Engineering Design I/II
Capstone Design Project Guidance

Academic Year 2016

United States Naval Academy

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The Capstone Design Project

This document describes the requirements for the capstone design project. The specific deliverables for the fall and spring semesters are summarized and guidance about the form and content of these deliverables is provided.

Overview

All Engineering students must participate in a capstone design project as part of the engineering curriculum. The capstone design project is an opportunity for you and your teammates to solve a practical engineering design problem using the engineering skills and knowledge that you have developed over the past three years. Your team will be challenged to define the problem, develop a number of candidate designs, select from among them, fabricate and test the selected design, revise it, and ultimately present your prototype – demonstrating that the design objectives have been achieved.

This is no small task! In order for you and your team to have sufficient time to complete the project, you'll begin the project in the fall and complete it in the spring. During the first semester we'll work through the initial stages of design, through design selection, and by the time winter break is upon us, you should have a detailed design that is ready for initial fabrication. When you come back in the spring, you'll focus on testing and evaluation, revising your design, and presenting a solution you are proud of.

You will document the design process in a report that you'll revise and add to throughout the academic year. You'll also present your work regularly to a panel of outside customers, faculty and staff members, and your peers in order to check your progress and offer additional guidance along the way. The due dates for these reports and presentations are detailed in the course syllabus. This schedule represents the maximum time allotted for the design process. In other words, your team may progress *more* quickly, but must meet this schedule at a minimum.

Course Administration

You are scheduled for four class hours per week. One class hour, Monday during sixth period, will be a lecture for a handful of the 16 weeks in both the fall and spring. All students taking engineering design will meet in Rickover Hall, room 102 (the large lecture hall). Some lectures will feature a demonstration of the next presentation done as an example, some will feature guest speakers, and some will include discussions of topics related to engineering design. Check the syllabus for details. One of the remaining hours each week you'll have a group meeting with your team mentor, technical advisor, and your TSD representative. The remaining two hours of class time each week are yours to work on your project tasks, though you will certainly need to work more than these four hours per week to be successful.

The team mentor, who you'd think of as your traditional *instructor*, typically has three design teams assigned to him or her. They will help you to manage your project and are responsible for assigning your grade. In addition to the team mentor, each team is assigned a technical advisor; someone who is very knowledgeable on a subject related to your capstone project. Technical advisors are only assigned one team. Each team is also assigned a TSD representative; a technician from one of the support shops who is also familiar with the subject related to your project and can help you with design and manufacture. TSD representatives may be assigned to more than one team.

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Course Material Storage

There are several options for storing your course materials. Discuss with your team mentor which is right for you. They include a local server (\\neptune\samba$\projects\Design 1&2) run by the Computer Support Branch (CSB), Google Drive, or some other cloud storage application such as Dropbox. Regardless of what arrangement you make with your team and team leadership:

1. All reports and presentations need to be stored on the CSB server eventually. This could happen as you go or at the end of each semester. Either way, we need to archive your work for posterity. If you chose to use Google Docs and Slides for your reports and presentations, respectively, please save them as .pdf rather than .docx. The reformatting from Word to Docs or vice versa makes the documents virtually unusable.
2. All follow-on materials such as code, engineering drawings, SolidWorks models, need to be archived on the CSB server for posterity.
3. Your instructor, technical advisor, TSD representative, and course directors, LCDR Ethan Lust and CDR John D. Stevens, need to have access to your folder. Be sure to share it with us.

Design Communication: Formatting, Conduct, Submission, and Archiving

During the fall semester you'll give three presentations to the review board, which will be composed of the faculty members who teach the course, technical advisors, TSD representatives, and often outside customers. These presentations are your System Requirements Review, Preliminary Design Review, and Embodiment Design Review Presentations. In the spring you'll give three additional presentations including the Prototype Demonstration, Progress Update Review, and the Final Design Review Presentation, which is given on Capstone Day. Specific guidance is given below. A corresponding report is due two weeks after each of these presentations. See the syllabus for specific dates. It may sound like a lot, but you'll see that each successive presentation and report builds upon the last.

The goal of all design communication is that it should be professional in appearance and make it easy for the reader to access the content. When in doubt, ask and/or follow the example.

All presentations will be scheduled during class time. All team members must be present for their respective presentation unless otherwise coordinated with your team mentor. Additionally, each student must attend at least one other group's presentation, preferably one scheduled prior to your own!

A computer with PowerPoint, access to the Internet, and a projection system will be available in the presentation room. Students are advised to load their presentation ahead of time – before presentations begin for the day - to preclude the delay of downloading and opening the presentation in front of the audience. Also, occasionally the e-mail server or the shared drive is unavailable. Students should have a back-up plan in the event of a technical malfunction.

Unless otherwise specified by your team mentor, you will submit each report by placing the final revision in the specified folder on your team shared drive. Feedback will be provided via *Track Changes* and comments. In some cases, you may be asked to print the report for easier reading. Be sure to check with your team mentor as to his or her preference. Presentations will be archived similarly. Also scan your rubrics and include the associated .pdf file(s) for each report and presentation.

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Team Roles

Each team will identify someone in their group to assume the following roles:

- Leader – tasked with organizing the efforts of the group and managing the project schedule. The team leader is also the primary liaison between the team and the project customer unless otherwise delegated.
- Design Communication Editor – tasked with reviewing reports and presentations for consistency, ensuring all items included in the rubric are included in the presentation or report, and proofreading for spelling mistakes, proper grammar, etc.
- Purchaser – tasked with obtaining purchase information and submitting purchase orders in accordance with instructions included below. Once submitted, the purchaser is also responsible for tracking the item(s), picking them up as they arrive, and maintaining the team budget.
- Technical Support Detachment (TSD) Liaison – tasked with reviewing shop work requests for completeness, reviewing them with the TSD representative and team mentor, getting them signed by the team mentor, submitting them to the shop managers, and tracking them through the manufacturing process. The TSD liaison is also responsible for keeping track of shop work hours.
- Safety Officer – charged with ensuring adherence to the division safety instruction (E&W Inst 5101.1 Risk Mgmt Procedures for Design Res Projs 20121215), which is contained in the *1_Course Administration* folder.

For teams with less than five people, some team members will have to have more than one role. The team mentor may assign additional roles as necessary.

Design Communication Guidance and Rubrics

Specific guidance for each report, presentation, and deliverable is provided in the following pages. Guidance includes the purpose of the document, a detailed description of what content is expected in each section and how it may differ from previous communications, and the rubric that will be used to grade it. The point totals for each category are used as a guide for you and your team mentor. However, team mentors may adjust the points as necessary to motivate teams, especially in cases when revisions from previous reports are unsatisfactory. That said, there are enough opportunities to present and revise that teams should be able to earn the grade they want so long as they are willing to work for it.

To reiterate, the presentation corresponding to each report is scheduled two weeks prior to the date the written report is due in order to give you the opportunity to add to, subtract from, or otherwise change the material in your report prior to submitting it formally. The content guidance provided below is written from the context of the written report. It is up to you to decide how best to use the time you are allotted to communicate your progress during your presentation. Be sure to use the presentation and report rubrics as guides in addition to consultation with your project mentor and technical advisor.

