TENNESSEE STATE UNIVERSITY
COLLEGE OF ENGINEERING
TECHNOLOGY AND COMPUTER SCIENCE

CAPSTONE DESIGN/TECHNICAL PROJECT MANUAL

COLLEGE OF ENGINEERING, TECHNOLOGY AND COMPUTER SCIENCE
TENNESSEE STATE UNIVERSITY
NASHVILLE, TENNESSEE
January 2009
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A. THE CAPSTONE DESIGN/TECHNICAL PROJECT

Each senior in the College of Engineering, Technology and Computer Science must execute a senior project. The required senior project is termed a Capstone Project. It is a two semester design or technical project which satisfies the Tennessee State University Senior Project Requirement and meets the ABET Engineering Design requirement. This manual outlines a methodology for writing the design/technical report. It contains the Capstone Design/Technical Project Policy, acceptable word processing specifications, project procedures and the necessary project forms.

1.0 Capstone Design/Technical Project Policy

All seniors in the College of Engineering, Technology and Computer Science are required to select and execute a theoretical or experimental design/technical project under the supervision of a capstone design project advisor. Students are also required to make an oral presentation and submit an acceptable written report on the project. Engineering students are required to execute a design project. The guidelines governing capstone design/technical projects are stated in this document.

2.0 Elements of the Capstone Design/Technical Project

The various elements of the student's curriculum are brought together in the senior project, which is termed a Capstone Project. The Capstone Design Project, which is required of engineering students, is built around a comprehensive, open-ended problem having a variety of acceptable solutions with many design constraints which must be addressed, including, but not limited to, economic factors, safety, reliability, ethics, societal impact and manufacturability. The Capstone design project must meet or exceed the ABET Engineering Design Requirement. The Capstone Technical Project, which is required of technology students, is built around a comprehensive, technical problem, which may have many constraints and solutions and require construction and testing of hardware.

3.0 ABET Engineering Design Requirements

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 and 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 most of the following features: development of student creativity, use of open-ended problems, development and use of modern design theory and methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility considerations, productions process, concurrent engineering design, 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. ELEMENTS OF THE CAPSTONE DESIGN PROJECT REPORT

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 covert resources optimally to meet a stated objective.

To ensure proper design content in a Capstone Design Project Report:

1.0 The following is required:
   1.1 Statement of desired need(s)
   1.2 Process of devising a method of satisfying those needs
   1.3 Utilization of basic science, mathematics and engineering science

2.0 Some of the fundamental elements of design must be included:
   2.1 The establishment of objectives and criteria.
   2.2 Synthesis
   2.3 Analysis
   2.4 Construction
   2.5 Testing
   2.6 Evaluation

3.0 The Engineering Design Report must demonstrate most of the following features:
   3.1 A student's creativity
   3.2 A student's understanding of design concepts and engineering principles
   3.3 Solution of an open-ended problem
   3.4 Development and use of modern design theory and methodologies
   3.5 Formulation of design problem statements and specifications
   3.6 Consideration of alternative solutions
   3.7 Feasibility considerations
   3.8 Production processes
   3.9 Concurrent engineering design
   3.10 Detailed system descriptions
   3.11 Mathematical modeling and/or simulation

4.0 It is essential to include a variety of realistic constraints, such as:
   4.1 Economic factors
   4.2 Safety
   4.3 Reliability
   4.4 Aesthetics
   4.5 Ethics
   4.6 Social
   4.7 Codes and Standards
   4.8 Environmental
   4.9 Security
   4.10 Health
C. ELEMENTS OF THE CAPSTONE TECHNICAL PROJECT REPORT

The Technical Capstone Project is the process of devising hardware and/or simulation to meet a desired need(s). It is a process (often iterative), in which the basic sciences, mathematics, and technical concepts are applied optimally to meet a stated objective.

To ensure proper technical content in a Capstone Technical Project Report:

1.0 The following is required:
   1.1 Statement of desired need(s)
   1.4 Process of devising hardware and/or simulation to satisfy the need
   1.5 Utilization of basic science, mathematics and technical concepts in analyzing the need and devising hardware to meet the need

2.0 Some of the fundamental elements of the solution must be included:
   2.1 The establishment of objectives and criteria.
   2.2 Synthesis
   2.3 Analysis
   2.4 Construction
   2.5 Testing
   2.6 Simulation
   2.7 Evaluation

3.0 The Technology Capstone Report must demonstrate most of the following features:
   3.1 A student's understanding of technical concepts
   3.2 Construction of hardware and/or simulation to solve a technical problem
   3.3 The use of modern technology and technological concepts
   3.4 Formulation of the technical problem statement(s) and specifications
   3.5 Consideration of alternative solutions
   3.6 Feasibility considerations
   3.7 Hardware considerations and specifications
   3.8 Detailed hardware descriptions

4.0 It is essential to include a variety of realistic constraints, such as:
   4.1 Economic factors
   4.2 Safety
   4.3 Reliability
   4.4 Aesthetics
   4.5 Ethics
   4.6 Social
   4.7 Power Requirements
   4.8 Size and weight
   4.9 OSHA and other Industrial Standards
   4.10 Security
D. CAPSTONE DESIGN/TECHNICAL PROJECT GUIDELINES

The following guidelines are to be followed when conducting a Capstone Design/Technical Project in the College of Engineering, Technology and Computer Science. Senior engineering/technology/computer science students must begin a Capstone Project at least two semesters prior to graduation. The Capstone Project will be executed in a two-semester Capstone D course.

