ENGR 491 / 492

SENIOR ENGINEERING DESIGN PROJECT I & II

Student Manual

Messiah College
Department of Engineering

INTRODUCTION

Overview

The Senior Design Project is the capstone design course in Messiah College's engineering curriculum. It is a two-semester project composed of ENGR 491 Senior Design Project I and ENGR 492 Senior Design Project II. During Senior Design Project I, the student team studies a technical problem, proposes a suitable solution, and plans in detail how the solution will be implemented. Technical specifications, schedule, staffing, resource requirements, and risks are all considered in developing the project proposal and plan. Senior Design Project II involves the implementation of the project plan including construction, testing, troubleshooting, and documentation of the results through written reports and oral presentations.

The Accreditation Board for Engineering and Technology (ABET) states its criteria for design as follows:

(a) Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation. The engineering design component of a curriculum must include at least some of the following features: development and use of design methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility considerations, and detailed system descriptions. Further, it is essential to include a variety of realistic constraints such as economic factors, safety, reliability, aesthetics, ethics, and social impact.

(b) Courses that contain engineering design normally are taught at the upper-division level of the engineering program. Some portion of this requirement must be satisfied by at least one course which is primarily design, preferably at the senior level, and draws upon previous coursework in the relevant discipline."

[58th Annual Report, Accreditation Board for Engineering and Technology, page 107]

Purpose of the project

1. Encourages the engineering students to bring to bear all of their technical skills on a practical project, similar to what they would experience in industry.

2. Teaches the students how to make decisions in situations where there is no easy answer or more than one "correct" answer.

3. Causes the students to learn new techniques and technologies on their own, without formal instruction.

4. Compels the students to learn project management and teamwork skills, including planning, scheduling, delegating, evaluating, and dividing larger goals into smaller sub-tasks.

5. Encourages the development of good verbal and written communication skills necessary for "real-world" engineering activities such as procurement of materials from vendors; communication with team members, consultants, faculty, etc.; and documentation of work through proposals, engineering logbooks, progress reports, and formal oral presentations.

Purpose of this Manual

The Student Manual provides the student team with specific guidelines for fulfilling the requirements of the design project, including detailed information about project selection, management, and required written documentation. The Manual also provides guidance in the preparation of oral presentations and outlines the course evaluation criteria.

Acknowledgments

The author gratefully acknowledges the efforts of Carl A. Erikson, Jr, author of the first Student Manual, from which this current edition has drawn heavily.

Dr. Don Pratt
Messiah College
August 2005

COURSE POLICIES

Overview

Having chosen projects during the spring semester of their Junior year, student teams, in cooperation with a faculty advisor (and perhaps industrial sponsors), begin work on the analysis of the problem and the design of a suitable solution. Early in the fall semester, each team puts together a Project Proposal, documenting the results of their research (to date) and proposing an approach to the problem. The advisor is responsible for helping the team make sure the problem is interesting, challenging, and technically complex, while at the same time remaining feasible within the constraints of a student project. By the end of the semester, each team prepares a detailed Engineering Design Report, which presents their detailed plan for solving the proposed problem. During the spring semester the student teams put their plans into action, including the construction, testing, and documentation of the project. A detailed written report and formal oral presentation brings the project (and the course) to completion.

Although formal written reports and oral presentations are required, the primary means of monitoring by the instructor is through the review of weekly progress reports and discussions with the team's faculty advisor and/or industry sponsors. *The required form for the weekly progress report is provided in the Appendix.*

Except by permission of the instructor, students will work together in teams of at least two and no more than four. It is expected that each student will spend (on average) 5 to 10 hours per week on the project. Teams will meet at least weekly with the faculty advisor and/or industry sponsors, and will have regular (in class) meetings with the course instructor. Typically, each team will meet on its own (without the faculty advisor) several times each week. Teams are encouraged to develop a "no surprises" policy, striving for open communication between team members at all times.

Drafts of the Engineering Design Report and of the Final Written Report will be submitted. All engineering drawings and schematics included with the Project Proposal, Engineering Design Report, and Final Written Report are to be completed using a computer-aided design package such as AutoCAD, Ideas, and/or Electronics Workbench. All written work submitted should be professional in appearance, with crisp, concise writing and proper grammar. Part of the grade for these documents will depend on these factors. In extreme cases, written work will not be accepted until it meets minimum standards. Note that MS Project is available for producing Gantt charts, or they can usually be made using the line and symbol functions available in word-processing software.

Engineering Faculty

Professor Job Ebenezer	Office: F230	ext. 2384
Professor Carl Erikson	Office: F221	ext. 3300
Professor David Gray	Office: F224	ext. 7032
Professor Don Pratt	Office: F227	ext. 7169
Professor Harold Underwood	Office: F225	ext. 7125
Professor David Vader	Office: F135	ext. 2630
Professor Timothy VanDyke	Office: F228	ext. 3986
Professor Timothy Whitmoyer	Office: F223	ext. 6810
Professor Robert Clancy (adjunct)	Office: F237	ext. 2386

Technical Support Staff

Mr. John Meyer	Office: F034	ext. 7101
Mr. Steve Frank	Office: F258	ext. 7225
Mr. Matt Walsh	Office: F253	ext. 7226

Engineering faculty members may or may not be assigned specific projects to advise in a given year, but all engineering faculty and staff are committed to helping teams within their expertise. Teams should feel free to contact any professor for help in specific areas of expertise as questions arise.

Faculty advisors will be assigned by the Engineering Department at the beginning of the fall semester, shortly after submission of the Project Proposals. Occasionally, an advisor may be assigned from another department, depending on the nature of the project. Student teams wishing to have an advisor from another department should contact the course instructor as soon as possible. Advisors will be available on a regularly scheduled basis (weekly) and on an as-needed basis (by appointment). Faculty advisors are required to sign all weekly reports, drawings and schematics submitted to the Model Shop, as well as materials or electronic parts requests. See the Material/Parts Use Policy in the Appendix.

Textbooks and Course Materials

This manual is the main text for the course. Occasionally, readings from reference books and periodicals may be assigned. Students will be required to purchase an engineering logbook for documenting their individual contribution to the project. Each student team is required to have at least one project binder. Additional materials may be required for presentations.

SCOPE OF PROJECTS

Projects come from many different sources, including (but not limited to); local industry, Engineering Faculty, needs in other campus departments, and students themselves.

Student-generated projects have the advantage of personal interest, motivation, and enthusiasm for a project that gives the students a real sense of "ownership." However, it should be noted that hobby-oriented projects are carefully evaluated by the advisor and course instructor to make sure the scope and magnitude of the project fulfills the requirements of the senior project course.

Note: while the course instructor and engineering faculty do try hard to help student teams identify potential projects and adjust the scope and magnitude, ultimately it is the responsibility of the student teams to propose a suitable project and set the scope, and students must take the initiative to consider all the alternatives and listen carefully to their advisors.

IMPORTANT: Project teams should work closely with the Engineering faculty during preparation of the project proposal to increase the probability that their proposal will be accepted by the Engineering Department. Teams should begin meeting regularly with their advisors as soon as they are assigned.

WORDS TO THE WISE

Getting Started

A successful project begins with careful planning at the beginning. A thorough job of planning at the early stages of the project will save the team many hours and many headaches.