If you and your teammates feel that the guidance and rubrics enclosed do not properly address your particular project and/or will hinder you in your pursuit of success, please feel free to propose a modification. Develop a revised rubric in consultation with your instructor. All reasonable requests will be entertained.

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System Requirements Review

Purpose
The System Requirements Review is the initial design communication. The client initiates the design process by soliciting design teams to submit proposals for future work, called a *bid*. The client then decides which bid it likes best and hires the design team to provide a design solution.

For this course, the purpose of the System Requirements Review is to define as specifically as possible the problem and what will be undertaken over the course of the project to solve it. It should communicate to the reader that a specific need exists, provide background and context on the problem, present the problem statement, outline specific design requirements, and convince him or her that a solution can be achieved in a timely and cost effective manner.

Content
Title Page: The title page shall include the team logo and name, a one sentence project description, the name of report (in this case the System Requirements Review), the name of the course (Engineering Design I or II), the date submitted, the names of each team member, and the names of the team leadership.

The team name and logo should be colorful, creative, and professional.

Executive Summary: The executive summary is a brief summary of the contents of the report. At its longest, when submitted affixed to your final report in April, it will be no longer than a page. It is used to help the reader decide if the report as a whole contains information that is of interest. The executive summary for the System Requirements Review should contain a statement of the problem and a summary of the most important customer requirements.

The executive summary should be on its own page and precede the table of contents as shown in the example.

Table of Contents: Each report shall include a Table of Contents.

Problem Definition: As shown in the example report, the course text is followed closely for this section.

This section of your report should begin with the customer's problem statement – the one you were provided at the start of the project. Next, it should include a discussion of what the problem is. The big question here is: *What about the current situation is unsatisfactory?*

Next, conduct a cursory background investigation. The intent here is to come up to speed enough on the problem, associated science, and other solutions, so that you can ask intelligent questions of your customers and those people you seek out as resources. It's often helpful to use a concept map to explore the problem. FreeMind is a mind-mapping tool that generates concept maps. It's part of the E&W Division software package and a good place to start and will help you to organize your thoughts. Here's one from our example project (you'll have to open using the MindMup App for Google Drive).

Next, identify the customers of your project. As mentioned in the text, the term *customer* does not necessarily mean *end user*. The textbook outlines a number of different sources of information aimed at helping you

determine what your customers want/need from a design solution. Please use them and record your findings in your report, as shown in the example report. You are highly encouraged to interview your customer if available and amenable. You might find it useful to write out your questions ahead of time. Here's an example of some that were asked during the conduct of the example project. It's also good practice to record the interview for later reference, with the customers' permission of course. Like all the other information you gather on your customers, be sure to distill your interview and add it to the content of your report.

As a team, from all the information you've gathered on the customer, develop a list of customer requirements. Often this list is very long. You certainly won't try to address all of these concerns directly, but recording them is important for reference. Once you have a better understanding of the scope of the problem, you'll pare this list down to a handful of customer requirements upon which to focus.

Now that you have a clearer picture of what the problem is and what the customers are looking for, gather as much information as you can about any and all previous efforts to address this problem (*see* D&S Section 3.4). Provide any amplifying information or context needed to understand these efforts, and distill the results of your effort into your report. Provide ample evidence that you have used all sources of information mentioned in the text that are applicable to your project. For example, students are often reluctant to consult technical papers, product literature, and patent literature. This should serve as your fair warning that we will be looking for these.

There will likely be some engineering modeling/calculations/estimations required to fully understand the problem, even at this early stage. For example, if one of the customer requirements is to create a human powered vehicle capable of winning a competition, you must determine what a winning time is and how fast the vehicle must travel to achieve it. Another example would be a project aimed at melting snow to provide drinking water. Even before the first drop is drunk, you should be able to figure out how much water the customer needs, how much snow is required to provide it, and how much energy it takes to turn one into the other. This sort of information is *solution-neutral* which is to say it doesn't matter what your final design looks like, this is information that must be known in order to provide a solution – any solution.

Also, regardless of the design, there are most likely associated codes and standards that may place particular constraints on the design. For example, if the goal of your project is to reduce emissions for a vehicle, then you need to know what the associated test standards are (*the EPA Federal Test Procedure (FTP) for Light Duty Vehicles and Trucks and Motorcycles*, if you're wondering). Please ensure these are referenced and the pertinent portions included in the discussion. If, even after consultation with your instructor, you can't find specific codes and standards applicable to your project, discuss any instances in which you think they *might* exist. For example, with regard to example project, it makes sense that one could not just install a buoy anywhere, but we had difficulty finding the specific code or regulation prohibiting it. The purpose of this is to avoid any fairly obvious limitations on the design space.

Finally, before stepping off on a march to cure the ills of the world, it's a good idea to take a moment to consider the impact of this project and your potential solution from a global, economic, environmental, and societal perspective. We're not looking for a philosophical treatise, just some evidence of consideration. Try and answer the following questions: Where does this design fit in the modern world? Who might interact with it, besides the customers, and what might be their experience with it? What is the economic impact of this design? What is the impact of the economy on this design? What is the environmental impact of this design, including the procurement of raw materials, manufacturing, service life, and disposal? What is the impact of

this design on society? The stated mission of many fields of engineering, generally speaking, is to benefit society in some way. How does this design benefit society? Might it be harmful to society? If so, how?

Need Identification: In this section you will define the goals toward which the entire rest of your project will be focused. Practically speaking, you're giving a tour of the House of Quality, as discussed in the assigned reading (Dieter and Schmidt 2013, section 3.6) and reviewed in lecture. Here's the one developed for the example project.

First, include a table of your customer requirements, listed in order from most important to least important (Room 1). Be sure to explain any customer requirements that require it. Accompany the table with a brief summary – how you developed them, with whom you spoke to confirm them, and which are most important. Please include images wherever useful in communicating the necessary details.

Next, include a table of Customer Assessment of Competing Products (Room 6) and describe how you determined customer preference. Did you use a focus group? A survey? What did you learn about what your customer wants and needs?

Then, include a table of your engineering characteristics (Room 2) - listed from most to least important - including units, and direction of improvement, as appropriate. Specify which of these design parameters are design variables (a parameter over which the team has a choice) and which are design constraints (a parameter whose value has been fixed). Discuss the top five ECs and describe how they relate to your customer requirements.

Also include a table of the Technical Assessment (Room 7). Instead of scaling the competing products with regard to your ECs as it says to in the text, include the actual value. For example, say your problem statement is to design a quarterback for the robotic football team. Suppose one of your ECs was *pass accuracy*, measured in inches from the target, and the direction of improvement is down (the actual pass lands fewer inches from the target). The Technical Assessment would list the pass accuracy for all the competing designs, if known: those of other universities plus last year's design. You may not be able to fill out the table completely, but you should do your best to fill in what you can.