1.0 First Semester Capstone Class (ENGR 4500) Requirements

1.1 Preparation for a Capstone Project

At the first meeting of the Capstone Class, the Capstone Design/Technical Project Policy and Procedures will be discussed in detail. The Project Approval Form and the Capstone Project Milestone Checklist will also be discussed.

1.2 Project Advisor

a. TSU Advisor

Each student will select and meet with a Project Advisor by the second week of the semester to outline a program of work, set major milestones and time frames required to meet the major milestones.

b. Industrial Advisor

A student may select an advisor from industry. An Industrial Advisor must be approved by the student's Department Head. A College of Engineering, Technology and Computer Science faculty member must serve as a co-advisor to ensure that Capstone Project procedures are followed. However, the industrial project advisor is the advisor of record and will evaluate the project. Industrial sponsored projects are encouraged.

1.3 Topic Approval

Each student must prepare and submit a Capstone Project Approval Form to a Project Advisor and to the department head and/or departmental committee for approval of the capstone design topic. Submission of the Capstone Design Project Approval Form to the Capstone Course Instructor will take place no later than the third meeting of the class.

1.4 Progress Reports

Each student must submit progress reports (written and oral) to the Project Advisor and Capstone Course Instructor. A copy of the Milestone Checklist will be submitted to the Capstone Course Instructor each class period. At least one oral status report will be given in class.

1.5 First Semester Requirements

Each student will submit a Problem Definition and four (4) chapters to the course instructor as scheduled on the Milestone Checklist.

The Problem Definition must include the following minimum components:

- Problem Statement
- List of References
- List of Specifications
- List of Constraints
- List of Alternative Solutions
- Design Methodology (Required of Engineering Students)
- Technical Approach (Required of Technology Students)
All requirements must be submitted in class on or before the date indicated on the Milestone Checklist. Each student must submit her or his own work in class to the Project Instructor.

CAPSTONE DESIGN/TECHNICAL PROJECT MANUAL

D. CAPSTONE DESIGN/TECHNICAL PROJECT GUIDELINES

1.0 First Semester Capstone Class (ENGR 4500) Requirements (Continued)

1.6 Oral Status Report Elements

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<td>b. Project Requirements</td>
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<td>c. Chapter Designations</td>
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<td>d. References/Bibliography</td>
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<td>e. Project Issues' Report #1</td>
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<td>f. Alternative Solutions</td>
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<td>g. Codes and Standards</td>
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<td>h. Chapter 1</td>
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<td>i. Project Issues' Report #2</td>
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<td>j. Specifications/Constraints</td>
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<td>k. Chapter 2</td>
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<td>l. Project Issues' Report #3</td>
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<td>m. Chapter 3</td>
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<td>o. Model(s)</td>
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<td>p. Chapter 4</td>
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<td>q. Project Issues' Report #5</td>
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1.7 Project Issues

a. Discussion of the mathematical, science and engineering/technical principles used to complete the design/technical project.

b. Detailed discussion of each realistic constraint, which follow, as they applied to the design/technical project: economic factors; safety; security; reliability; aesthetics; ethics; social factors; power requirements; size and weight; ASME, OSHA and other codes and standards.

c. Discussion of the skills (programming, computational, experimental, etc.), techniques (numerical, analytical, etc), model(s) (analytical, computer, graphical, numerical) and modern tools (software, computer hardware, instrumentation, etc.) required to complete the design/technical project.

d. Discussion of the design/technical methodology, including codes and standards, used in the project.

e. A personal statement of being ethical and professional at all times, particularly while analyzing and/or designing a system, system component or process for your capstone project and when communicating the project.

Project Issue Reports must be graded, signed, dated by the project advisor and submitted on or before the date indicated on the Course Outline. All Issue Reports must be submitted to receive a grade.

1.8 Chapter Requirements

A preliminary list of Chapter Designations, approved and signed by the Project Advisor, is required which indicates the chapter where fundamental elements, design/technical features and constraints will be discussed. Chapter Designations are subject to change during the course of the project. The list of Chapter Designations is to be submitted in class to the Project Instructor on or before the date indicated on the Milestone Checklist.

It is the responsibility of the student to ensure that the Preliminary Material and each chapter is free of all grammatical errors, miss-spelled words and in the correct format as defined in the Capstone Design/Technical Manual. A chapter is not complete if grammatical errors exist or misspelled words are present and if the chapter is not in the proper format.

