arrived at in primarily a quantitative or qualitative manner?
Qualitative______ Quantitative_______
b) was the alternative that appeared most promising selected on the basis of primarily qualitative or quantitative factors?
Qualitative______ Quantitative________

E) Is there evidence of **analysis** in the proposal; i.e., have mathematical and or physical models and fundamental principles of engineering been used to transform the stated quantitative specifications into numerical values for the parameters of the system, component or process?
Yes 10 9 8 7 6 5 4 3 2 1 0 **No**

F) Estimate what proportion of the **design methods** used in the proposal were:
a) **Device evolution** (cut and try, i.e. no formal engineering design ______%
b) **Repeated analysis** (iteration based on an incomplete models) ______%
c) **Synthesis** (based on complete mathematical models) _______%

G) Is there evidence that significant consideration was given to the following constraining factors and, if so, was the consideration based primarily on qualitative or quantitative factors? (Please ✓ mark) NA = not applicable

	NA	Yes	Maybe	No	Qualitative	Quantitative
a) economic	___	___	___	___	___	___
b) health & safety	___	___	___	___	___	___
c) environmental	___	___	___	___	___	___
d) sustainability	___	___	___	___	___	___
e) ethics	___	___	___	___	___	___
f) social impact	___	___	___	___	___	___
g) manufacturability	___	___	___	___	___	___
h) political	___	___	___	___	___	___

H) Is there evidence that a **literature survey** was performed? **Yes** 10 9 8 7 6 5 4 3 2 1 0 **No**

If so: a) rate the apparent thoroughness of the survey from
0 (superficial) to 10 (exhaustive): 0 1 2 3 4 5 6 7 8 9 10

b) is each entry in the literature reference list cited at some point in the proposal?
Yes______ **No _____**

I) Is there evidence that a **patent search** was performed? **Yes** 10 9 8 7 6 5 4 3 2 1 0 **No**

If so: a) rate the apparent thoroughness of the survey from
0 (superficial) to 10 (exhaustive): 0 1 2 3 4 5 6 7 8 9 10
b) is each entry in the patent search list cited at some point in the proposal?
Yes______ **No______-**

J) Does the proposal contain a **critical path network** for the project?
Yes______ **No______**

If so, rate the apparent thoroughness of the network from
0 (superficial) to 10 (exhaustive): 0 1 2 3 4 5 6 7 8 9 10

K) Does the proposal contain a precedence **matrix** for the project? **Yes______** **No______**

If so, rate the apparent thoroughness of the network from
0 (superficial) to 10 (exhaustive): 0 1 2 3 4 5 6 7 8 9 10

III) Use of the ENGINEERING METHOD

A) Are the project's **specifications** clearly and obviously spelled out in the proposal?
Yes 10 9 8 7 6 5 4 3 2 1 0 **No**
Is it clear which of the specifications are;
a) Requirements, which are b) Goals and which are c) Preferences?
Yes 10 9 8 7 6 5 4 3 2 1 0 **No**

B) Is the **design concept** that was developed to meet these specifications clearly and readily identifiable?
Yes 10 9 8 7 6 5 4 3 2 1 0 **No**

C) Were **physical and/or mathematical models** used to test the developed design concept?
<u>Yes</u> 10 9 8 7 6 5 4 3 2 1 0 **<u>No</u>**

D) Is it clear that the testing via modeling unequivocally lead to the conclusion that the design concept would meet the originally stated specifications? **<u>Yes</u>** 10 9 8 7 6 5 4 3 2 1 0 **<u>No</u>**

IV) Additional Factors

A) Were project **DELIVERABLES** including hardware items, software, manuals and software documentation listed in the proposal? **Yes**_____ **No** _____

If yes, rate the apparent thoroughness of the listing from
0 (superficial) to 10 (exhaustive): 0 1 2 3 4 5 6 7 8 9 10

B) The proposal contains a well-defined and realistic plan for measuring the performance of the completed project and for comparing that performance with the original specifications.
<u>Yes</u> 10 9 8 7 6 5 4 3 2 1 0 **<u>No</u>**

C) Have components to be used in the design (e.g. ICs, transistors, micro-processors, resistors, inductors, SCRs, LCDs, RAMs, PLDs, motors, actuators, sensors, transducers, PC boards, enclosures...) been selected and sized? Have circuit configurations been determined and have schematic circuit diagrams been drawn? Have drawings of mechanical parts been dimensioned? Have software flow charts been completed and has software been written where appropriate? (Note, all that should remain for ECE 482 is implementation/building of the physical system, followed by testing and design revisions cycles.)
<u>Yes</u> 10 9 8 7 6 5 4 3 2 1 0 **<u>No</u>**

D) Experience shows that design teams occasionally resort to "cut-and-try" designing because of an alleged "lack of time" needed to identify the necessary models, synthesis techniques and engineering principles governing the technology in their project. By insisting that the ECE Design I proposals explore and identify the models and engineering principles involved, the temptation of "cut-and-try" designing can possibly be diverted and at best completely avoided.

This proposal is strong enough to effectively avoid inappropriate "cut-and-try" designing. (encircle choice)
(emphatically disagree) 0 1 2 3 4 5 6 7 8 9 10 **(emphatically agree)**

E) Project's scope; **(too simple)** **(just right)** **(too ambitious)**
(encircle choice) 0 1 2 3 4 5 6 7 8 9 10 9 8 7 6 5 4 3 2 1 0

F) Project's effect on student's ability to use engineering design methodology.

(unnoticeable) 0 1 2 3 4 5 6 7 8 9 10 **(extensive)**

G) Project's effect on the development of student's creativity.