At the beginning of the fall semester, the student teams should immediately begin working on their Project Proposals. Student teams are strongly encouraged to work closely with the tentative faculty advisors assigned to their project prior to the submission of the Project Proposal to improve the chances for acceptance. After the Proposal is accepted, final assignments of project advisors will be made. In most cases, this will just be the tentative faculty advisor, but depending on the nature of the Proposals some shifting of advisors may be deemed advantageous by the Engineering Department.

General Guidelines

Follow the design process. Set aside plenty of time for brainstorming sessions right at the start. Creativity is the key to finding the best solution to the problem, so do everything possible to foster creative thinking. Consider alternative solutions before the final approach is selected, perhaps even experimenting with several possible solutions before making a decision. Make good use of reference materials as you consider various ideas. Remember: "A few weeks in the laboratory can save hours in the library." [Vader 1993]. Also, "Don't believe everything you read on the Internet." [Pratt 1999].

Virtually all design projects require students to venture beyond the boundaries of campus. Student teams will be interacting with sponsors, consultants, vendors, etc. from the surrounding community and beyond. Please remember that you represent Christ and Messiah College. Make sure that your team's conversation, actions, phone manners, etc. are "above reproach" at all times.

At the end of the fall semester, the results of this part of the design project will be formally documented in the Engineering Design Report, so start organizing your documentation clearly and carefully right from the beginning. Make careful notes of any assumptions and/or special requirements as they come up.

This course requires you to use both written and oral methods to communicate the results of your work, and the quality of your written and oral documentation is important. Make sure your work is well organized and clearly presented. Note the value placed on this work in determining the project grade.

WRITTEN DOCUMENTATION

Communication is vitally important to an engineer working on a problem. The majority of practical engineering tasks are complex enough to go beyond the expertise of a single individual, and so the efficient completion of a project depends on the ability to work with the ideas of others, and specifically, the results of their work. Whether or not your project requires extensive background research, it is hard to imagine an engineering enterprise that isn't in some way built upon the work of those who have gone before. It follows then that the work you do should be carefully documented so that others can build on what you have done.

At the beginning, spend the time required to get your documentation process organized. Plan out what needs to be documented and how it will be done. Decide who will be responsible for what records. Set up binders, notebooks, files, etc. and use them. Date and initial all drawings, specifications, meeting notes, etc. Minutes invested in organizing and keeping your documentation current will save hours of misery later. Don't trust your memory.

Any time you turn in written work, please keep a copy. This will allow you and your team to continue working on the project and give you insurance against the (unlikely) possibility that your submission is misplaced.

PROJECT BINDER

Teams should have at least one three-ring binder to collect and organize project materials, including results of research, weekly meeting reports, etc. Spend the time to make it organized and keep it up to date. This will dramatically reduce the amount of work required to produce the written reports.

ENGINEERING LOGBOOK

The information gathered during an engineering project is important. During your career, you may well be called upon to document what you have accomplished; for example, during the process of applying for a patent or dealing with product liability litigation (hopefully not). In these and other cases, the documentation you are able to supply could make a very significant difference in the outcome.

The typical engineer gathers information from a wide variety of sources, such as books, journals, conferences, discussions with colleagues, experimental results, phone conversations, etc. One means of keeping track of this kind of information is the engineering logbook. In legal proceedings, a bound engineering notebook with numbered, dated, and witnessed pages is considered highly credible evidence.

For the Senior Design Project, each student is required to purchase a logbook and use it throughout both semesters. It will be reviewed and graded by the instructor periodically during the course of the project. While it is not necessary to number, date, and witness your entries, you should take the logbook seriously. Some general guidelines for using a logbook are given in the Appendix.

PROGRESS REPORTS

The weekly progress report will help you organize the weekly status meetings with your faculty advisor and/or project sponsor. It also provides you with a written record of the development of your project, including both accomplishments made and difficulties encountered. Thus the report should communicate the current state of your project as accurately and objectively as possible. To assist you in preparing this report, a standard form will be used. (see Appendix)

PRIOR to the weekly meeting with the advisor, team members will complete the sections of the report covering the number of hours worked and the previous accomplishments. Any problems or specific questions should be noted on the second page in the appropriate section. During the meeting, the advisor will complete the "Tasks to be completed" section of the report and make any notes or comments in the spaces provided. At the conclusion of meeting, all team members will initial the report and the advisor will add his or her signature. These initials and signature indicate consensus on the current status of the project and the stated tasks and objectives. In addition, the form constitutes an agreement by the team members to carry out the assigned tasks prior to the next meeting. Failure to complete the agreed-upon tasks will have to be explained to the advisor and/or sponsor and documented in the subsequent report.

PROJECT PROPOSAL

The Project Proposal is a formal, written document that details the problem the team plans to address, suggests an approach that will lead to a solution, and gives time and resource estimates for completion of the project.

Since the Proposal is due early in the semester, before teams have had a chance to do a great deal of research and analysis, many aspects of the project will be ill-defined and thus, hard to document. However, the Project Proposal forms the basis of the Engineering Design Report, and so teams should try to work out as many of the details as possible for the Proposal. It is well understood by the instructor that there will be sections in the Proposal that will not be completely finished at the time of submission.

Format for the Project Proposal

Each team generates a single Project Proposal. The format for the proposal is not particularly rigid, but the following guidelines should be taken as a rough outline of the points to be addressed (particularly the six major headings).

1 INTRODUCTION

The Introduction presents a complete description of the problem.

1.1 Abstract

A simple, concise, "big picture" statement that summarizes the project and its participants (student team, sponsor(s), and consultant(s)) in as few words as possible.

1.2 Description

A clearly written, detailed yet concise statement of just what the project entails, including any sub-topics. While the Abstract seeks to describe the problem in as few words as possible, the Description should be as complete as possible without unnecessary words. Pay particular attention to minimizing "loose ends." Carefully identify any aspects of the project that cannot be clearly defined at this stage. What EXACTLY are you going to do?

1.3 Purpose/benefit

A description of how the proposed project relates to a current problem, opportunity, product, situation, etc. List some specific benefits of the proposed solution (e.g., satisfaction of a specific need, economic gain, contribution to society, advancement of scientific knowledge, etc.). In other words, why are you doing this project?

1.4 Objectives

List at least five objectives. Each must be specific, clearly stated, and measurable. Without these, how will you know if you've accomplished what you set out to do?

For example, "To learn more about robotics" is a poor objective. How much is more? How will we measure how much you've learned? If it can't be measured, we don't know when it's been achieved. On the other hand, "To design and build a speed sensor that is accurate to within 0.5 m/s and has a MTBF of 2 years" is a specific, clear, measurable goal.

Note: Students often have trouble writing good objectives. Before you turn in the Proposal, ask yourselves if the objectives are clear, specific, and measurable. The course instructor will be most happy to review and help with your objectives.

2 TECHNICAL ISSUES

2.1 Feasibility

The proposed project must be technically feasible within the given resource constraints. Make a convincing argument that the project can be done with the resources at your disposal. At this stage, your arguments may be somewhat qualitative and general. By the time you write the Engineering Design Report, you will be able to be much more specific. Bear in mind that the most likely constraints for a student project are probably time, money, and manufacturability.