The Preliminary Material must be submitted with each chapter. The each chapter must be (1) 85% complete, (2) free of miss-spelled words grammatical errors and in the correct format, (3) submitted with a signed statement from the Project Advisor verifying that the chapter is 85% complete, (4) with a grade recorded on the Milestone Checklist and (5) submitted in class to the Project Instructor on or before the (6) date indicated on the Procedural Checklist. If any one of these requirements is not met then a grade of zero will be given for the chapter.

Chapter I Introduction must contain, as a minimum, the items listed in Section 7.8 Introduction in the Capstone Design/Technical Project Manual.
D. CAPSTONE DESIGN/TECHNICAL PROJECT GUIDELINES (Continued)

2.0 Second Semester Capstone Class (ENGR 4510) Requirements

2.1 Abstract

A one-page, abstract, approved by the Project Advisor, is to be submitted to the course instructor on the date indicated on the Milestone Checklist.

2.2 Report Drafts

a. It is the responsibility of the student to ensure that each draft and the final report is free of all grammatical errors, miss-spelled words and in the correct format as defined in the Capstone Design Manuel. A draft is not complete, nor is the final report complete if grammatical errors exist or miss-spelled words are present and if the paper is not in the proper format.

b. The first draft must be (1) 85% complete, (2) submitted with a signed statement from the Project Advisor verifying that the project is 85% complete, (3) with a grade recorded on the Milestone Checklist and (4) submitted in class to the Project Instructor on or before the (5) date indicated on the Milestone Checklist. If any one of these requirements is not met then a grade of zero will be given for the first draft.

c. The final draft must be (1) 95% complete, (2) submitted with a signed statement from the Project Advisor verifying that the project is 95% complete, (3) with a grade recorded on the Milestone Checklist and (4) submitted in class to the Project Instructor on or before the (5) date indicated on the Milestone Checklist. If any one of these requirements is not met then a grade of zero will be given for the final draft.

2.3 Final Oral Presentation

The final draft must meet the requirements listed in Item 2.2 c. above with a minimum grade of “D” before the formal oral presentation can be made. The final oral presentation must be presented using Power Point, to the advisor. If the final oral presentation is not given prior to the date indicated on the Course Outline, a grade of zero will be given for the final oral presentation and a grade of “F” will be given for the course.

2.4 Project Issues’ Report

A one-page word-processed report is required for each of the topics listed below. Each report must be graded, signed and dated by the Project advisor.

a. Detailed discussion of each realistic constraint, which follows, as they are applied to the design/technical project: safety; security; reliability; aesthetics; ethics; power requirements; size and weight.

b. Discussion of the impact of your project in light of contemporary and social issues.

c. Discussion of the feasibility of implementing your project from a business and economic perspective.

d. Discussion of how ASME, OSHA and other codes and standards impact the project.

e. Explain, in detail, how you plan to remain technologically current in your field over the life of your employment

If all the Project Issues Reports are not completed and/or are not submitted on the dates as indicated on the course outline, then a grade of zero (0) will be given for all the Projects Issues Reports.
2.5 Final Written Report

The student must submit to the course instructor, one bound original and two bound copies of an approved final report on or before the date indicated on the Milestone Checklist. Capstone design projects will not be accepted by the capstone design instructor without the Procedural Checklist. Only those projects submitted in class to the capstone design instructor will receive a grade for the Capstone Design Written Report. The Department Head must sign-off on the project before copies are made, bound, and submitted to the course instructor. The final project report must follow the format outlined in this document. The written report must be word processed according to the word processing specification for a Project Report, which is presented in this document.

If a signed Capstone Report with two copies, and the signed and graded Milestone Procedural Checklist are not submitted to the Capstone Design instructor on the date indicated on the Milestone Checklist, then an “I” contract and the signed and graded Milestone Checklist must be submitted to the Capstone Instructor. If an “I” contract nor the Final Written Reports is not submitted to the Capstone Instructor then a grade of “F” will be given for the final written report and a grade of “F” will be given for the course. The “I” Contract delivery date cannot be more than seven (7) days from the date the report was due.

3.0 GRADING

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<td>c) Oral Presentations*</td>
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<td>d) Problem Definition</td>
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<td>h) Model</td>
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<td>j) First Draft</td>
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<td>k) Final Draft</td>
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<td>l) Final Written Report</td>
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100% 100%

* The capstone design instructor will provide these grades.

Please note the following:

- A grade of “I” will not be given except according to University policy described in the current University catalog.
- If the Problem Definition is not completed and submitted to the Capstone Design instructor on or before the date indicated on the Milestone Checklist, for the first Capstone Design course a grade of “F” will be given.

4.0 PROJECT FORMS

The forms, which are listed below, will be used to monitor the progress of the project. They will also be used in the evaluation process. The forms listed below follow this section.

