AC 2009-1630: ASSESSING SENIOR DESIGN PROJECT DELIVERABLES

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ASSESSING SENIOR DESIGN PROJECT DELIVERABLES

Abstract

Historically at the University of North Carolina at Charlotte (UNC Charlotte), a grade was assigned to a senior design student at the end of each of their two semesters based on one document. Therefore, students did not know how well they were progressing in the class until the end. This method of assessment also did a poor job of validating the ABET criteria for assessing the learning objectives.

A new method of assessing student groups has been implemented concurrently with a new model that requires students to turn in "development documentation" throughout each semester. Each group's industry sponsor, faculty mentor, and course instructor grade these documents against a previously published rubric. This method of assessment provides plenty of feedback on the group's performance early in the semester. The original rubrics were inspired (and sometimes duplicated) from rubrics developed by another university.

The faculty found that the original versions of the UNC Charlotte rubrics needed modifications due to several different reasons, mostly to encourage more design content in the documentation. This paper describes the history of this program and the development of the rubrics. Versions of the currently used rubrics are included in an appendix.

1. Introduction

Capstone design courses offer engineering students an opportunity to apply the skills they have learned throughout their undergraduate education to an applied engineering project. One of the main goals of the senior design course is to engage students in a project with real world implications that are similar to those they will face once the student enters the work force.

UNC Charlotte currently offers a two-semester, multi-disciplinary senior design sequence that spans all of the departments within the College of Engineering (COE). Industry-sponsored and faculty funded research efforts comprise the projects for the senior design sequence. This is particularly advantageous for the industry sponsors, since these sponsors are afforded the opportunity to initiate elective research projects in their respective areas of interest while working closely with seniors that the company may be interested in recruiting. Students prioritize their interest in available projects through analysis of posted Statements of Work and the course instructors, who represent all departments and programs in the COE, form groups with three to four students containing diverse talents that would be representative of a typical engineering team in industry.

Students participating in the industry sponsored senior design program are expected to produce industry-standard deliverables throughout the two-semester course. The following documents are described in earlier papers[1,2,3] and include:

1. Requirements and Capabilities
2. Planning (Work Breakdown Structure, Schedule (Gantt Chart), Risk Assessment and Mitigation Plan)
3. Financial (Project Budget, Bill of Materials, Purchase Orders)
4. Engineering Notebook
5. Status Reports
6. Poster Presentation
7. Written Report – Semester I
8. Project Presentation
9. Written Report – Semester II

A group leader is identified by each team and held accountable for the production and updating of the project documents.

2. Rubrics

All documents are assessed by the course instructors, the project faculty mentors, and the project sponsor based on a system of grading rubrics suggested by Estell and Hurtig[4]. It should be noted that Estell and Hurtig developed only the following rubrics:

- Written Report
- Technical Design
- Oral Presentation
- Realistic Constraints (design)
- Web Site
- Poster

UNC Charlotte used the Estell and Hurtig rubrics as a ***basis*** of evaluation. The range of evaluation has been expanded to encompass all documentation and refined to reflect the importance of various aspects of each document. Each rubric is provided to the students before the assignment is due so that they may ensure their document meets the high-level of standards the sponsor will expect.

The nine rubrics defined were in use during the Fall 2008 semester. Based on observation of student performance, we determined that some modifications were needed to add weight to the actual design component of the project, not just the formatting and mechanics of the documentation. Therefore, the descriptions below refer to the old version of the rubric (Fall 2008) versus the new version of the rubric (Spring 2009).

2.1 Capabilities and Requirements Rubric

The Capabilities and Requirements grading rubric is used to assess a student's understanding of the project he or she is starting to design. Requirements Engineering is the disciplined application of scientific principles and techniques for developing, communicating, and managing requirements. Requirements will serve as the rubric by which anyone can verify that the end device has all the functionality the customer desires.

The rubric measures each of these components of the document:

- Capabilities: These represent the functionality of the end product, but are not necessarily bounds on what the product should do. These are not requirements, constraints, or specifications.
- Requirements: These specify specific behaviors of a system. They define the internal workings of the system: that is, the calculations, technical details, sizes, data manipulation and processing, and other specific functionality.
- Demonstration Test Plan: This plan should describe the tests and test steps needed to demonstrate the capabilities of the device.
- Acceptance Test Plan: This is written at the same time as the Requirements. The Test Plan represents the test and test steps needed to verify that the requirements have been met.