Finally, include a table of Target Values (Room 8). For design variables, include a range. For design constraints, include the constraint limit itself. Continuing with the previous example, the team would define success with regard to *pass accuracy* as ± 2 in. from the intended target point. Do your best to set achievable target goals. It is unlikely that you will be able to achieve the best value in each of the categories listed in the Technical Assessment. Focus on the ECs which will please your customers the most.

Note: It is not enough to simply copy and paste the table from your House of Quality in your report. Every figure and table must be discussed. Tell the reader explicitly what the figure or table tells you.

Project Management: Understanding many of the specifics will not have been determined yet, this section should provide the customer with a proposed timeline by which progress can be tracked and judged as well as a general schedule as to when they can expect your project deliverables. Following a brief introduction, include a table of project-specific milestones (in addition to those listed on the syllabus). Tasks should be assigned to specific group members as appropriate.

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This may seem like putting the cart in front of the horse, but providing a projected timeline with a project bid is common practice in industry. It is also good practice and will help you get in the habit of looking forward. Tasks that are close at hand will be scheduled with a high degree of certainty, whereas those further out will be more tentative and rescheduled as they draw nearer in time. Work with your team leadership to develop a detailed, project-specific timeline.

Budget: Likewise, it may seem a bit premature to propose a budget for a project for which the details have yet to be determined. However, projects are almost never proposed without preliminary budget estimates. In fact, the proposed budget is likely to be a deciding factor in determining which firm the client will select. In an engineering design firm, the members will have experience that will allow them to be more specific and likely more accurate in their budget estimation. You, unfortunately, do not have this experience. So, like all other cases in which you need to make a decision but have no prior reference, you should make the best decision you can with the information available to you. We're not looking for a bill of materials. What we want is evidence of thoughtful consideration. And, just so you don't view this as a fool's errand, your inputs are going to be used to request project funds. Be specific when you can be (e.g. travel costs, contest registration, etc.) but always be thoughtful. Budgets for previous related projects is a good place to start. For reference, a typical project budget is approximately $1000. Round your request to the nearest $100 increment.

References: Technical documentation should always be written such that without direct contact with any of the group members someone could follow the design process and continue or revise the design without reconstructing the project themselves. Thus, documenting references is crucial. In this course the *Chicago Manual of Style* format is recommended for references, mostly because it's complete, professional looking, and widely-accepted. You may use footnotes or endnotes, so long as they are professional in appearance and complete in content.

Note: Appendices should be lettered A – Z and appear in the order they are referenced in the text. Appendices are composed of any information that does not complement the narrative flow of the in-text discussion, but must be included for the sake of completeness. For example, the reader would gain little from having a detailed explanation of your engineering modeling calculations, but some (perhaps your instructor?) might be interested in reviewing the details. Placing your calculations in an appendix would provide them with that information.

Appendix - Deliverables. Though it is not a contract, you can think of this section as an agreement between you, the students, your faculty leadership, and your customers describing what, specifically, you will provide them at the conclusion of the project. Think of it in terms of answering the question, "What are we going to give the customer in exchange for their patronage" be it their time, material support, or financial support. If the scope of the project changes, as it often does, be sure to discuss it with your customer and faculty leadership and revise the deliverables agreement.

Appendix – Team Charter. The charter is your agreement, as a team, about what your goals are and how you are going to work together to accomplish them. It should include:

- Team name and logo
- Team goal(s) (different from problem statement)
- A table with student information including names, team roles, and cell phone numbers

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- A table with faculty member (team mentor, technical advisor, and TSD representative) information including names, roles, office numbers, and desk phone numbers
- Weekly meeting schedule (where and when)
- Conflict resolution statement: Describe how you, as a team, intend to work together and to resolve disagreements
- Personal statement: For each individual, briefly discuss what you hope to gain from this experience

Note: the rubrics for the SRR are different from those that follow because we're in the process of revising them - specifically making them more general to accommodate good work of all kinds. Additional updates may follow.

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System Requirements Review Presentation Rubric

Team Name: Reviewer:

Statement and Description	Comments	Letter Grade
I understand what problem the team is trying to solve. Including any necessary terminology, concepts, and context.		
I understand who the intended customers are. The team has included all obvious customers.		
The team has captured the Customer Requirements. The most obvious needs/wants have been identified. I understand how the information was gathered.		
The team has been thorough in their gathering of information. Including related science, trade study, benchmarks, state of the art, etc.		
The team has made good use of engineering models. Including calculations/estimations necessary to further elucidate the problem. Also including assumptions and limitations.		
The team has translated the CRs into Engineering Characteristics (ECs). The most obvious have been identified. Appropriately describe intended performance. Prioritized and include constraints, and Codes and Standards as appropriate. Identified target values for each EC to enable the identification of success.		
The team has a project management plan. Detailed and complete to facilitate efficient use of time, manpower, and resources.		
I understand how much funding the team estimates they'll need and why. Value based on reasonable engineering decision making.		
I understand what the project deliverables are. Developed with the customer and the team leadership. Complete and scoped to provide a reasonable chance at success.		
The team's verbal delivery of the material was clear and professional. Practice was obvious, completed in the required time, enthusiastic, questions answered completely and objectively.		
The team's non-verbal presentation was clear and professional. Including clear, concise, professional slides and/or prototypes and demonstration items.		

Overall Score out of 100: _____

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System Requirements Review Report Rubric

Team Name: Reviewer:

Statement and Description	Comments	Letter Grade
I understand what problem the team is trying to solve. Including any necessary terminology, concepts, and context.		
I understand who the intended customers are. The team has included all obvious customers.		
The team has captured the Customer Requirements. The most obvious needs/wants have been identified. I understand how the information was gathered.		
The team has been thorough in their gathering of information. Including related science, trade study, benchmarks, state of the art, etc.		
The team has made good use of engineering models. Including calculations/estimations necessary to further elucidate the problem. Also including assumptions and limitations.		
The team has translated the CRs into Engineering Characteristics (ECs). The most obvious have been identified. Appropriately describe intended performance. Prioritized and include constraints, and Codes and Standards as appropriate. Identified target values for each EC to enable the identification of success.		
The team has a project management plan. Detailed and complete to facilitate efficient use of time, manpower, and resources.		
I understand how much funding the team estimates they'll need and why. Value based on reasonable engineering decision making.		
I understand what the project deliverables are. Developed with the customer and the team leadership. Complete and scoped to provide a reasonable chance at success.		
The report has a professional appearance. Formatting is consistent and clean making the content easy for the reader to access. Figures and tables are numbered, captioned, and referenced.		
The report is well-written. The narrative is strong and logical, written from a third-person perspective. Proofreading is evident. Grammar and Spelling have been checked.		

Overall Score out of 100: _____

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Preliminary Design Review

Purpose
The purpose of the Preliminary Design Report (PDR) it to document the process of design evaluation and selection. In it, all design concepts are included – at least one for each member of the team. In order to select a single design from these alternatives they must be compared on an impartial basis, based on each concept's predicted performance with regards to the engineering characteristics developed in the System Requirements Review. In other words, the design which is predicted by modeling and experimentation to do the best job of meeting the engineering characteristics, and thus the customer requirements, wins.