- CAPSTONE DESIGN/TECHNICAL PROJECT APPROVAL FORM
- CAPSTONE I MILESTONE CHECK LIST
- CAPSTONE II MILESTONE CHECK LIST
- WRITTEN REPORT EVALUATION FORM
- ORAL REPORT EVALUATION FORM
TENNESSEE STATE UNIVERSITY
COLLEGE OF ENGINEERING, TECHNOLOGY AND COMPUTER SCIENCE

CAPSTONE PROJECT APPROVAL FORM

1.0 STUDENT INFORMATION

_____________________________________________  ______________________
Student’s Name                                  Expected Graduation Date

_____________________________________________  ______________________
Local Address                                    Local Phone Number

_____________________________________________  ______________________
E-mail Address

2.0 DESCRIPTION OF PROPOSED PROJECT

2.1 PROJECT TITLE:

2.2 PROPOSED METHOD OF INVESTIGATION:

2.3 DESIGN PROCESS

2.4 PROPOSED REFERENCES/EQUIPMENT:

3.0 SIGNATURES:

_____________________________________________  ______________________
Student                                             DATE

_____________________________________________  ______________________
Project Advisor                                     DATE

_____________________________________________  ______________________
Department Head                                     DATE

_____________________________________________  ______________________
Capstone Project Instructor                         DATE
TENNESSEE STATE UNIVERSITY  
COLLEGE OF ENGINEERING, TECHNOLOGY AND COMPUTER SCIENCE  
ENGR 450 CAPSTONE DESIGN/TECHNICAL PROJECT I  
CAPSTONE PROJECT I MILESTONE CHECKLIST  

NAME: _____________________________________________________  PROJECT TITLE: ______________________________________________________

DEPARTMENT OF:_________________________________________    PROJECT ADVISOR NAME: _______________________________________________

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<td>3.0 Project Proposal and Milestone Checklist</td>
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<td>4.0 Oral Status Report</td>
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<td>5.1 Project Issue #1</td>
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<td>5.2 Problem Definition</td>
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<td>5.3 Chapter 1: Introduction</td>
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<td>5.4 Project Issue #2</td>
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<td>5.5 Chapter 2 &amp; Project Issue #3</td>
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<td>5.6 Project Issue #4</td>
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<td>5.7 Chapter 3:</td>
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<td>5.8 Model and/or Instrumentation/Test Set-Up</td>
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<td>5.9 Project Issue # 5</td>
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<td>5.10 Chapter 4</td>
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<td>6.0 First Semester Signed Milestone Checklist</td>
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<td>7.0 Second Semester Milestone Checklist</td>
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Grades:  Complexity of the Problem: _______  Meeting Milestones _______  Oral Presentations _______  Problem Definition _____  Model/test Set-up ________

Chapter 1: _____  Chapter 2: _____  Chapter 3: _____  Chapter 4: _____  Issues’ Reports: 1._______  2._______  3._______  4._______  5.______Final Grade:_____ 

APPROVALS:

__________________________________  ___________________________________  ___________________________________
PROJECT ADVISOR  DEPARTMENT HEAD  PROJECT INSTRUCTOR

- If a Problem Definition is not submitted and/or if the Problem Definition does not include the components outlined in the Capstone Design/Technical Manuel, and/or if Issues Report #2 is not submitted on the assigned date a grade of “F” will be given or the student should withdraw.
- If all five (5) Project Issues’ Reports are not submitted as required, a grade of “0” will be given for Project Issues’ Reports.
- If the Project Issues Essays are not submitted and/or if the Project Issues do not include all three (3) required essays, a grade of “0” will be given for Project Issue.
- Advisor Due Dates are to be recorded on the Project Milestone Checklist prior to the date the Checklist is due.
TENNESSEE STATE UNIVERSITY
COLLEGE OF ENGINEERING, TECHNOLOGY AND COMPUTER SCIENCE
ENGR 4510 CAPSTONE PROJECT II
CAPSTONE PROJECT MILESTONE CHECKLIST

NAME: __________________________________________ PROJECT TITLE: _______________________________________________________
DEPARTMENT OF: ________________________________ PROJECT ADVISOR NAME: _____________________________________________

<table>
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<th>PROCEDURE</th>
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<td>7.10 Life Long Learning Exercise</td>
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<td>8.0 Signed and Graded Final Report &amp; 2 copies, and Signed Milestone Checklist or Signed “I” Contract and Signed Milestone Checklist</td>
<td>12/07/05*</td>
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</tbody>
</table>


Issues’ Reports: 1. _______ 2. _______ 3. _______ 4. _______ 5. _______ Final Grade: ___________

APPROVALS:

_________________________________________  _______________________________  _____________________________
PROJECT ADVISOR                           DEPARTMENT HEAD                       PROJECT INSTRUCTOR

- *This is the last day to submit the signed Capstone Design/Technical Project reports (one original and two copies) and the signed Milestone Checklist with grades or a signed “I” contract and the signed Milestone Checklists with grades in class to the Capstone Project Instructor. Capstone Project Report Milestone Checklists and/or “I” contracts will not be accepted after the class ends on this date. Capstone Design/Technical Project Reports with the Milestone Checklist or "I" contract must be submitted in class to the Capstone Project Instructor.