Since the established rubric assesses the student's ability to define each of these parts of the document, the originally defined rubric did not need to be changed. The rubric is included as the first document in Appendix A.

2.2 Planning Rubric

The Planning grading rubric is used to assess a student's planning documentation. This document represents the project Work Breakdown Structure (WBS), the schedule (Gantt chart), and the Risk Assessment.

The original methods of assessing the students work consisted of three different rubrics. All three rubrics were merged into one rubric called the Planning rubric with one format and one heading instead of three different forms.

The original WBS rubric assessment included measurements of time, tasks, and resources identified for the project. It did not include an assessment on time estimates for the design and implementation of the project. It was noted that some students scored well on this assignment but still lacked project quality. Therefore, with the new consolidated rubric, redundancy was eliminated and the content quality of the rubric was enhanced by adding measures for product design and product implementation. The new rubric is included as the second document in Appendix A.

2.3 Financial Rubric

The Financial grading rubric is used to assess the student's financial documentation. This document represents the project budget, bill of material (BOM), and the purchase order process. The original methods of assessing the students work consisted of two different rubrics.

The original BOM Rubric assessment included measurements of the format, heading, item description, cost and completeness. The Budget rubric measurements consist of the format, heading, development tools cost, materials cost (from BOM), and the labor cost.

The two rubrics were combined into one with only one measurement for the format and one for the heading, and one measurement was added to assess the purchase order. The new rubric was designed to emphasize merit of content, rather than reward the mechanics of completing the documentation correctly. The new rubric is included as the third document in Appendix A.

2.4 Engineering Notebook Rubric

The Engineering Notebook grading rubric is used to assess a student's engineering notebook kept as a part of the documentation of the project. This document details the calculations, sketches and day to day work on the technical portion of the project. The students are instructed to do this in a format that is appropriate to protect intellectual property rights. These notebooks are provided as a deliverable to project sponsors.

The original rubric included assessment measurements of individual components of proper notebook maintenance, such as; was the student's name written in the notebook or was the notebook legible to the reviewer, but did not include the standard level of mastery format of other rubrics used for the class. The original rubric did not include a technical assessment of the quality of the work done by the student. This rubric was modified for purposes of standardization and to provide quality assurance for the single most important deliverable to industrial sponsors of student projects.

The rubric was changed to comply with the format of other course rubrics, and now includes an assessment of project progress to address the previously perceived shortcoming. Additionally, weights were added to areas that assess the technical quality of the work done by the student group, reflecting the importance of substantive engineering work compared to documentation skills. The new rubric is included as the fourth document in Appendix A.

2.5 Status Report Rubric

The Status Report grading rubric is used to assess the progress of each project. Status reports are submitted twice during the first semester and biweekly during the second semester. The report should provide a brief synopsis of the project and work to date, outline the work completed since the last report, identify any issues that need immediate assistance, define the team's plans for the next 2-3 weeks and document communication with faculty mentor and sponsor. Students are

provided with a status report template and an example report for reference. The template includes a section for the faculty mentor's signature to help insure students are communicating with their mentor on a regular basis.

The original rubric included assessment measurements of format and organization, language, work completed, issues, plans and the signature of their faculty mentor, all of which were weighted equally. This equal distribution of points did not place enough emphasis on the work completed and allowed students to achieve a passing grade for the report by making small modifications to the provided template and only documenting a few details pertaining to their progress. Additionally, the original rubric did not allow for assessment of the student's weekly interaction with their faculty mentor and industry sponsor.

The rubric was modified to place more emphasis on the content of the work completed, and now includes an assessment of the documentation of weekly mentor meetings. The new rubric is included as the fifth document in Appendix A.

2.6 Poster Presentation Evaluation Rubric

The Poster Presentation Evaluation rubric is used to assess the project poster created for a joint sponsor, faculty and student dinner held at the end of the first semester. This document is a visual aid in the presentation of the project preliminary results to interested parties that attend the dinner, including college faculty, the sponsor, course faculty and the faculty project advisor. This activity satisfies a portion of the ABET requirement for oral communications by Engineering and Engineering Technology students since each group is evaluated by multiple individuals on their ability to convey pertinent information in a concise manner, and is also a helpful exposure to visual forms of communication not normally covered in a standard engineering curriculum.