Content
The Preliminary Design Report (and each subsequent report) builds upon work previously submitted. Begin by revising your System Requirements Review, as marked up by and discussed with your project mentor. Be sure also to continually revise the content of previously-written sections to reflect new information gained since the last time it was submitted. Sections that do not require any specific additions are omitted from the description below but should appear in the report. As a matter of course, the report should also contain the most up-to-date table of contents, project management information, and budget. In addition to those sections included in the SRR, the PDR shall include sections describing the Design Concepts and Concept Evaluation and Selection.

Executive Summary: In addition to what was included in the System Requirements Review, include a brief summary of the design concepts proposed. State which of the concepts was ultimately selected by the team for embodiment design and why.

Design Concepts: Included after the Need Identification section, the purpose of this section is to describe each of your design concepts and demonstrate, using research, analysis, modeling, and/or experimentation, how each design concept is predicted to perform with regard to each of the top five ECs stated in your System Requirements Review.

Start by summarizing which design concept generation methods were used by the team and why. All designs must include a Functional Decomposition and a Morphology Chart. You are highly encouraged to use a variety of the suggested methods, both creative thinking methods and systematic design methods, to determine which suit you and your team best. With the results of these methods in mind, each student will develop a unique design concept. For each design concept, you must have a separate, independent subsection that provides a complete description of a proposed solution to the problem. It should be able to stand alone without reference to the other concept subsections. It should describe a specific configuration for the design, including specification of the major components and/or subsystems.

For physical systems, the description of each design concept should refer to solid models and/or drawings (notice the word *sketches* was not used) in order to communicate the design concept. Three-dimensional models such as foam-board or poster-board mock-ups can be extremely helpful, however, in most cases computer rendering or professional quality drawings are also required.

Note: cell phone images or other photographs taken of drawings used in lieu of scanning will be torn from the report and burned in a public forum.

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For non-physical systems such as software engineering projects, design concepts will take the form of flowcharts that describe the proposed algorithms. Use standard symbology whenever possible. The idea here is to communicate how each design concept functions, how it is different from the others, and in particular how it compares to the baseline concept.

Through research, analysis, modeling, and/or experimentation, you must predict how each of your designs is predicted to perform with regard to your top five ECs. You must also state explicitly how the proposed design will meet all the design constraints, supporting your assertion with objective proof as opposed to wild speculation (however sincere).

The more specific you are in this section, the more informed your selection process and the more well-defined your tasks will be for the Embodiment Design Report.

Concept Evaluation and Selection: Once you have an objective view of how each of your candidate designs is expected to perform with respect to each of your top five ECs, you can use this information to make an informed evaluation and select from among your design concepts. Keep in mind that if there is little variation between the design concepts with regard to your ECs, you may have to expand your consideration to the next five ECs. This section follows the Design Concepts section.

Summarize the predicted performance of each of your design concepts by creating a table with the design concepts in the rows and the ECs in the columns. Include the predicted performance parameters for each. Include the weighted-decision matrix and state explicitly, referencing the matrix, which design was selected and why. There is an opportunity here to consider combining the best parts of each of the individual design concepts into a single concept. If your team is inclined to do this, please briefly describe what you chose to do and why.

Budget: The budget for the project should be clearer now than it was in the previous stage, so crude estimates should be revised in favor or more accurate estimates. For example, you may not have sized and selected a particular pump, but you know about how big it will need to be and about how much pumps that size cost.

A note on the presentation: you'll notice that for this and each subsequent presentation, including the final presentation, you are still limited to 15 minutes even though you have more to talk about each time. The intent here is not to torment you but to force you to think carefully about what you need to talk about and how to efficiently present it. Keep in mind, no matter how important your topic, no Admiral or General listens to a brief longer than 15 minutes unless it's his or her own. You've got to learn to make your point efficiently.

To that end, the project motivation/problem definition slide(s) should provide the necessary information to bring the audience up to speed on the problem and any necessary background information quickly (1-2 minutes at most). The purpose of this is to jog the respective memories the review panel members, who have to try and keep all 20-odd projects straight in their minds. Careful consideration will pay dividends. Also, make sure you highlight in your presentation any feedback you received from the CDR phase. A good presenter will emphasize "fixes" throughout the brief (technical, cosmetic, or otherwise). This way, your audience will gain confidence in your ability to steer your solution to the customer's desires. Seek clarity from the customer here, if necessary.

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Preliminary Design Review Presentation Rubric

Team Name: Reviewer:

Statement and Description	Comments	Letter Grade
I understand what problem the team is trying to solve. Including any necessary terminology, concepts, and context.		
I understand who the intended customers are. The team has included all obvious customers.		
I understand what the Engineering Characteristics are, including Constraints. Referenced to Customer Requirements. Include units, direction of improvement, and target values.		
It is clear the team has used formal design tools to explore the design space. Examples include creative thinking methods such as brainstorming and *the Five Whys* method and systematic methods such as Functional Decomposition and Morphology Design.		
Each member of the team has developed his or her own design concept. Concepts are developed to a level sufficient to facilitate performance prediction.		
The team has appropriately predicted the performance of each design concept for each Engineering Characteristic and Constraint. Performance predictions are based on sound engineering judgement.		
The team has selected a design using a Weighted Decision Matrix. Matrix inputs based on performance prediction. Selected design identified specifically.		
The team has a revised and updated project management plan. Detailed and complete to facilitate efficient use of time, manpower, and resources.		
The team has a revised and updated budget. The budget is sufficiently detailed for the conceptual design stage.		
The team's verbal delivery of the material was clear and professional. Practice was obvious, completed in the required time, enthusiastic, questions answered completely and objectively. Feedback from the CDR phase were clearly identified and incorporated accordingly.		
The team's non-verbal presentation was clear and professional. Including clear, concise, professional slides and/or prototypes and demonstration items.		

Overall Score out of 100: _____

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Preliminary Design Review Report Rubric

Team Name: Reviewer:

Statement and Description	Comments	Letter Grade
The team has revised all previously submitted material to my satisfaction. Including revisions based on mentor feedback and updated information.		
It is clear the team has used formal design tools to explore the design space. Examples include creative thinking methods such as brainstorming and *the Five Whys* method and systematic methods such as Functional Decomposition and Morphology Design.		
Each member of the team has developed his or her own design concept. Concepts are developed to a level sufficient to facilitate performance prediction.		
The team has appropriately predicted the performance of each design concept for each Engineering Characteristic and Constraint. Performance predictions are based on sound engineering judgement.		
The team has selected a design using a Weighted Decision Matrix. Matrix inputs based on performance prediction. Selected design identified specifically.		
The team has a revised and updated project management plan. Detailed and complete to facilitate efficient use of time, manpower, and resources.		
The team has a revised and updated budget. The budget is sufficiently detailed for the conceptual design stage.		
The report has a professional appearance. Formatting is consistent and clean making the content easy for the reader to access. Figures and tables are numbered, captioned, and referenced.		
The report is well-written. The narrative is strong and logical, written from a third-person perspective. Proofreading is evident. Grammar and Spelling have been checked.		