- Advisor Due Dates are to be recorded on the Project Milestone Checklist prior to the date the Checklist is due to the Capstone Instructor.
**TENNESSEE STATE UNIVERSITY**  
**COLLEGE OF ENGINEERING, TECHNOLOGY AND COMPUTER SCIENCE**  
**CAPSTONE DESIGN/TECHNICAL PROJECT**  

**WRITTEN REPORT EVALUATION FORM**

NAME: _____________________________________________   DATE: ____________________

TOPIC: ________________________________________________________________________

<table>
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<tr>
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<th>MAXIMUM VALUE</th>
<th>POINTS EARNED</th>
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<tr>
<td>1. Sufficient Introduction to the Report</td>
<td>15</td>
<td>_______</td>
</tr>
<tr>
<td>2. Thoroughness in identifying and defining the subject and the method of solution</td>
<td>20</td>
<td>_______</td>
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<tr>
<td>3. Logical and systematic analytical/experimental Approach, approximately and correctly applied</td>
<td>30</td>
<td>_______</td>
</tr>
<tr>
<td>4. Collection, presentation, and analysis of data</td>
<td>10</td>
<td>_______</td>
</tr>
<tr>
<td>5. Sufficient number and quality of graphs and graphics</td>
<td>10</td>
<td>_______</td>
</tr>
<tr>
<td>6. Arrival at a strong conclusion(s) with Recommendations if required</td>
<td>15</td>
<td>_______</td>
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100

GRADE: _________

COMMENTS:

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

Evaluation by: ___________________________________________  Date:___________________
COLLEGE OF ENGINEERING, TECHNOLOGY AND COMPUTER SCIENCE
CAPSTONE DESIGN/TECHNICAL PROJECT
EVALUATION OF ORAL PRESENTATION

SPEAKER: ___________________________ DATE: ________________

TOPIC: _________________________________________________________________________

PROJECT ADVISOR: _____________________________________________________________

| INTRODUCTION: Did the speaker begin effectively? | EVALUATION |
| Was the purpose and content of the talk clear? | |

| ORGANIZATION: | Was the talk well-organized into parts that followed in a logical order? |
| | |

| KNOWLEDGE: | Was the speaker knowledgeable of the topic? |
| Was the technical content explained adequately? |
| | |

| CONCLUSION: | Did the speaker summarize the main points of the talk? |
| Was the talk ended effectively? |
| | |

| VOICE & MANNERISM: | Eye contact, gestures, confidence, enunciation, speed volume, pitch, etc. |
| | |

| AUDIO-VISUAL AIDS: | Were they appropriate, easily read, and easily understood? |
| | |

| RESPONSE TO QUESTIONS: | Did the response relate to the question(s) asked? |
| | |

| LENGTH OF TALK: | (Maximum of 20 minutes) |
| | |

| OVERALL EVALUATION: | (0) Unsatisfactory (1) Poor (2)Satisfactory (3) Excellent |

COMMENTS: ____________________________________________________________

__________________________________________________________________________

Evaluation by: ___________________________ Date: ____________________________

CAPSTONE DESIGN/TECHNICAL PROJECT MANUAL

- 12 -
CAPSTONE DESIGN PROJECT SPECIFICATIONS FOR WORD PROCESSING

1.0 **PAPER**

Use 8 ½ x 11 inches sheet size.

2.0 **NUMBER OF COPIES**

A total of three Capstone Design/Technical Project reports are required as follows:
One (1) original and two (2) copies. One copy will be returned to the student.

3.0 **BINDING**

The three copies are to be spiral bound with a clear plastic front cover and a hardback cover. The student is responsible for getting all three copies bound.

4.0 **WORD PROCESSING**

4.1 The project shall be word-processed using Courier 10 or TMS 12 fonts using a near letter quality printer.

4.2 The text shall be double-spaced, except for long quotations and abstracts, which are single-spaced. Footnotes are not permitted.

4.3 Margins shall be one and one-half inches at the top and left margins, and one inch at the bottom and right margins. The top margin on the first page of each chapter should be two (2) inches.

4.4 Text, tables, and figures shall be neat, clear and without error. The same word processor must be used throughout.

4.5 Reference numbers must be placed in square brackets behind the last word of the citation.

4.6 Avoid mistakes in the hyphenation of words at the end of lines. One-letter and two-letter divisions, such as e-vil, en-velope, entire-ly, and a-tone are not acceptable.

4.7 If figures and tables are to be included, reproductions must be of good quality. Reproductions must be referenced. Tables and figures must be referenced in the text. See the sample table on page 22 and sample figure on page 23.

5.0 **PAGINATION**

Assign a number to every page, except on the title page which is not numbered. Preliminary pages are numbered with small Roman numerals (ii, iii, iv, etc.) and are centered at the bottom of the page on the fifth line above the edge. The numbering begins with: “ii”, the title page counts as “i”, but is not numbered. Arabic numerals should be used in numbering pages of the main text, and no periods or dashes should be used before or after the number. The first page of a chapter should be numbered in the center at the bottom. The appendices, bibliography, and references should be numbered continuously with the text. Roman numerals are used to designate chapters.