2.2 Design Challenge

Discuss specific aspects of the proposed project that use technology in a new or innovative way. What new ground do you intend to break?

2.3 Analysis/Experimental work

Describe the types of analyses that are planned (e.g., electronic, structural, thermodynamic, stress, magnetic, etc.). Will you need to carry out any experiments before you can finalize your design? What, where, when, and how?

2.4 Difficulties

Identify and explain any difficulties that can be anticipated in the design. Where do you think the major problems are going to be in making your idea work?

2.5 Human Factors

Show that you have considered how your project will impact the people who physically come into contact with it. This includes both ease of use (ergonomics) and safety. Try to identify any areas that pose potential risks, in both construction and operation.

2.6 Literature Review

The literature review is an extremely important but often poorly understood element in a good Proposal. Before work begins on any new project, the participants would be wise to find out if their proposed approach has already been tried (and thus the problem has been solved) or perhaps failed for some non-obvious reason. To answer these questions, the team must review any and all pertinent literature in order to establish the state-of-the-art of the proposed technology. Typically, the two best sources are the Library and the Internet, but don't neglect one for the other - carefully search both. Other possibilities include discussions with advisors and other faculty members, review of technical journals, industrial catalogs, scientific magazines (e.g., NASA Tech Briefs), etc.

The literature review will not be complete by the time the Proposal is due, but it should be well under way. After the Proposal is submitted, finish the literature review as soon as possible, as it will give direction to the project. In many cases, significant changes are made in the focus and scope of the project as a result of doing this research, and it's best to find this out as soon as possible. Note that the Engineering Design Report is expected to contain a complete, detailed literature review.

2.7 Alternatives

Discuss alternative approaches to the problem. Consider and compare other solutions in view of the desired outcome and show why yours is best.

3 RESOURCES

This section details the required resources, including not only what is needed, but also when and how it is to be used. In addition to the items listed in the cost estimate (raw materials, etc.), other types of resources (e.g., facilities, expertise, etc.) are often required to complete a project. The specific resource required, how it is to be used, and the source (personal, college, sponsor, etc.) should all be documented. As with some of the other sections, this will not be completely finished at the time the Proposal is submitted; however, it is not too early to be thinking about what you will need to complete your project.

3.1 Materials

What parts and supplies will you need for your project?

3.2 Facilities

List the physical facilities (labs, shop, etc.) your project requires and how they will be used, including the expected number of hours, critical dates, etc.

Using the Engineering Department's Model Shop and/or Electronics Lab is probably the most efficient and cost-effective method of constructing of your project. If you plan to use these facilities, discuss how they will be used, making specific references to the resources available in the Shop and/or Lab.

In certain cases, the project sponsor may make facilities and other resources available to the student team, and these commitments should be carefully documented in the proposal (this will help avoid misunderstandings later). A word of caution: industrial sponsors will generally place your project on a somewhat lower priority than you might hope for, and in some instances may even renege on promises made with regard to use of facilities when you need them most. You should make sure you have a contingency plan in case this happens.

3.3 Personnel

Discuss the human resources needed for the project, giving careful consideration to how you will proceed if the required person(s) become unavailable. Consider the requirements of the project in light of the credentials of team members. Make note of any areas that will require the acquisition of new knowledge or skills.

4 ECONOMIC FACTORS

This section describes the economic and financial aspects of your project. What will it cost and how will it be paid for?

4.1 Justification

The economic benefits of this new design should be discussed. In Section 1.3 you presented the benefits of your solution in general. Here you should make a case for why it makes economic sense. Is it worth what it will cost?

4.2 Budget

Prepare a comprehensive, detailed, and itemized list of expenses, including (but not limited to): raw materials, tooling, custom machining, software, professional consultants, phone usage, research costs, travel, etc. If you aren't sure, estimate. You will have a chance to adjust these figures in the Engineering Design Report. If you have items that you expect will be donated (usually referred to as "gifts-in-kind"), include the value of the item in your budget and put in a footnote indicating that the item will be donated.

4.3 Funding

List the source(s) of funding for the project, including gifts-in-kind. Limited departmental funds are available for projects. See the section on Project Finances for more details.

5 PROJECT MANAGEMENT

Successful completion of the design project will require careful planning and wise use of time. Here you will provide detailed information on how the project will be carried out.

5.1 Scheduling

A project of this magnitude requires careful planning and adherence to that plan. The timely completion of tasks according to a precise schedule is critical if time, budget, and other constraints are to be met. While there are many planning tools available for project management, the traditional Gantt (bar) chart will be used for this course. General instructions for preparing a Gantt chart are given in the Appendix. Note that MS Project is available.

With the help of their advisors, student teams should identify several significant "milestones" for each semester that mark the completion of important tasks in the project, breaking the project down into key pieces. These milestones must be clearly marked on the Gantt chart. The advisor should carefully monitor the progress of the team toward each of these events and encourage the team to regard these as "due dates" for the scheduled tasks.

In addition to the tasks required to physically complete the project, the Gantt chart should also display the tasks associated with the requirements of the course itself, such as reports and presentations. It should be noted that while due dates for these "deliverables" have been assigned (see ENGR 491 syllabus), early completion is encouraged.

When writing the reports at the end of each semester, there is an opportunity to look back and see how well you achieved the objectives set out in the Gantt chart. Resist the temptation to "re-write history" by altering your Gantt chart to match reality! Instead, clearly mark on your chart the actual completion dates of the various tasks. Carefully studying the differences can help you become a better planner on future projects. I will be looking for these differences when I grade your reports, not so much to penalize you for missing due dates, but rather to see that you are learning how difficult it is to set a reasonable schedule and then hold to it.

5.2 Delegation of responsibility

First, break the entire project down into pieces, which we will call "tasks." Then these tasks can be distributed evenly among the team members. The collection of tasks allotted to a team member constitutes his/her "job." This organizes the project into separate jobs for each team member.

Each job needs to represent a somewhat uniform load over the course of the entire semester, not concentrated at any particular point. Care must be taken to ensure that each role is about equally challenging, and suited to the individual's strengths and weaknesses. Obviously, it is very important that individual team members be in agreement over the time estimates made concerning the work for which they are responsible.

5.3 Contingency

It is very important that the lead-time for any necessary materials be accurately estimated. Add in some extra "slack time" to account for unexpected delays. This is particularly important for those pieces that are difficult to estimate and those having high priority.

Careful planning includes consideration of alternatives when things go wrong (note the intentional use of the word "when"). Describe the contingency plans you have developed for problems such as late arrival of material, unexpected results of analysis (and so the need to redesign), lack of performance by an external participant or a team member, etc.

6 APPENDIX

6.1 Gantt Chart

Your Gantt chart should either go here or in Section 5.

6.2 Specifications

These will be much more detailed in the Engineering Design Report, but you should include any parameters that have been identified at the time the Proposal is prepared.