Overall Score out of 100: _____

Engineering Design I/II
Capstone Design Project Guidance

Embodiment Design Review

Purpose
Design is a process which involves making decisions at successively finer levels of detail (sometimes referred to as the *design spiral*); from enumerating functions, to identifying systems and subsystems to carry out those functions, to designing and selecting specific components, to manufacturing and assembling those components. The purpose of the Embodiment Design Review (DDR) is to capture these choices in a process that will ultimately result in the first generation prototype, ready for testing and evaluation.

Depending on the project scope, the initial prototype won't likely be a fully-realized product. Often, it's a scaled-down proof-of-concept model that serves to answer critical questions about the efficacy of an approach. It must, however, be a milestone on a well-planned progression toward a final product. This will require thoughtful planning and committed project management.

From this point forward, the mantra is: *Build a little. Test a little. Learn a lot.* Your report should be based around a strong narrative of *objectives, modeling, procedures, results, analysis, discussion, conclusions* (repeat!). Everything should be documented such that customers and clients can understand what questions you had, what your considerations were, what decisions you made, and what the results of those decisions were. You can think of subsequent reporting as a sort of *design journal* albeit one written in the third person, professionally presented.

Content
As with each previous report, the EDR should build upon the previous iteration. The Embodiment Design section should follow the Design Selection section from the Preliminary Design Review.

Embodiment Design: Begin by reviewing the customer requirements and deliverables as agreed upon by the team, the faculty leadership, and the customer. Try to answer the following questions: *What is the end goal of the project? Is it to provide a working product? Proof-of-concept model? Scale model with analysis to demonstrate the performance of a full-sized prototype? A fully tested software design? A repeatable set of experimental results with accompanying analysis?* Another way to think of this is, *what will you present on Capstone Day? What do you hope to deliver to the customer?* Start with the end in mind and work backwards.

Next, discuss what steps are necessary in achieving that goal. Include specific milestones of what will be tested by what date. It's often easiest to break the design into subsystems, each of which is designed, built, and tested separately, prior to integrated testing. This section must include a table or timeline and a narrative that will convince the reader that the team has carefully considered what it needs to do and has a thoughtful, well-reasoned plan for how to do it. Each successive step should build upon the last, marching methodically toward the final goal.

For a software design, you might begin by designing and testing one submodule of the final program. For a project targeted at experimental results, you might begin by establishing that you can collect an initial set of samples of the relevant data and then verifying that the samples are accurate and provide the level of precision required.

Each of the milestones described above will correspond to a separate section in the report, and should be

formatted like a laboratory report (which is itself a narrative description of the scientific method). In the past, the experiment was designed for you. In this case, you design and conduct the experiments. In general, each section should be broken up into the following subsections:

Objectives. State as accurately and succinctly as possible what it is you want to know. Try to answer the questions *What is the purpose of this experiment or test? What is to be learned by conducting it?* Remember, Engineering Characteristics and constraints are always a good place to start though some of the objectives may be more qualitative in nature, especially at the proof-of-concept stage.

Prototype Detail Design. This section will contain all of the pertinent Embodiment Design (D&S, Chapter 8) considerations as well as any discussion of the necessary test parameters. Any calculation and/or modeling that is required prior to fabrication and evaluation must be included here.

For each physical prototype, include a Bill of Materials including any standard and special purpose parts as an appendix, referenced in the body text. For each special purpose part, include the associated engineering drawing in a separate appendix (i.e. one of your appendices should contain all of your engineering drawings). Engineering drawings should likely include a three-view orthographic drawing and one isometric view. They should include any additional views required to describe the prototype detail. Be sure to fill out the title block completely and annotate the drawings appropriately. If you require multiple special purpose parts to be made, an assembly drawing must also be included showing how all of them fit together.

Note: in the past the word *drawing* has been misinterpreted as meaning the same as *sketch,* i.e. a hand-drawn depiction on paper with pencil. This is incorrect. In this case *drawing* means *engineering drawing* or a detailed graphical depiction of the part, in standard format, detailed such that a machinist could create the part or parts with minimal additional direction from you. If you are unclear about what this is or how to produce it, ask your team mentor.

For non-physical prototypes, Embodiment Design should include detailed flow charts or other graphical representations of the solution such that a faculty reviewer would not need to know the specific language or program being used to follow your methodology. For example, for each software element include the appropriate flow chart. For experimental results, this would include any software design required to generate the desired data.

Procedures. Include an overview of the experiment, including any necessary schematics, followed by a step-by-step procedure for the conduct of the experiment. Try to answer the questions *What will be done? What steps would one need to follow to recreate this experiment?*

The procedures section should include a table of required equipment that will serve as a checklist prior to testing. It should also reference a test matrix, included as an appendix, of what items are to be measured/observed during the experiment.

This section will be critical in the event the test plan needs to be reviewed by the Division Risk Management Review (RMR) Committee. Instructions for requesting a meeting of the RMR Committee are listed in the *How to…* section of the course website. This section should also include any pertinent Operational Risk Management (ORM) discussion. For instruction on how to conduct an ORM review, please see the associated

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Capstone Design Project Guidance

How to...

Results, analysis, and discussion. This section should include a narrative of the experiment, especially detailing any significant deviations from the stated procedures along with measurements and observations as required. Please be sure to include pictures whenever possible. Include any appropriate figures (i.e. plots) and tables to describe and summarize your results. Also include a description of each figure and table, along with a quantitative discussion. Try to answer the questions *What happened? What was measured/observed? Was it expected? Why or why not? How does this result inform a broader understanding?*

Conclusions. Review the objectives of the experiment. Summarize, quantitatively if possible, what you learned. State explicitly the impact of these results on the next stage of your project. Try to answer the questions *Did we answer the question(s) we set out to answer? If so, what did we learn? If not, why? How will this information be used? How will we proceed based on what we learned?*

Think of the Conclusions section as an executive summary for the experiment or test. Students often want to save the results from the previous section and introduce them here like the reveal in an episode of *Scooby-Doo*. This is not in keeping with professional formatting and style and must be avoided. Again, the conclusions section should only summarize, quantitatively, what you've already stated in the previous section.

Project Management: For the report, include a summary table as before including major, project-specific (i.e. not just the syllabus dates) tasks, the dates they are to be completed, and the personnel to which they are assigned. For the presentation, please be prepared to show your Gantt chart in Gantter, MS Project, or similar in its entirety.

It's important to be detailed and realistic in your planning. Be sure to review your project management plan with your team mentor, technical advisor, and a TSD representative at a minimum. If your design requires fabrication by one of the shops, be sure to check how long it is estimated to take and *when it is scheduled to be complete*. Students often ask the first question but not the second, the difference being that each design may only take a day or two to manufacture, but depending on the shop workload, it may not be the first in the que.

This project management plan will be used to judge your progress during the spring semester's Prototype Demonstration and Progress Update Review. Consider it a contract between you and your team leadership and customer stating clearly what you are going to do and by when.