Page numbers are at the center bottom and should be placed five (5) spaces from the bottom of the page. Number in the upper right corner should be 3/4 inches from the top and 1 inch from the right side of the page. However, page numbers can be placed using the pagination feature found in the word processor. Placement of page numbers on the appendices, bibliography, references, and abstract are the same as for the text.
6.0 ARRANGEMENT: The design/technical project report should be arranged as follows:

6.1 Preliminaries
1. Clear plastic front cover
2. Title page
3. Signature Page
4. Abstract
5. Dedication
6. Acknowledgement
7. Table of Contents
8. List of Figures
9. List of Tables
10. Nomenclature (optional)

6.2 Text
1. Introduction
2. Main body of report
3. Conclusion(s)/Recommendation(s) (if any)

6.3 Reference Matter
1. Appendix
2. References
3. Bibliography

6.4 Other Matter
1. Resume
2. Fly page, for protection in binding
3. Hard back cover
4. 

7.0 BRIEF DESCRIPTION OF EACH REPORT PART

7.1 Title Page: The title page should conform exactly to the sample shown.

7.2 Signature Page: The signature page should conform exactly to the sample.

7.3 Abstract: A precise and concise summary of what was done, stating the significant results and the significance of the significant results.

7.4 Dedication and Acknowledgement: The form of the acknowledgement and dedication should conform to the sample shown.

7.5 Table of Contents: Outline of report, which lists in order, the major parts of the report and their corresponding page numbers.

7.6 List of Figures: The figure number, name and corresponding page number must be the same as in the text. (See example)

7.7 List of Tables: The table number, name and corresponding page number must be the same as in the text. (See example)
E  CAPSTONE DESIGN PROJECT SPECIFICATIONS FOR WORD PROCESSING

7.0  BRIEF DESCRIPTION OF EACH REPORT PART (Continued)

7.8  **Introduction** - Statement of the purpose(s), objectives(s), and the scope of the investigation. A literature survey is included if appropriate. Last paragraph should give a brief summary of each chapter in the text.

7.9  **Conclusions** - A precise statement of the results that answer the project objective(s).

7.10  **Recommendations** - Precise statement of what is advised. Must contain precise action suggested, identify the responsible person to carry it out, and appropriate dates for the suggested action.

7.11  **Appendix** - Supplementary material that is referred to in the report.

7.12  **References** - Sources used for any verbatim facts, information, or concepts contained in the paper. References are numbered according to where the citation is made in the writer's text, see examples


3.  Wills, op. cit., p. 44. (Same as reference 1, but different page).

4.  Ibid., p. 46 (Same as reference 3, but different page. Ibid. is used because Wills' book has just)


7.  Murray, loc. cit. (Same as reference 5.)

8.  V. Table 2, p. 3. (The reader is referred to a table, which was presented and discussed on a previous page in this report).

9.  Wills, *Advanced Chemistry, p. 39*. (Op. city. cannot be used because two works by this author have been cited.)

10.  Ibid. (exactly the same as reference 9.)


12.  Allerton, J.D. Professor of Chemical Engineering, Eastern State University, in a personal interview, November 11, 1971.

13.  Chicago Journal-Times, October 18, 1971, p. 40, col. 1. (Newspaper article without title.)

14.  "*Desalination*," National Encyclopedia, 7th ed., vol. IV, p. 61. (Encyclopedia article with author's name not shown.)
BRIEF DESCRIPTION OF EACH REPORT PART (Continued)

7.13 Bibliography

Sources used for general information or concepts, which do not appear verbatim in the paper. The bibliography is presented in alphabetical order, by the first letter of the author’s or editor’s last name. Second line of bibliography citation must be indented five spaces. If there is no author or editor, then the first letter of the title is used. See examples listed below:


7.14 Resume

At the end of each investigative paper, the student author is to include a one-page resume.
CAPSTONE DESIGN/TECHNICAL PROJECT MANUAL

F. SAMPLE PRELIMINARY MATERIAL
THE USE OF A DIGITAL COMPUTER TO SOLVE
THE LOAD FLOW PROBLEM

by

(Student Name)

Design Project Report

Submitted to the Faculty

of the

College of Engineering and Technology

in

Partial Fulfillment of the Requirements

for the Degree of

Bachelor of Science

in

Electrical and Computer Engineering

(Month, year)

College of Engineering, Technology and Computer Science
Tennessee State University
Nashville, Tennessee
THE USE OF A DIGITAL COMPUTER TO SOLVE
THE LOAD FLOW PROBLEM
DESIGN PROJECT REPORT

APPROVAL RECOMMENDED:

PROJECT ADVISOR

DATE

COURSE INSTRUCTOR

DATE

DEPARTMENT HEAD

DATE

APPROVED:

DEAN, COLLEGE OF ENGINEERING, TECHNOLOGY AND COMPUTER SCIENCE

DATE
Fracture of beryllium under biaxial states of stress has been studied in the past using thin-walled tubes loaded by combinations of axial load, torsion, and internal pressure. In the present investigation to obtain a triaxial state of stress, notched beams of beryllium with varying dimensions were tested in plane strain four-point bending. The conditions necessary to ensure plane strain are discussed in detail and plane strain finite element analyses are used to determine the stresses and strains at fracture in the notched specimens. Based on the test results a strain dependent, maximum tensile stress fracture criterion is proposed for parts without macroscopic cracks. In addition, the plane strain fracture toughness of beryllium is estimated from the notched bar tests using the RKR model.
To my Father, Samuel T. Gibbs, who, through his financial and moral support was the source of inspiration and the mainstay in my attaining an education, I dedicate this project.