6.3 Drawings and/or schematics

6.4 References and Bibliography

6.5 Resumes of team members

PROJECT SPECIFICATION

The Project Specification ("spec") is a technical document defining the functionality of the device or process that meets the stated objectives (see the Project Proposal, section 1.4). The purpose of writing specifications is set down clear and quantitative terms that determine the requirements for meeting the objectives of the project. The difference between this and the design is that the specifications tell someone what the device must do, not how it is done or what the finished product looks like (unless that is an important part of meeting the objectives), while the design is just one possible method for fulfilling the specifications. There are nearly always many possible designs that can be implemented from a single specification, and so the specifications must be complete and general enough so that any competent engineer could be expected to be able to produce an acceptable design given only the specifications. In the real world, bids for jobs are often made based on little more than the specs.

To get some ideas about what this section should look like, take a look at some handbooks for industrial test equipment or tooling. Even the owner's manual for a VCR usually has a brief list of specs. The spec should be prepared by carefully considering the objectives in light of what can realistically be achieved technically, and then setting down the parameters that are required to achieve those objectives. This process should begin as soon as the objectives are defined and will continue as you learn more about your problem. The first draft of the spec is due mid-semester, with the final version forming a key part of the Engineering Design Report.

ENGINEERING DESIGN REPORT

The Engineering Design Report (EDR) is the main deliverable for the fall semester and builds on the foundation laid by the Proposal. Many sections in the Proposal can simply be expanded or clarified for the EDR. The Spec obviously forms the basis for the section on specifications. Arguments that were largely qualitative in the Proposal should be made tighter and more quantitative in the EDR. Conclusions should be based on the clearly documented results of research, analysis, or experiment.

The EDR will finalize the specifications and design of the project, and provide a detailed plan for carrying out the implementation of the project (including testing and debugging) during the spring semester. The EDR starts with the Proposal and the Spec and adds the knowledge gained through the research, analysis, and design carried out during the fall. Therefore, the format of the EDR is very similar to that of the Proposal, with greater emphasis on the technical details.

1 Introduction

The Introduction presents a complete description of the problem. This section can be taken almost directly from the Proposal, with some tightening up and editing to reflect the increased understanding of the problem gained by the team over the fall semester.

1.1 Abstract

A simple, concise, "big picture" statement that summarizes the project and its participants (student team, advisor(s), sponsor(s), and consultant(s)).

1.2 Description

A clearly written, detailed yet concise statement of just what the project entails, including any sub-topics. Where the Abstract seeks describe the problem with as few words as possible, the Description should be as complete as possible without unnecessary words. Pay particular attention to eliminating "loose ends." There should be no aspects of the project that cannot be clearly defined at this stage. What EXACTLY are you going to do?

1.3 Purpose/benefit

A description of how the proposed project relates to a current problem, opportunity, product, situation, etc. List the specific benefits of the proposed solution (e.g., satisfaction of a specific need, economic gain, contribution to society, advancement of scientific knowledge, etc.). Why are you doing this project?

1.4 Objectives

List at least five objectives. Each must be specific, clearly stated, and measurable. In the end, the success or failure of your solution will be judged according to these criteria, so spend some time thinking about them.

2 TECHNICAL ISSUES

2.1 Feasibility

The proposed project must be technically feasible within the given resource constraints. First, you must make a convincing case that your solution is possible, considering the current level of technology available to you. References to your Literature Review would be helpful here. Next, consider the total "cost" (time, money, facilities, etc.) of producing the critical parts of the design. Making specific references to Sections 3, 4, and 5 will strengthen your argument.

2.2 Design Challenge

Discuss specific aspects of the project that use technology in a new or innovative way. What makes your design different from what has been done before?

2.3 Analysis/Experimental work

Describe the types of analyses and/or experimental work that have been carried out and discuss any work that remains to be done. Summarize the results and draw conclusions based on those results. Detailed results (e.g., printouts) can be placed in the Appendix to improve readability of the report.

2.4 Specifications

The Spec is one of the two most important sections in the EDR. Present a complete and detailed list of specifications for the device you intend to construct. Start with the Spec you submitted earlier in the semester and update it as necessary to reflect what you've learned since it was originally written. Make sure that your specifications represent a complete description in technical terms of what your device or process must do. Be sure to include any special constraints, such as cost, weight, materials, power consumption, etc., that are required to meet your objectives.

2.5 Design

This is the other of the two most important sections in the EDR. Present a detailed and complete design for a device that meets your specifications and fulfills the objectives. Your goal should be to create a design that would allow a competent person with no prior knowledge of how or why your device works to build one from your plans. If you wish, drawings and other supporting documents may be placed in the Appendix to improve readability.

2.6 Construction

Present any special plans or considerations you have with regard to actual construction of the project, for example, a part that must be sent out for heat treatment could easily impact the overall construction schedule to accommodate the necessary lead time.

2.7 Testing

Present your test plan, giving details of what type of testing is to be done and just what each test will entail. Give some measurable objectives for your testing (these should follow logically from your Objectives in Section 1.4).

2.8 Difficulties

Discuss the difficulties encountered during the design process and identify any aspects of the implementation that are anticipated to be problematic.

2.9 Human Factors

Show that your project will be comfortable and safe for the people who are affected by it. Discuss the placement, orientation, and labeling of operator controls and displays. Identify any areas that pose potential risks during construction and operation, and in the event of failure. If someone could be hurt if your machine breaks, include a failure mode analysis.

2.10 Literature Review

The literature review is to be complete and well documented, with clearly presented references (including Internet sites) that establish the state-of-the-art and where your project fits. Clearly state your conclusions regarding what you have learned from this research, as it relates to your project.

2.11 Alternatives

Briefly describe the alternative approaches you considered. Give reasons for why you rejected each alternative in favor of your proposed solution.

3 RESOURCES

This section details the required resources, including not only what is needed, but when and how it is to be used. The Proposal should provide an good starting point, appropriately updated to reflect your clearer understanding of what it will take to build your design.

IMPORTANT NOTE: Be sure to check well ahead of time to make sure that your critical resources will be available when you need them. Listing your needs in this document does not guarantee that they will actually be available when you need them. This is your responsibility.

3.1 Materials

List the parts and supplies will you need for your project. List the sources for any unusual parts, e.g., Model shop stores, Electronics lab, local vendors, mail order, etc.

3.2 Facilities

Document the physical facilities (labs, shop, etc.) your project requires and how they will be used, including number of hours, critical dates, etc. Make a note here referring to Section 5.3, telling how you will proceed if the required resources are not available when you need them.

3.3 Personnel

Discuss the human resources needed for the project, giving careful consideration to how you will proceed if the required person(s) become unavailable. Consider the requirements of the project in light of the credentials of team members. Have the team members acquired the skills they need to complete the project, as outlined in the Proposal?

4 ECONOMIC FACTORS

4.1 Justification

The economic benefits of this new design should be clearly demonstrated. This could be as simple as a comparison of the costs associated with an existing method to the cost of implementing the new design, or it could require a more subjective analysis of benefit vs. cost to society.

4.2 Budget

Present your comprehensive, detailed, and itemized list of expenses.

4.3 Funding

List the source(s) of funding for the project, including gifts-in-kind.

5 PROJECT MANAGEMENT

This section gives detailed information on implementation of your solution.

5.1 Scheduling

Update your Gantt charts, paying particular attention to the implementation phase of your project. Don't forget to add the actual completion dates to the Gantt chart you prepared for the Proposal, clearly showing the difference between what you thought you could achieve (back when you wrote the Proposal) and what the actually completion dates were.