Budget: With embodiment design complete, the budget should be a translation of the purchase orders you are ready to submit. There should be little uncertainty in your accounting for the parts needed for your initial prototypes.

Appendix – Engineering Drawings: as described above.

Appendix – Prototype Test Plan test matrices: as described above.

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Capstone Design Project Guidance

Embodiment Design Review Presentation Rubric

Team Name: Reviewer:

Statement and Description	Comments	Letter Grade
I understand what problem the team is trying to solve and for whom they are trying to solve it. Including any necessary terminology, concepts, and context. The team has included all obvious customers		
I understand what the Engineering Characteristics are, including Constraints and Targets. Referenced to Customer Requirements. Include units and direction of improvement.		
I understand what the team is ultimately trying to achieve and think it's a reasonable goal considering their time and resource constraints. Agreement between the customer, faculty, and team evident.		
The team has a thoughtful, well-reasoned plan for achieving its goal. Milestones are project specific and time estimates are appropriate. Plan includes enough margin to allow for reasonable contingencies.		
The team has been methodical in their execution. Design decisions based on sound engineering judgement including research, modeling, and analysis. Testing has been conducted thoughtfully with a clear goal in mind.		
The level of design detail is appropriate for this stage in the process. Based on scope and available resources. Clear demonstration of appropriate progress toward the goal.		
I feel confident that the team will complete the project on time. Project management plan is detailed and well managed.		
I feel confident that the team will satisfy the customer. The design is feasible and the scope reasonable.		
The team has a revised and updated budget. The budget is sufficiently detailed for the embodiment design stage.		
The team's verbal delivery of the material was clear and professional. Practice was obvious, completed in the required time, enthusiastic, questions answered completely and objectively. Feedback from the PDR phase were clearly identified and incorporated accordingly.		
The team's non-verbal presentation was clear and professional. Including clear, concise, professional slides and/or prototypes and demonstration items.		

Overall Score out of 100: _____

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Embodiment Design Review Report Rubric

Team Name: Reviewer:

Statement and Description	Comments	Letter Grade
I understand what problem the team is trying to solve and for whom they are trying to solve it. Including any necessary terminology, concepts, and context. The team has included all obvious customers		
I understand what the Engineering Characteristics are, including Constraints and Targets. Referenced to Customer Requirements. Include units and direction of improvement.		
I understand what the team is ultimately trying to achieve and think it's a reasonable goal considering their time and resource constraints. Agreement between the customer, faculty, and team evident.		
The team has a thoughtful, well-reasoned plan for achieving its goal. Milestones are project specific and time estimates are appropriate. Plan includes enough margin to allow for reasonable contingencies.		
The team has been methodical in their execution. Design decisions based on sound engineering judgement including research, modeling, and analysis. Testing has been conducted thoughtfully with a clear goal in mind.		
The level of design detail is appropriate for this stage in the process. Based on scope and available resources. Clear demonstration of appropriate progress toward the goal.		
I feel confident that the team will complete the project on time. Project management plan is detailed and well managed.		
I feel confident that the team will satisfy the customer. The design is feasible and the scope reasonable.		
The team has a revised and updated budget. The budget is sufficiently detailed for the embodiment design stage.		
The report has a professional appearance. Formatting is consistent and clean making the content easy for the reader to access. Figures and tables are numbered, captioned, and referenced.		
The report is well-written. The narrative is strong and logical, written from a third-person perspective. Proofreading is evident. Grammar and Spelling have been checked.		

Overall Score out of 100: _____

Engineering Design I/II
Capstone Design Project Guidance

Prototype Demonstration

Purpose
There is no formal report or PowerPoint presentation associated with this milestone. The purpose of this assignment is to provide faculty and staff an opportunity to evaluate your progress toward project completion by demonstrating your design prototype. Think of it as your investors visiting to ensure their start-up capital is being well spent!

Content
Much like the formal presentations you gave first semester, you will have 15 minutes to discuss your prototype with the faculty and staff. The venue need not be room 301. You can demonstrate your prototype anywhere in the complex so long as you arrange it with your project mentor in advance.

Practice your presentation just as you would any other presentation. Ensure all group members give a portion of the presentation. Be sure to discuss the following at a minimum:

- Team and project introduction
- Problem statement
- General description of prototype
- Description of subsystems
- Description and demonstration of operation
- Fabrication/manufacturing
- Summary of prototype test plan
- Summary of next steps

The absence of a screen upon which to communicate your ideas may prompt you to want to create handouts for faculty members. Please avoid this if possible. The idea here is to focus on "pitching" your design without the use of visual aids other than your prototype. For example, when discussing your prototype test plan, instead of pointing to your Gantt Chart and saying, "Static load tests will begin on February 5" you might say, "Next week, we'll begin static load testing with dynamic loading scheduled for the following week. Preliminary testing and evaluation will be complete one week prior to the Progress Update presentation."

Expect this presentation to be much more interactive than previous presentations - be prepared to answer questions on the spot. It might also be a good idea to have tools and/or spare parts ready in the event a quick fix needs to be made. If PPE is required, please be sure to have it ready and available. Invite your customers, if possible!

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Progress Update Demonstration

This is not a "standard" presentation but a demonstration like the Prototype Demonstration done earlier in the semester. The visiting committee will visit you in your project work space and will expect to see a project that is nearly complete. The committee will also be accompanied by a film crew from MSC who will record your demonstration.

Purpose
Your objectives for this demonstration are as follows:

- To hone the "elevator pitch" for your project—a concise, jargon-free, and audience-appropriate "forest view" of your project.
- To demonstrate your team's substantive progress towards timely project completion.
- To compare your measured results against the targets for your engineering characteristics, and to explain any deviations.
- To capture video footage that illustrates your project's functionality.

Content
You should begin with an overview of your project. This "elevator pitch" should be carefully thought out and rehearsed. Avoid the common mistake of assuming that your audience is familiar with your project. Even faculty members who have seen your previous presentations require a reminder of the problem you are trying to solve and your methods. Use this demonstration as an opportunity to practice the introduction you will use on Capstone Day when you are presenting your project to a technically savvy audience with no prior knowledge of your project. As you describe your project, you should highlight what your team has accomplished and distinguish your team's work from what was purchased or done by others. Then you should show the committee the functionality of your system with a demonstration or a set of demonstrations (it's okay for these to be pre-recorded if this is necessary). **Prepare a one-page handout of your constraints and ECs with the target and measured performance values for each**. Use this handout in your description of your results. Finally, you should describe your plans for project completion.

General Guidance
This is not your only opportunity to capture video footage of your project, but it is the only opportunity that the faculty will arrange for you, so you should take advantage of it. Think about what you'd like to have recorded for posterity that best captures your project.

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Progress Update Report

Purpose
Up to this point, the design process has likely been fairly linear: complete step A, move on to step B. However, as you enter the first phase of testing and evaluation, you'll find that the design process may become much more recursive: design, build, test, break, repeat. There may not be a clear delineation between versions 1.0 and 2.0 or even 1.0 and 1.1. Thus, the purpose of the Progress Update Report (PUR) is to provide a formal opportunity for reflection and to capture what you've done, summarize what you plan to do with what time you have left, and plan out how you're going to do it.