A.G.
This project was written under the direction and supervision of Dr. Satinderpaul Devgan. I would like to express my sincere appreciation to him for the interest and assistance given to me.

A.G.
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Symbols

a  acceleration

a  activity

a.A  Specific Helmholtz function and total Helmholtz function

AF  air-fuel ration

c  velocity of sound

C_D  coefficient of discharge

C_p  constant-pressure specific heat

C_v  constant-volume specific heat

C_{p0}  zero-pressure constant-pressure specific heat

C_{v0}  zero-pressure constant-volume specific heat

e.E  specific energy and total energy

f  fugacity
CAPSTONE DESIGN/TECHNICAL PROJECT MANUAL

G. SAMPLE PAGES
CHAPTER I

INTRODUCTION

A. Significance of Predictive Maintenance

In today’s society, engineering has taken a different perspective due to processes such as lean manufacturing, agile manufacturing and just-in-time manufacturing. These concepts are based on efficiency and effectiveness of various operations in the manufacturing industry [1]. Therefore, in an attempt to uphold these standards the equipment and machinery need to be maintained prior to failure. Consequently, avoiding sudden system failure, downtime, a major repairs and reduction in productivity. The purpose of the project is to design a tool that will predict pending failure in an electric motor before catastrophic failure. This project was done as an experimental analysis of motor-alternator setup, proving that pending failure of a motor can be predicted.

B. What is Predictive Maintenance?

Predictive maintenance is based on knowing the actual functional characteristics of the events being predicted: in this case lack of lubrication of a bearing, shaft misalignment and the combination of lack of lubrication and shaft misalignment.

Knowing the faulty conditions of a system and how the system operates under these conditions is the most effective way to design a predictive tool.
### Table 1.

Some Solid-Liquid-Vapor Triple Point Data [3]

<table>
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<tr>
<th>Elements</th>
<th>Temperature (°F)</th>
<th>Pressure (atm)</th>
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<tr>
<td>Hydrogen (normal)</td>
<td>-435</td>
<td>0.071</td>
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<tr>
<td>Nitrogen</td>
<td>-346</td>
<td>0.1237</td>
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<td>Oxygen</td>
<td>-362</td>
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<td>Mercury</td>
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<td>Zinc</td>
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<tr>
<td>Silver</td>
<td>1760</td>
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<tr>
<td>Copper</td>
<td>1981</td>
<td>0.00000078</td>
</tr>
</tbody>
</table>

Figure 1. Example of Figures
NAME

PRESENT ADDRESS
7242 Cabot Drive
Nashville, Tennessee 37209
Phone: (615) xxx xxxx

PERMANENT ADDRESS
xxxx S.Beverly Avenue
Chicago, Illinois CCCCC
Phone: (312) XXX XXX

OBJECTIVE
To obtain any entry level position in the area of Mechanical

INDUSTRIAL EXPERIENCES

Summer 1988
Exterior Product Group: Troy, MI
Major responsibilities: Analyze thermal effects on rim-injected moldings and production problems on bi-laminate moldings.

Summer 1987
General Motors (Fisher Guide Division) -GM Scholar
Exterior Product Group: Troy, MI
Major responsibilities: Forming a World-Class analysis on hi-gloss materials and finishes. Performing and analyzing particle counts in various point spraying booths.

Summer 1986
General Motors (Buick, Oldsmobile & Cadillac)-Co-op.
Metal Stamping Plant: Chicago, Illinois
Major responsibilities: Worked in quality, scheduling, traffic and die design.

ACTIVITIES
Chairperson: School of Engineering and Technology Student Leadership Council.
President: National Society of Black Engineers.
Member: American Society of Mechanical Engineers.
Member: Society of Automotive Engineers.
Member: Society of Manufacturing Engineers.
Tennessee State University Peer Counselor.

AWARDS and HONORS
General Motors Scholarship and Stipend.
Scholastic All-American.
Outstanding Young Men of America
Who's Who Among American Colleges and Universities
National Dean's List 5 consecutive semesters.
Outstanding College Student of America (General Award).
Outstanding College Student of America (Engineering Award).

Reference available upon request.
H. SUGGESTIONS FOR MAKING ORAL CAPSTONE DESIGN/TECHNICAL PROJECT PRESENTATIONS
1.0 COMMENTS AND SUGGESTIONS FOR ORAL PRESENTATION OF CAPSTONE PROJECTS

B. G. Eads
Oak Ridge National Laboratory

T. L. Hayford
Aluminum Company of America

R. Shyne
NASA-Glenn Research Center

The following comments and suggestions are given in light of expectations in industry of the elements of an effective technical presentation.