5.2 Delegation of responsibility

Define the job to be carried out by each team member and list the specific tasks associated with each job. Note that these tasks should easily cross reference to the Gantt chart.

5.3 Contingency

Present the contingency plans you will execute in the event of unavailability or late delivery of parts and materials, lack of availability of key personnel, lack of performance by an external participant, lack of performance by a team member, etc. A word to the wise: almost without exception, teams will underestimate the time required to complete important phases of the work. What will you do when that happens?

6 APPENDIX

6.1 Gantt Chart

Your Gantt chart should either go here or in Section 5.

6.2 Specifications

These should be described in the text and referenced here.

6.3 Drawings and/or schematics

All engineering drawings and schematics are to be completed using a computer-aided design package such as AutoCAD, Ideas, or Electronics Workbench.

6.4 References and Bibliography

List your sources of information, including references for your Literature Review, texts and handbooks used in the design process, commercial software packages, etc.

6.5 Resumes of team members

Optional but recommended.

FINAL WRITTEN REPORT

Near the end of the spring semester, each team will prepare a Final Written Report. This report should provide the reader with a clear understanding of what the project team has accomplished over the two semesters. Generous use of engineering drawings, schematics, diagrams, and other types of graphics is recommended, but students should remember that clarity in conveying the results of the project is much more important than fancy presentation. Keep in mind that the purpose of the report is to "tell the story" of your project. In addition, the written report should include a persuasive argument establishing a need for this work and that the project resulted in a meaningful solution.

These reports are expected to be professional in appearance and content. (Students may ask to see a sample of a Final Written Report from the faculty advisor or course instructor).
The typical final report format would include:

Title page (cover)
Abstract (updated from EDR)
Table of Contents
Acknowledgments (optional)

1 Introduction

The Introduction presents a complete description of the problem. This section can be built on the EDR, with the updated version of the solution.

1.1 Description

A clearly written, detailed statement of what the project entailed, as complete as possible, but without unnecessary words. Exactly what problem were you trying to solve?

1.2 Literature Review

This is your opportunity to fill in any gaps, update, and edit the literature review from the EDR, with clearly presented references that establish the state-of-the-art and where your project fits. Clearly state your conclusions regarding what you have learned from this research, as it relates to your project.

1.3 Solution

Present your choice for the solution to the problem stated above, in the context of the Lit Review, and in view of the alternatives. Give a concise justification for your choices.

2 Design Process

Summarize the processes that lead to your design. This should include brief descriptions of analysis and experimental work, and may make reference to detailed results in the Appendix. This is also a good place to "tell the story" of the problems and unforeseen circumstances that are a part of any significant design experience.

3 Implementation

3.1 Construction

Summarize the process of constructing your prototype. Include a discussion of what was learned during construction, and how the design changed as challenges were encountered and overcome.

3.2 Operation

Present the results of your test program, with references to your overall objectives. Numerical results are appropriate here, but large amounts of raw data may be placed in the Appendix for improved readability.

4 Schedule

Present your Gantt chart, clearly showing the difference between the actual and projected completion dates. You may also wish to discuss how the schedule was impacted by various unforeseen events, such as late arrival of parts, etc.

5 Budget

Present a detailed breakdown of the cost of your project. Use your judgment to determine the level of detail that is appropriate to your particular project. Clearly show the overall cost. You may wish to comment on the cost difference between producing a prototype and a full-scale product.

6 Conclusions

Draw conclusions about the level of success of your work. Did you substantially meet your objectives? What did you learn in the process?

7 Recommendations for Future Work

This is one of the most important sections in the Final Report, at least for those who may pick up where you left off. Knowing what you know now, given the same problem, what would you do if you had it to do all over again? Understanding that problems of significance are rarely if ever solved perfectly the first time, what would you suggest as the next step toward finding the answer?

References
Bibliography
Appendices

FORMAL ORAL PRESENTATIONS

Employers of engineering graduates look for prospective employees who have the ability to communicate well, both orally and in writing. The two formal oral presentations included in the Senior Design Project not only disseminate the student's work but also provide an opportunity to strengthen and develop the student's presentation skills, both in preparation and delivery.

Note that one class period will be devoted to discussing the preparation and delivery of oral presentations in general, including the use of computer-generated slides. While not absolutely required, these techniques add a great deal of professionalism to a presentation (without a great deal of effort) and so are highly recommended.

At the end of the fall semester, each team will prepare and give (in class) a 20 minute oral presentation of the final design approach. These presentations should be professional in content and delivery. Each team member must participate orally and the level of participation should be about equal for all members. Be sure to state your objectives, tell what your team has accomplished, and provide a wrap-up summary. Presentations should be clear and concise, and students are expected to demonstrate good communication skills. Teams are strongly encouraged to practice their presentations until they are confident and well prepared. Make good use of charts, diagrams, videotape, photographs, on-screen programs, etc. Be creative. A Project Presentation Review Form will be used by the faculty advisors and course instructor to evaluate the oral presentation (see Appendix).

The Final Oral Presentations will be 20 minutes in length and will be expected to be polished and professional. These presentations will be part of the Senior Engineering Design Project Conference held near the end of the spring semester during MEB Scholarship Day. Project sponsors, industrial representatives, Messiah College faculty, parents, prospective students, and others will be in attendance. A Project Presentation Review Form will be given to selected attendees, which will be used to evaluate the oral presentation (see Appendix). Students should take this presentation very seriously.

A word to the wise: Early in the project, begin taking photographs and video footage of key events (and candid moments) during your project. These will not only be wonderful additions to your final oral presentation, but will be fun to look back over when the project is finished. If you are reading this the night before the final oral presentation, think about how much you wish you had some pictures and plan to take some of your next project.

COURSE EVALUATION

Overview

The intent of the Senior Design Project is to give every engineering student at Messiah College the opportunity to apply the principles of engineering, guided by a spiritually and socially responsible perspective, to the design, construction, testing and documentation of a complex and multifaceted engineering project. Through this process, each student will not only experience the challenge of "real world" engineering, but hopefully will discover the fun and excitement of their chosen field.

Assignment of a grade to such an experience is both difficult and subjective. To aid the instructor in making a knowledgeable and comprehensive evaluation of each student's performance, additional sources of input will be considered in the grading process. In addition to written and oral assignments, evaluations will be solicited from the project sponsor(s), faculty advisor, peers, and (to a somewhat lesser degree) staff and faculty attending oral presentations.

Course Requirements

The student's grade is based on the following:

Senior Project I

Engineering Logbook	15%
Project Proposal	15%
Weekly Progress Reports	10%
Engineering Design Report	30%
Oral Presentation	20%
Faculty Advisor, Sponsor, and Peer Evaluations	10%

Senior Project II

Engineering Logbook	10%
Weekly Progress Reports	10%
Performance of finished product	10%
Final Written Report	40%
Final Oral Presentation	20%
Faculty Advisor, Sponsor, and Peer Evaluations	10%

Engineering Logbooks are to be used by every team member for personal research, literature searches, team meetings, consultations with sponsors, faculty, vendors etc. The logbooks will be collected and graded by the instructor twice during each semester.