Content
As with each previous report, the PUR should build upon the previous iteration. This report focuses on the execution of the Prototype Test Plan.

General Guidance
All projects fall somewhere on a broad spectrum of scope and complexity. Some projects are small in scope with designs that take little time to fabricate and test. Teams with these sorts of projects may get the opportunity to go through several iterations - cycles of design, build, test. With regard to the PUR, these teams should present the results, analysis, and discussion – including how the design has or will change as a result of fabrication and testing – for each of the experiments conducted in accordance with their prototype test plan. Teams in this category should also show, in the Project Management section, how well they are following the project management plan as stated in the Embodiment Design Report. Discuss any significant deviations as an opportunity to reflect on the efficacy of your predictions.

Other projects are of such scope and complexity that teams may only get one or two opportunities to test their design. If your team's project lies on this end of the spectrum, you may still be working toward executing your prototype test plan. In this case, the focus is twofold: 1) capture your design decision-making process, and 2) communicate your progress with regard to the established project management plan.

In capturing your decision-making process the intent here is not to digress into a day-to-day design journal, but to summarize the group's thought process: what design decisions did you face? What were the considerations surrounding each design decision? What did the team choose to do and why? For example, one year a team was tasked with building a hydrofoil – essentially an underwater airplane. They had ordered aluminum extrusions in the shape of an airfoil that they were going to use for wings. However, there was a significant delay in the purchasing process and the students had to explore other options. Why record this information you may ask? This project was sponsored by Boeing. Several years down the road, if Boeing engineers want to build upon the efforts of this student team, knowing what decisions were made and why is likely to save the Boeing engineers a great deal of time and effort in not repeating what was already done.

Tracking and communicating your progress with regard to the project management plan is especially critical for team whose projects have a significant scope and/or are fairly complex. This is because you may only have time enough time to get one or two tests in before Capstone Day. It is equally critical that you establish a well-considered project management plan and prove to yourselves, your team leadership, and the review board, that you are aware of your current progress with respect to the timeline and have a detailed plan of execution. This discussion should be included in the Project Management section.

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Regardless of where you fall on the spectrum of scope and complexity, the overall intent is communicate your progress and to assure the board that you will finish what you set out to achieve by the end of the semester. Exactly what content is required to communicate this should come from a discussion with your team mentor and technical advisor.

Project Management: See guidance in preceding section.

Appendix – Engineering Drawings: Include all updated engineering drawings, paired with the original versions (i.e. keep drawing revisions together in this appendix so the reader can see how the design progressed).

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Capstone Design Project Guidance

Progress Update Report Rubric

Team: _____ Reviewer:_____

Criteria or Requirement	Comments	Points
Front Matter Title page revised as required Executive Summary revised and updated including summary of progress to date ToC/LoF/LoT revised and updated		**/2**
Problem Definition Section revised and updated		**/1**
Need Identification Section revised and updated		**/1**
Design Concepts Section revised and updated		**/1**
Concept Evaluation and Selection Section revised and updated		**/1**
Embodiment Design Section revised and updated		**/5**
Progress Ideally includes results, analysis, and discussion of prototype test plan Discussion includes redesign considerations including calculations, modeling, and updated drawings, as necessary At a minimum describes the decision making process from detail design to present capturing decision points, considerations, choices, implementation, and outcomes if available		**/40**
Project Deliverables Section revised and updated		**/1**
Project Management Discussion of progress with respect to the project management plan established in the detail design report Includes detailed plan of execution		**/26**
Budget Section revised and updated		**/1**
References Section revised and updated		**/1**
Appendix - Engineering Drawings Section revised and updated		**/5**
Formatting Figure/table formatting (centered, numbered, captioned, referenced) Justification and pagination Clean and professional appearance		**/5**
Style Strong, logical narrative Correct voice (third person) Appropriate tense – consistent with narrative for each section Grammar and spelling; evidence of proofreading		**/10**
Overall		**/100**

Engineering Design I/II
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Final Design Report

Purpose
The purpose of the final design report is to capture the details of your entire design process. Specific additions since the Progress Update Report should include the results, analysis, and discussion from your prototype test plan, competition results from applicable projects, customer feedback, and what further revisions you might make if you had more time and money.

Content
As with each previous report, the Final Design Report should build upon the previous iteration, with earlier sections revised as is appropriate. It should include the following sections:

Title Page
Executive Summary (see more guidance below)
ToC/LoF/LoT
Problem Definition
Need Identification
Design Concepts
Concept Evaluation and Selection
Embodiment Design
Prototype Test Plan (see more guidance below)
Future Work (see more guidance below)
Societal, Ethical, Economic and Global Context (see more guidance below)
Project Deliverables
Project Management
Appendix: Team Charter
Appendix: Engineering Drawings or Code, as applicable
Appendix: Prototype Test Matrices
Appendix: Gantt Chart
Appendix: Closeout Memos (see more guidance below)
Appendix: Quad Chart (see more guidance below)
Appendix: Project Summary (see more guidance below)

Here are some further notes on the sections that are new or significantly revised:

Executive Summary: include a brief summary of your testing, evaluation, and redesign process. Also include a brief summary of final evaluation results, including competition results for applicable projects. Please break up into paragraphs, but the entire summary should be less than one page in length. You may have to winnow down earlier paragraphs to make sure it all fits.

Prototype Test Plan: if your team had the opportunity to do one test or a dozen, please ensure all testing and evaluation details are captured here. Ensure the discussion is held together with a strong, logical narrative, but the specific formatting of this final version is up to you and your team mentor.

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For a given EC you may have multiple modifications/redesigns and multiple associated tests. Please try and capture, to the best of your ability, what changes were made to the design and how those changes affected the performance of the design. Make sure to compare initial and subsequent design performance and comment as to whether or not the design changes made resulted in better performance and thus increased customer satisfaction.

Future Work: hopefully, your communication with your customer has been candid and regular. In this section, the idea is to try and capture your customers' level of satisfaction with your design.

Start by demonstrating your final design to your customer. Provide them with a list of the customer requirements as you interpreted them, and ask them to rate the performance of your design, much like they did for the customer assessment of competing products portion of the House of Quality (Room 6). Ask them what they like about the design. Ask them what improvements they'd like to see. As a team, evaluate and discuss the difference between the customer requirements as you understood them, and the feedback you got from the customer about what they *actually* wanted. Detail specific opportunities for future work and improvement. Please limit your comments to technical evaluations. There will be an opportunity for more qualitative comments in the close-out memo.

Societal, Ethical, Economic and Global Context: this section should describe the broader context of your project. What is the benefit to the common good that is served by your project? Are there any potential drawbacks? Consider the possible effects of your project or project area on health and safety, social justice, the environment and the economy. It is recommended that you discuss this section with your mentor.