There is an old adage that says that every presentation to inform others should contain three parts:

1. Introduction: Tell them what you are going to tell them.
2. Body: Tell them.
3. Conclusion: Tell them what you told them.

It is referred to this as the ABC method.

A. **ANNOUNCE**: (introduce) what you will say. You can give an outline of the talk if you wish, but you must tell the audience the main purpose of your presentation. Example: "My purpose is to introduce a better mousetrap to the world."

The introduction is critical to making an effective presentation and contains three elements: (1) and introduction to subject matter; (2) rational as to why the audience should listen; (3) the introduction should overview the entire presentation.

B. **BODY** of the presentation. Present the background of the technical work and the analysis, data, design, test results, etc. that supports the main purpose stated in A.

C. **CONCLUSION.** In this portion, you should summarize the major points of the presentation, which in turn, support the stated main purpose. For example, you might say, "I have shown how to make the world a better place with a new approach to mousetraps. A design for the new mousetrap was presented. The test results showed this design to be 30% more efficient, and the cost is no more than for a conventional mousetrap."

The conclusion is critical to making an effective presentation. Do not finish your last word and stop. The last 30 seconds or so, people really pay attention when you say, “Now, in conclusion...”or “Now, I would like to review.....”. To give your presentation cohesiveness, closely tie your conclusion to the introduction.

1. The most common shortcomings observed in the Senior Projects come in the A and C portions.

   Failure to clearly state the main purpose in part A. You are generally trying to sell the audience on an idea; your design, your approach, your work is better, faster, and cheaper, revolutionizes the world or such like. Tell the audience the main conclusion you want them to reach as a result of your presentation. Do not leave them to draw their own conclusions.

2. Including all the background of your project in portion A. Background belongs primarily in the **Body** of the presentation. Part A should only include a brief background statement to gain the interest of the audience.

3. Launching straight into the Body without a statement of purpose.
2.0 SUGGESTIONS ON MAKING ORAL CAPSTONE PROJECT PRESENTATIONS

1) **Opening:** A few presentations did not use a title overhead to open the presentation.

2) **Organization:** An early slide (probably the second one) should give an outline of the presentation. Be sure to include any assumptions made.

   Problem statements are an excellent way to begin the actual presentation (after the outline). However, problem statements should describe the need not the solution. The solution is best presented in the objective of the design. ALCOA teaches a problem solving technique known as the "Alcoa Eight Step Quality Improvement Process". Problem statements are an important part of this process and the description of a "Problem Statement" from that training is presented in Table A.1.

3) **Slides:** Limit the amount of information on a slide and use large print (presentation-sized fonts). Usually, typed material will be too difficult to read from a distance.

   Do not read a list from an overhead word-for-word to the audience. Just summarize the points being presented.

4) **General:** Limit "jargon" as much as possible.

   Be tolerant of questions. Most reviewers do not have intimate knowledge of your project and may even be a different discipline than your own.

   Do not try to cover too much detail, just enough to describe the design process.

   Be prepared before standing up. Sorting through papers slides or setting up a demo while opening a presentation is too much of a distraction.

   Practice enough so that you do not have to constantly refer to notes. This allows you to judge the time required for your presentation. Stay within the time guidelines provided (less than 20 minutes).

   Include cost analysis information if your project involves construction or manufacturing. These cost estimates should include labor to build or assemble and not just be a summary of the cost of part.
3.0 PROBLEM STATEMENT

A good problem statement:

- States the specifics of the problem - who, what, when, and where.
- States the effect, but not the cause - what is wrong, not why it is wrong.
- Focuses on the gap between what is and what should be. The gap may be a change or deviation from a norm, standard, or reasonable expectation.
- Includes some measurements of the problem - how often, how much or when.
- Avoids broad categories like moral, productivity, communication and training since these tend to have different meanings for different people.
- Do not state problems as questions, since this implies that the answer to the questions is the solution to the problem.
- States why the problem is important.

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4.0 ORAL PRESENTATION OUTLINE

- TITLE
- OUTLINE
- GENERAL IMPORTANCE OF THE WORK
- SPECIFIC MOTIVATION FOR THE WORK
- OVERALL SCOPE OF THE WORK
- SPECIFIC OBJECTIVES
- DETAILS OF THE WORK
- RESULTS
- SUMMARY
- CONCLUSIONS
- FUTURE WORK
THE SUCCESSFUL ORAL PRESENTATION MUST PROVIDE THE MEMBERS OF AN AUDIENCE WITH THE ANSWER TO THE FOLLOWING QUESTIONS:

- What is the title of the work?
- What is the name of the presenter and his or her affiliation?
- Why is the work important?
- What is the presenter’s motivation for the work?
- What related work exists?
- What is unique about the presenter’s approach?
- What is the overall scope of the work?
- What are the specific objectives of the work?
- How was the work performed?
- What are the results?
  Technical results?
  Economic results?
  Environmental impact?
  Safety and security requirements?
- Did the results meet the objectives?
- What happens next?