Progress reports are due each week (for the previous week) at the beginning of the class period. These will be graded primarily on completeness and technical progress achieved. Points will be deducted for incomplete or missing reports. Sketches, updated timetables, revisions to project objectives, etc., should be attached as needed to the reports. An extra copy of the weekly progress report should be kept in the team's project binder.

The Project Proposal, Engineering Design Report, and Final Written Report have been described above. These are expected to be professional in every way and to demonstrate the highest quality of work the team is able to produce. They will be graded accordingly.

The two oral presentations, like their written counterparts, should be professional in every way and must include each team member in a significant and unique role. Grading will rely to a limited extent on feedback from the audience.

Each project sponsor will be asked to evaluate the students involved in working on the project, using the Project Sponsor Evaluation Form (see Appendix). Similarly, the faculty advisor will complete a Faculty Advisor Evaluation Form (see Appendix) for each student involved in working on the project. Lastly, each team member will evaluate the other members of the project team, using the Peer Evaluation Form (see Appendix). These evaluations will have a significant effect on the student's grade, providing a basis for differentiating the grades of individual team members. In other words, the individual grade received by a student will depend on both group work and individual performance.

The results of the implementation phase of the project will also be judged by the finished product. These will be evaluated on the basis of quality of construction, successful operation, and achievement of the objectives set forth in the Proposal.

PROJECT FINANCES

Project Budget

Each project is allocated $500 by the Engineering Department. This money is intended to pay for materials to construct the prototype and to cover expenses associated with preparing the written and oral documentation required for the project. Normally, parts and supplies are ordered by filling out a Purchase Requisition, available from the advisor or course instructor. Students are encouraged to purchase parts and materials from the Model Shop and Electronics Lab if possible, since these are usually obtained in larger quantities and at lower prices than single purchases. To make use of these parts and materials, fill out a material request form, available from the shop/lab supervisor. Alternatively, students may purchase parts and materials using their own resources and request reimbursement by filling out a Request for Payment form. However, students are cautioned to get authorization from the advisor, course instructor, or the shop/lab supervisor prior to making such purchases. Unauthorized purchases may or may not be reimbursed, at the course instructor's discretion.

Some projects sponsored by the Engineering Department will have additional funds available, and other projects may have external sources of funding. These projects will have to make special arrangements to access those funds, usually requiring the assignment of a special account number for Purchase Orders. Projects with alternative funding should contact the course instructor as soon as possible to discuss these arrangements.

APPENDIX

How to make a Gantt chart

A Gantt chart is a graphic picture of your project team's planned activities, milestones, and accomplishments over the next two semesters. The chart shows in detail how your project fits into the time you have to complete it.

Henry L. Gantt is credited with initiating the concept of a class of charts in which the progress of some set or sequence of activities or resources in the vertical dimension is plotted against time in the horizontal dimension.

In project management it is tasks or activities (project performance) that must be charted against time (project schedule). Three things must be established in the project planning process before Gantt charts can be created:

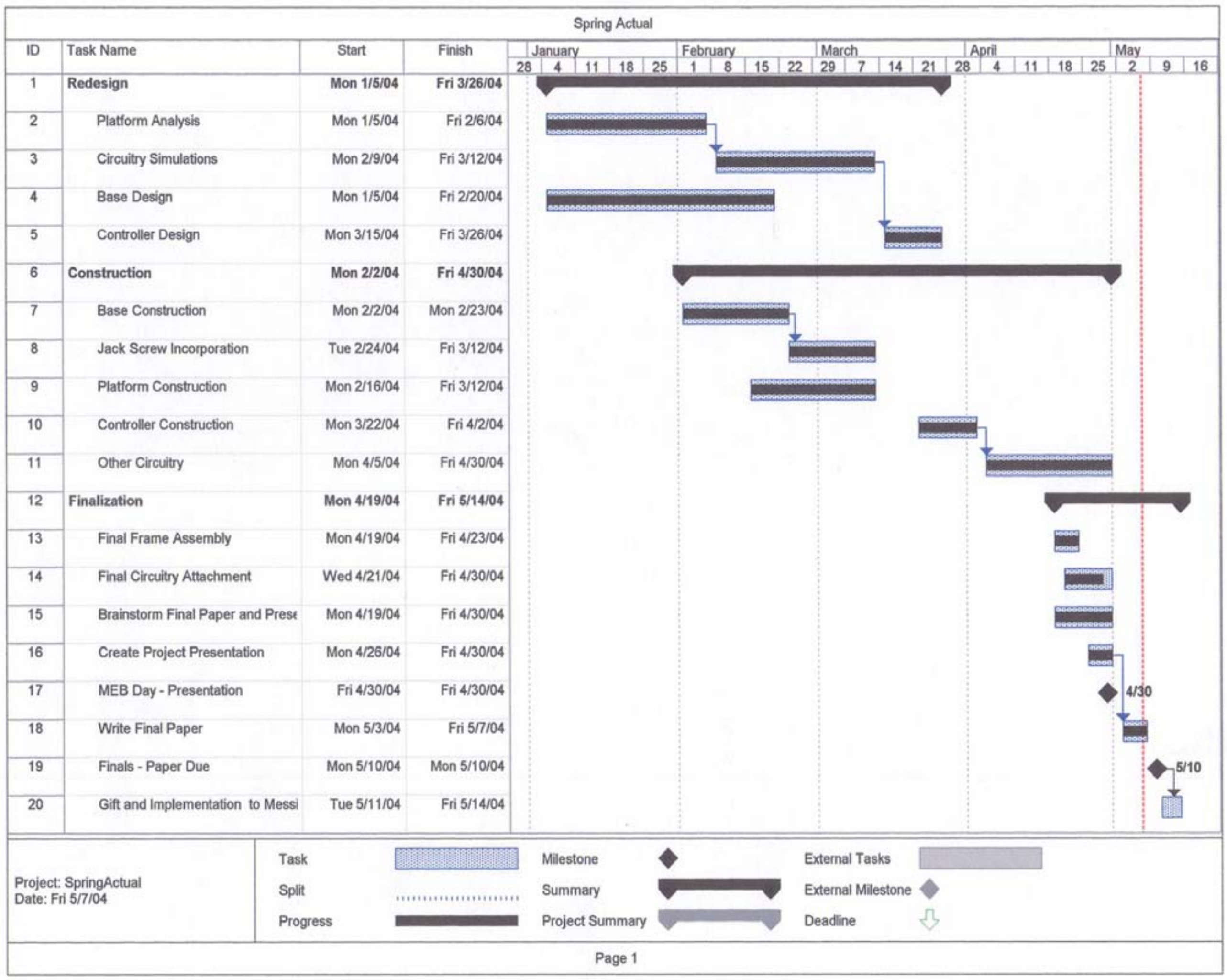
1. The tasks (activities) needed to complete the project

2. The priority relationships of the tasks (i.e., the tasks that must be complete before other specified tasks can begin)

3. The expected duration of each task

The following figure shows an example of a Gantt chart for the spring semester of a Senior Project. Note the use of different symbols to represent different things on the chart, such as the difference between the defined task and the current progress of the task. Students are free to use their own symbols, but the common goal should be to clearly communicate the project schedule, both planned and actual.

Students are encouraged to create their Gantt charts electronically so that changes can be made easily. MS Project software is available in the laboratory.