(unnoticeable) 0 1 2 3 4 5 6 7 8 9 10 **(extensive)**

H) This draft of the proposal was submitted **ON TIME.** Yes______ No_____

Appendix III **PEER EVALUATION**

Use this form to evaluate your teammate(s). Complete one form for each teammate. Print the name of the teammate on the following line.

NAME (of teammate)__________________________________ Date ______________

In items 1-10, give your evaluation using the following 1 to 5 scale.

5 - Far superior. Ranks first among all I know.
4 - Better. Ranks in top half.
3 - Same as most I know. An average performer.
2 - Must do better. Lacks a little.
1 - Very poor. Ranks last.

Is this person:

1. Knowledgeable and technically competent? . . . . _____
2. Creative - an idea source? . . . . . _____
3. Willing to take responsibility? . . . . _____
4. A decision-maker? . . . . . . _____
5. Well organized - prompt - dependable? . . . . _____
6. A valuable - loyal - teammate? . . . . _____
7. Capable of leadership? . . . . . _____
8. Friendly - easy to get along with? . . . . _____
9. Honest - reliable? . . . . . . _____
10. One with initiative and drive? . . . . . _____

For items 11-21, evaluate by circling the appropriate response.

From your experience with this person on this project, would you:

11. Recommend for a raise? yes no

12. If yes, how much of a raise? high medium low

13. Recommend for a management position? yes no

14. Choose this person to serve with you again? yes no

15. Judge this person's attitude as: warm cold self-centered

16. Judge this person as: energetic indifferent lazy

17. Judge this person as: shy compatible domineering

18. Judge this person as: abrasive neutral enjoyable

19. Judge this person as: opinionated flexible open-minded

20. Judge this person as: immature showing potential mature and professional

21. Judge this person to have earned the following grade as a teammate: A BA B CB C DC D E

Additional comments? Make on back of form. If made, check here ( ).

Please submit in sealed envelope. Signed ______________________ / Name printed ______________________

Appendix IV

WESTERN MICHIGAN UNIVERSITY
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING
ORAL PROJECT PRESENTATION EVALUATION FORM V5

Please complete one form for each team. Score the teams performance in each of the following categories on a 0 to 10 scale, **10 = STRONG AGREEMENT, 0 = STRONG DISAGREEMENT and 5 = NEUTRAL**. Please complete and **RETURN THESE FORMS TO THE TEAM ADVISOR** no later than three (3) working days after the presentations. Thank you.

Team Members:____

Project Title or Topic:____________________________________

Advisor:____

1. The team members clearly and appropriately introduced themselves or each other. (Score 0 to 10, see above) ______

2. The project title or topic was clearly and understandably stated. ______

3. Had this presentation been for a group of engineering and management professionals in an industrial setting, the team members would have been appropriately dressed and groomed. ______

4. The need that this project is to satisfy was clearly stated. ______

5. The original quantitative specifications for the project were clearly presented and reviewed in detail. ______

6. The presentation clearly illustrated that quantitative performance measurements were taken on the finished project and a discussion of those measurements was given. ______

7. The presentation contained a clear and meaningful discussion and comparison between the completed project's measured performance and the original specifications. ______

8. The presentation clearly indicated which of the original specifications were met and which were not. ______

9. All of the teams members demonstrated public speaking technique (eye contact, body language, audience facing, sound level, etc.) that were developed to a level consistent with what might be expected of college seniors. ______

10. Visual and/or audio aids were well prepared, planned, organized and significantly enhanced the presentation. ______

11. The team brought the physical hardware of their finished (or near finished) project to the presentation and identified, described and discussed the various parts, controls and other remarkable features of this hardware to an extent which gave reasonable assurance that hardware had actually been built, operated and tested and that its performance clearly substantiated the claims made in the oral presentation. ______

12. The team clearly stated an estimate of the proportion of the their project that they had completed as based on the goals that were stated in their ECE 481 project proposal. ______

13. The presentation was neither too long nor too short for the allotted 25-minute time interval. ______

14. The presentation was well planned, organized and executed. ___________

15. Aside from satisfying the ECE 482 course requirements, the results of this project should have genuine utility. ___________

16. Should the situation arise that student groups from each of the engineering colleges in the state of Michigan were to present their senior projects to a representative group of engineers and managers from industry, you would enthusiastically recommend that this group and its project be chosen to represent the department (i.e., Electrical & Computer Engineering) at such an event? ___________

17. OPTIONAL: You may be able to assist the team's advisor in evaluation by grading the individual members. If you choose to do so, please enter grades below.

Name________________ Grade____; Name _______________ Grade____;

Name________________ Grade____; Name ________________Grade____.

EVALUATOR'S NAME (optional) ______________________________________

If you would permit disclosure of this form to the student team

members, please indicate so here. ____

Comments:____

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BIOGRAPHICAL INFORMATION

JOHN GESINK (john.gesink@wmich.edu) is an Associate Professor of electrical and computer engineering at Western Michigan University where he teaches graduate courses in instrumentation, is responsible for the department's capstone senior design projects courses and is the department's graduate program coordinator. His research area is rehabilitation engineering, sensors and instrumentation. He is a member of the IEEE and ASEE.

S. HOSSEIN MOUSAVINEZHAD (h.mousavinezhad@wmich.edu) is Professor and Chair, Department of Electrical and Computer Engineering, Western Michigan University. His teaching and research interests include digital signal processing (DSP) and Bioelectromagnetics. In addition to administrative responsibilities, he teaches undergraduate/graduate courses in his research area and is co-PI for a DSP grant funded by NSF. He is also an active member of ASEE and IEEE.