Appendix - Closeout Memo: each member of the team will write a memo, addressed to his or her project mentor, no more than two pages in length addressing the following questions in order:

1. What did *you* do, specifically? What were your roles in the team – official and unofficial.
2. What did you learn about engineering, project management, team dynamics, etc.? How does this compare to your original personal statement in the team charter?
3. What would you do differently, given the opportunity? (i.e. from a personal as opposed to a technical standpoint)
4. What advice would you give to the next class?
5. What resources (i.e. people, books, programs, etc.) were most useful to you and how?
6. What grade do you think you've earned and why?

Include the closeout memos in alphabetical order by last name.

Appendix – Project Summary:
This is a stand-alone document that could be given to your customers to summarize your project. The body of the project summary can be the same as your executive summary, but you should also include your project title, your names, your mentors and technical advisors, and your team picture.

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Final Design Report Rubric

Team: _____ Evaluator: _____

Team composition by major: ___ECE ___EEE ___EGE ___EME ___ENR ___ESE ___ESEH ___SCS ____Other ( )

Evaluator Instructions: Please mark the column that best applies to each item as well as providing a score. Your input will be used in departmental assessment..

Item	Outcome	Unsatisfactory	Below Expectations	Meets Expectations	Exceeds Expectations		Score
Compliance with instructions	–	Multiple minor sections or any major sections omitted; very late submission	One or two minor sections omitted; incorrect formatting; late submission	All sections included as specified in course guidance; proper format; submitted on time	--		/5
Responsiveness to revision requests	–	Comments and edits by mentors or advisors largely ignored	Revisions mostly addressed but a few missed	All revisions requested by mentors and technical advisors addressed	--		/10
Problem definition	c	Problem statement, need identification or engineering characteristics not included	All relevant sections are there but it could use further revision	Problem and need clearly stated; ECs and targets are verifiable, reasonable and comprehensive	Extensive benchmarking and/or customer engagement		/5
Design decisions	c	No evidence of substantive design decisions	Concepts not well developed; decisions not based on sound technical reasoning	Design alternatives considered; selection based on sound technical reasoning	Significant quantitative analysis used in concept selection		/10
Design prototyping	b,c,k	Functional prototype never achieved	Prototype is functional but sloppy or buggy	Prototype fully debugged; usable and reliable	Prototype is at market standards		/10
Ability to develop a test plan	b	No evidence of a systematic testing strategy; safety issues not addressed	Not every EC addressed in test plan; procedures lack necessary detail	Tests for every EC; procedures complete; safety issues addressed	Special cases included to test system limits		/10
Ability to execute a test plan	b	Did not test	Testing was incomplete	Tested every EC	Tested every EC and used advanced testing methods		/10
Use of simulation tools (e.g. SolidWorks)	b,k	Did not use available and applicable simulation tools	Used incorrectly or with more guidance than should be needed	Used tools correctly with an appropriate level of faculty/staff guidance	Demonstrated expert ability	N/A	
Use of test equipment	b,k	Did not use available and applicable test equipment	Used incorrectly or with more guidance than should be needed	Used equipment correctly with an appropriate level of faculty/staff guidance	Demonstrated expert ability	N/A	
Use of analysis tools (e.g. MATLAB)	a,b,k	Did not use available and applicable analysis tools	Used incorrectly or with more guidance than should be needed	Used tools correctly with an appropriate level of faculty/staff guidance	Demonstrated expert ability	N/A	
Application of theory to the analysis of data	a,b	No analysis	Incomplete analysis or theory applied incorrectly	Sufficient analysis conducted to evaluate EC performance; theory correctly applied	Meaningful analysis beyond what is required for EC evaluation		/10
Project management	c	No evidence of project management	Project management documentation provided but resources were inefficiently used	Documentation evidences efficient planning and use of resources	Significant unpredictable obstacles overcome through extraordinary resource management		/5
System integration and verification	c	No attempt made to close the loop between problem definition and performance; customer not asked for feedback	Customer engaged but not all ECs addressed in evaluation	Results compared back to original problem statement and ECs; customer's feedback on final performance included in report.	Customer feedback used to guide detailed consideration of potential improvements to design		/10
Appreciation of context	f,h,j	No consideration of larger project context	Project context addressed superficially	Ethical issues and project relationship to society and world explored in detail	Not only explored, but weighed in design decisions		/5

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Writing	g	Hard to read	Overall organization good but could use further revision	Good organization, grammar and language use; thoroughly proofread	---		/10
Teaming	d	Team completely dysfunctional	Unequal loadsharing (please provide fractions for assessments)	The team members contributed equally to the project	---	Not obs rvd	----
						Report Score:	/100

Engineering Design I/II
Capstone Design Project Guidance

Capstone Design Project Poster

The purpose of the poster is to present a summary of each team's capstone design project to fellow students, faculty, staff, and visitors in a professional, eye-catching visual format. Teams should emphasize visual/graphical versus textual explanations to the maximum extent appropriate. The textual portions of the poster should be written with the non-technical reader in mind. Specifically, the poster should have the following:

1. Project title, department name, course number, group member names, and project advisor's name
2. Concise problem statement
3. Brief explanation of the project background
4. List of customer requirements
5. Figures of design concepts
6. Figure of selected design
7. Brief explanation of testing and evaluation (including images!)
8. Brief summary of the project outcome
9. Group picture with caption including group member names

Items 3-5, may be truncated or omitted as necessary to preserve presentation clarity. Creative formatting, layout, and style are highly encouraged so long as they do not detract from the purpose of the poster. Additional pictures showing design efforts, fabrication, installation, testing, and design use are also highly encouraged.

Formatting:

1. Create all posters in PowerPoint (2010 version is preferred).
2. Size poster
    a. Click on the "design" tab, and select "Page setup"
    b. Select Landscape orientation
    c. Make width 40" and height 30"
3. Insert text
    a. As a general rule:
        i. Title: 100 point font
        ii. Body: 40 point font
4. Insert pictures
    a. Use .jpg format
    b. Use image files larger than 80k
    c. Check images at 100% size to ensure images are not overly pixilated
        i. Click on "View", then "Zoom" and select the "100%" radio button

For more information, please visit the MSC poster instructions page, linked from the MSC main page.

Submission: once you and your team mentor have agreed on the final poster design, print a copy on an 8.5" x 11" sheet of paper and have your team mentor sign it. Take this to the MSC graphics studio on the ground floor of Nimitz Hall. They will help you make any final revisions to ensure a quality product. You do not need to pick up your poster from MSC. The Capstone Day Committee will do this for you and hang them in the passageways on the Lab Deck of Rickover Hall in time for the poster session on Capstone Day. However, please keep a final copy in your shared folder and include a copy of the 8.5" x 11" poster as an appendix in your final report.

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Capstone Project Video

The purpose of the project video is to provide a brief, entertaining, visual summary of your capstone design experience. It will be shown on during Capstone Day and during senior awards presentation. It may also be shown to perspective students.

Please provide a short video (<2 minutes) that can be shown with or without sound, which provides the viewer with a summary of your design and capstone design experience. Videos should be professional, but are highly encouraged to be funny and creative. Please include lots of pictures and video clips of testing and working; group shots; funny moments; mishaps, etc.

Submission: Please include the video file in your team folder on the course shared drive.