Gantt chart for Senior Engineering Design Project

Faculty Advisor Evaluation Form

Faculty advisor: Please evaluate each of the students on the project team you advised.

Project Title: ____

Team Members: 1) ____________________________________

2) ____________________________________

3) ____________________________________

4) ____________________________________

5) ____________________________________

Please rate each team member objectively on the factors listed below based on the following 1-10 scale: 1-unacceptable, 3-poor, 5-average, 7-good, 10-outstanding. Your responses will be kept strictly confidential.

	TM#1	TM#2	TM#3	TM#4	TM#5
1. Displays a positive attitude at team meetings					
2. Contributes "fair share" to team discussion					
3. Quality of assigned work					
4. Timeliness of work completed					
5. Ability to work with other team members					
6. Overall impression of each team member					

If you have specific comments about any of the student team members, please elaborate: (for example; exceptional performance, achievements, irresponsible behavior, difficulties, etc.). Again, your response will be held in strictest confidence.

(If necessary, please continue on the back of the page.)

Senior Engineering Design Project Presentation Review

Project Title:

Reviewer: Engr Fac./Advisor ___, Faculty/staff ___, Student ___, Relative/guest ___

Please rate the overall presentation on the following 1-10 scale: 1-unacceptable, 3-poor, 5-average, 7-good, 10-outstanding.

____ Preparation: Were the students ready to present? Did they appear confident of their material and sure of themselves? Did the presentation flow smoothly?

____ Content and organization: Did they provide a complete story of their project, including objectives, procedures, problems, and results? Do they appear to have solved the problem?

____ Delivery: Was the presentation professional in delivery? Did every team member participate equally? Were you able to see and hear clearly?

____ Difficulty/effort: It is not easy to judge the difficulty of a project. Some very simple-sounding problems can be exceedingly difficult to solve. Your rating should reflect your perception of the amount of effort put forth by this student team.

____ Overall: Give your overall rating for this project and the student team.

Additional comments:

I especially liked:

This project would have been better if:

Thank you for participating in this review!

Project Sponsor Evaluation Form

Project Title: ____

Sponsor: _______________________Reviewer: ________________________

Team Members: ____

____

Please evaluate the performance of the student design team you sponsored, using the following 1-10 scale: 1-unacceptable, 3-poor, 5-average, 7-good, 10-outstanding. Your responses will be kept strictly confidential.

Project quality:

_____ Suitability of the solution (usefulness)
_____ Attention to detail (thoroughness)
_____ Quality of execution (construction and operation)

Written documentation:

_____ Organization and structure (clear, concise, and readable)
_____ Graphics (neatly drawn, clear)
_____ Content (well researched and documented material)

Oral presentations:

_____ Preparation (organized and professional)
_____ Content (interesting and relevant)
_____ Delivery (clear, good communication skills)

If you have specific comments about any of the student team members, or the team in general, please elaborate below (for example; exceptional performance, achievements, difficulties, irresponsible behavior, etc.). Again, your response will be kept confidential.

Thank you for your support of the Project. We appreciate your involvement.

Peer Evaluation Form

Please evaluate your performance and that of each of your fellow team members.

Project Title: ____

Team Members: 1)________________________ 2)__________________________

3)______________________ 4)_____________________ 5) __________________

Please circle your name above and then rate each team member objectively (yourself included) on the factors listed below based on the following 1-10 scale: 1-unacceptable, 3-poor, 5-average, 7-good, 10-outstanding. **Your responses will be kept strictly confidential**.

	TM#1	TM#2	TM#3	TM#4	TM#5
1. Displays a positive attitude at team meetings					
2. Contributes "fair share" to team discussion					
3. Quality of assigned work					
4. Timeliness of work completed					
5. Ability to work with other team members					
6. Overall impression of each team member					

Please make any specific comments, both positive and negative, about any of the team members or the project in general (for example; major obstacles encountered, conflicts, achievements, etc.). Again, your response will be held in strictest confidence.

(If necessary, please continue on the back of the page.)

Recommended Engineering Logbook Practices in Industry

The following guidelines have been compiled from industrial practice. While not all of these are directly applicable to the Senior Design Project (e.g., witnessing of logbook entries is not required), students should strive to keep as professional a logbook as possible, in preparation for their future careers. Having said this, it should be made clear that the typical logbook is a record of the process of design (which is at times chaotic and circuitous) and so does not have the organized and polished appearance of say, a lab report. Perhaps the most important aspects of a professional logbook would be clarity and completeness.

1. Any person doing technical work should keep a logbook. Some discretion in this regard should be left to a technical person who employs a technician and may wish to have the technician record results in the technical person's logbook, but it should be very clear as to who has written what. A technical person who requests work done by a service group should assume responsibility for keeping records of the results. The service group need not maintain the research logbook maintained by the rest of the company. A chronological reference log which is indexed, dated, provided with proper identification, and initialed by the head of the service group is entirely satisfactory, even if the data appears on separate sheets of paper.

2. Each technical person should keep only one logbook at a time, although it is permissible to keep a logbook for each major project.

3. Wherever possible, original data should be recorded directly in the logbook. This avoids the problem of misplacing the data after it is obtained and also minimizes copying errors. Where tests are described under the entry for a specific date and the test results are not obtained until later, block off an area in which the data will be placed (later); and then carefully sign, date, and witness the entry when it actually takes place.

4. If several days' work is written up separately on a single page, each entry should be signed and dated by the author. A witness (discussed below in 6.) may either sign each day's entry or sign at the bottom of the completed page. In any event, however, all blank pages should be lined out before either the author or the witness signs at the bottom of the page.

5. To make it easier to use the completed logbook, all subjects discussed on a given page should be listed at the top.

6. All logbook pages must be witnessed and dated. A satisfactory witness is someone who is familiar with the work done, but is not associated with the project directly. The purpose of a witness is to establish a date of disclosure and it is therefore fundamental that a witness must be able to understand what he/she reads. Witnessing by a co-

inventor, however, does not serve as proof of disclosure, merely having the same effect as if the author had signed his/her name twice. Because a supervisor is frequently associated directly with the project, that supervisor should probably not be a witness except in those rare instances where the supervisor is the only one besides the author who can understand the work. A notary public is not a satisfactory witness and cannot establish date of disclosure unless that person is technically trained. Logbook entries should be witnessed as soon as possible after they are made; in no event should more than a week elapse.

7. A pen, preferably black ink, must be used for all logbook entries as a means of insuring uniformity, permanence, ease of reading, and ease of reproduction.

8. Supervisors have a heavy responsibility in seeing that logbooks are kept properly. Logbooks often provide a space on the back cover for a supervisor to indicate familiarity with the logbook's contents. By signing this statement the supervisor does not serve as a witness in the sense discussed previously. The function is merely to review the logbook keeping methods which are being followed.

9. Exhibits, whether or not actually present in the logbook, need to be signed, dated, and witnessed.

10. In order to tie together various methods of keeping records, a research person should refer to other logbooks where this is appropriate. Similarly, logbook entries should be cited in formal reports and experiments.

11. The logbook is actually the property of the company or agency, not the individual. It represents work that the company or agency has sponsored and so rightly owns. (For the Senior Design Project, the logbook belongs to the student unless the client/sponsor asks for ownership of the logbook before the project begins.)

12. When an employee is preparing to leave the company, it is the responsibility of the supervisor to see that all logbooks are turned in to the appropriate department.

Use of the logbook in Senior Project

For the Senior Project, the logbook will serve primarily as a method of collecting and organizing information. By the end of the project, it may well be your most valuable asset. With this in mind, consider the following suggestions:

1. Divide your logbook into logical sections to make entering, organizing, and especially finding information easier. Some possible sections might include Brainstorming, Meeting Notes, Diagrams, Calculations, Research, Websites, Contacts, Analysis, Budget, Questions & Problems, etc. Please note that this is not an exhaustive list, nor are all of these sections appropriate for every individual's logbook. Think carefully about what information will be most useful for your particular project and structure your logbook accordingly.
2. Make sure your name, phone, email, and address are written inside so that a lost logbook has a better chance of being returned. As the project progresses, loss of your logbook will have increasingly more negative consequences, so make every effort to protect it.
3. Bring your logbook to all team meetings, advisor meetings, and class sessions. If you learn to use it wisely, your logbook will become your "best friend" during the Senior Project.

Use of Engineering Department's Model Shop

SAFETY WARNING: Working in the shop is dangerous. One careless move could easily cost you a finger, an eye, an arm, or even your life. Wear safety equipment, observe safety rules, and use common sense. Safety violations will result in immediate suspension of shop privileges and the resulting difficulty in completing your project.

General Shop Procedures and Safety Guidelines

1. Safety glasses are to be worn at all times while inside the shop area.

2. Wear proper work clothing. Shorts, tank-tops, and loose fitting clothing are not permitted in the shop. Do not wear gloves while operating machine tools.

3. Remove all watches, rings, jewelry, neck-ties or anything that could easily be caught in machinery. Roll up shirt sleeves above the elbows.

4. Long hair can get caught in machinery and must be tied back or worn under a hat.

5. Wear proper shoes. Open-toe or soft-soled shoes are not permitted in the shop.

6. Store personal belongings in the project room (Frey 68) while working in the shop.

7. Get approval before starting work or using any machine or power tools.

8. Clowning around or engaging in horseplay will not be permitted.

9. Never talk to or distract a fellow student who is working with equipment.

10. Never leave a machine while it is running or before it has come to a complete stop.

11. Always keep the area around your work area clean. Pick up your tools as soon as you are done using them and return them to the proper storage area. Keep the floor clear of debris.

12. Report all injuries at once.

13. Get instruction and sign-off prior to using any unfamiliar piece of equipment.

14. All drawings, sketches, and materials/parts lists submitted to the Model Shop for work by the shop technician(s) must be approved (signed off) by the faculty advisor.

15. The shop is available only when an instructor is on duty.

Machine/Welding Shop Equipment Use Policy

1. All students must be trained in the proper and safe use of each piece of equipment they wish to use. After training and review of the safety rules, the student will sign a card indicating that he/she has read and understood the rules.

2. Students must get an instructor's permission before using machine or power tools.

3. All instances of broken or damaged machinery should be brought to the attention of the instructor immediately.

4. Students are required to clean any machinery they use before signing leaving the shop. Repeated failure to clean machinery will result in the loss of shop privileges.

5. Specific safety rules are posted near each machine. These rules should be reviewed frequently to insure safe use of the machinery.

6. Under no circumstances will anyone be allowed to work alone in the shop.

Hand/Power Tool Check-out Policy

1. All hand and power tools must be signed out before using them. A sign-out sheet will be provided on the inside of the tool storage cabinet.

2. There are six (6) tool kits designated for student use. A list of the contents can be found on the inside lid of each tool box. It is the student's responsibility to check the contents of each kit before signing it out. Once the kit is signed out, the student(s) will be responsible for any missing items.

3. Access to tooling and equipment cabinets, other than those designated for student use, is not permitted without the specific permission of an instructor.

Material/Parts Use Policy

For each project, a detailed record must be kept of all raw material and hardware taken from shop stock. A Material Use/Request Form should be completed, signed by the faculty advisor, and initialed by the shop technician before any materials are used.

For projects requiring electrical components from the Electronics Laboratory, a detailed record must be kept of all components used. An Electrical Part Use/Request form should be completed and signed by the faculty advisor before any components are removed from stock.

Work Scheduling Policy

1. All requests for machine work will be done in the order in which they are received.

2. A work request will consist of the following:

   a. A completed Work Request Form
   b. A completed Materials Use/Request Form
   c. A detailed drawing, including all relevant dimensions.

3. Drawings submitted for shop work must be done using CAD software or drafting equipment. Rough sketches will not be accepted.

4. Whenever possible, teams will be notified when work begins so that they can assist in fabrication, if they wish to do so.

Shop/Lab Hours

1. The shop and labs are open during regular school hours. During periods of heavy use, it may be necessary to use the shop on a sign-up basis. When this policy is in effect, a list of available time slots will be posted outside the shop office.

2. If necessary (most likely during periods of heavy use), the shop may be open during some night or weekend hours. Time slots for use during these hours will be made available in advance on a sign-up basis.

3. The project area (Frey 68) will be open from 8 AM to 11 PM Monday through Friday, except during normally scheduled classes assigned to that room.

4. For safety reasons, students cannot work alone in the shop, labs, or project room.

5. Mr. Meyer will be available to answer questions about projects by appointment only. A sign-up sheet for this purpose will be posted outside the shop office.

Shop/Lab Safety Equipment

IMPORTANT: All persons using the shop and laboratory facilities should become familiar with the location and operation of the following safety equipment before starting work.

1. There are four bright red **Emergency Stop** push buttons located in the shop. Pressing any one of these buttons immediately cuts off power to the machine tools. Note: These

switches only control the power to the machine tools. Wall outlets and other electrical devices are not affected by the Emergency Stop buttons and must be turned off using the circuit breakers located near the air compressor.

2. There is one bright red **Emergency Gas Shut-Off** valve located in the welding area. This valve is operated by pressing the button, clearly marked to distinguish it from the Emergency Stop buttons. Note that the Emergency Gas Shut-Off valve does not affect any of the gas cylinders used with the welding equipment.

3. A **shock/fire blanket** is located on the wall of the welding area.

4. There is an **eye wash station** in both the shop and the Material Science lab.

5. There is an **emergency shower** just inside the door of the Thermal Sciences lab.

6. **Fire extinguishers** are located in both the shop and the project room. Each of these extinguishers is mounted on the wall near the hallway doors.

7. There is a **first-aid kit** located on the back side of the shop office door. However, this kit is for emergencies only and is to be used only with the explicit permission of an instructor.

First Aid and Emergency Policy

1. All injuries should be reported immediately to the instructor on duty.

2. First Aid Kits are intended for emergencies only and are to be used only with the specific permission of the instructor on duty. All other non life-threatening injuries will be referred to the health center.

3. All injuries should be examined by health center personnel. Persons refusing treatment by the health center will be required to sign a treatment refusal form.

4. **For serious or life-threatening injuries, dial 9 911 from a public campus phone (like the one in the hallway near the vending machines) or 9 911 from an office phone**. This will put you in touch with the local First Aid Squad. **Any time you call 911, you must also contact Public Safety by dialing 6005.**