The original rubric included assessment measurements of poster design mechanics, appropriate level of technical detail, ability to communicate design intent as well as perception of interaction with the reviewer and ability to handle pertinent questions. The rubric did not include an assessment of professional behavior by the students. The rubric was modified to include assessment of student dress and general appearance, since the participants are told to dress as if going on a job interview. Professional behavior evaluation was also added to prepare the students to be aware of what is said to others in the workplace.

The rubric was modified to include content on professional appearance and behavior, and now includes an assessment of these characteristics. The new rubric is included as the sixth document in Appendix A

2.7 Written Report Rubric- Semester I Rubric

The Written Report grading rubric is used to assess the first semester work of each group. This document represents the work the student team has performed in preparing their design solution.

It is expected that the documentation be complete such that another engineer could continue the project with minimal research.

The original rubric included assessment measurements of format, grammar, word choice, equations, charts and pictures and the use of references and appendices. It was found that this rubric left out technical content. A team's final report could excel in all the measurements but not contain sufficient technical information on the detail of the design so that another group of engineers could pick up the document and continue the project with little, if any, prior knowledge of the design. Reports submitted with little design detail could achieve passing grades.

The rubric was changed to include technical details, design, design documentation and implementation to address this shortcoming. The report is now expected to include the detailed bill of material, design files from the design system (CAD, Software Development, Mechanical Drawings, etc) as well as calculations that support the choices made in the design. (e.g. flow rates for pipe size, currents for conductor size and operation rates for software). The new rubric is included as the seventh document in Appendix A

2.8 Project Presentation Evaluation Rubric

The Project Presentation Evaluation rubric is used to assess the poster and project demonstration display (a model, prototype, documentation package or computer simulation or display) generated for a joint sponsor, faculty and student design exposition held at the end of the second semester. These deliverables are visual aids in the presentation of the project final results to interested parties that attend the expo, including: the general public, College faculty and students, sponsors, course faculty and faculty project mentors. The quality of the demonstration display assists evaluators in assessing the quality of the results achieved for the project. As for the first semester presentation, this activity satisfies a portion of the ABET requirement for oral communications by Engineering and Engineering Technology students, and is also a head start on learning to interact with non-technical audiences the students are sure to encounter in the workplace.

The original rubric included assessment measurements of poster design mechanics, appropriate level of technical detail, ability to communicate design intent as well as perception of interaction with the reviewer and ability to handle pertinent questions. The rubric did not include an assessment of professional behavior by the students or an evaluation of the demonstration display produced by the students. The rubric was also modified to include assessment of student professional appearance and interaction with the reviewer, as was done in the poster evaluation rubric. An assessment of how the demonstration display enhanced, supported or detracted from the project results presented was also added.

As was the case with the Engineering Notebook rubric, weights were added to areas that assess the technical quality of the work done by the student group, reflecting the importance of

substantive engineering work instead of exclusively mechanics of documentation. These weights also serve to provide separation of scores, since this rubric is used as the assessment mechanism for an end of semester and end of course sequence design exposition, where the students compete for cash awards based on the quality of their work. The new rubric is included as the eighth document in Appendix A

2.9 Written Report Rubric- Semester II Rubric

The second semester Written Report grading rubric is used to assess the ability of each team to document final accomplishments of the project. This document represents the work the student team has performed in preparing the design, implementation and test of the solution to the problem and should contain enough information so that others may duplicate that work with minimal design effort.

The original rubric included assessment measurements of format, grammar, word choice, equations, charts and pictures and the use of references and appendices. It was found that this rubric left out technical content. A team's final report could excel in all the measurements but not contain sufficient technical information of the detail of the design so that another group of engineers could pick up the document and duplicate or even maintain the project with little if any prior knowledge of the design.

It was found that some teams did not include their CAD drawings of mechanical parts, schematics for electronic assemblies or code listings for software projects so that maintenance of these projects could be performed by capable people. A CD pocket in the laboratory notebook was provided but seldom used for "soft" documents (see lab notebook rubric for details).

The rubric was changed to include technical details, design, design documentation and test to address this shortcoming. The report is now expected to include the detailed design files from the design system (CAD, software development, mechanical drawings, etc) as well as calculations that support the choices made in the design. (e.g. flow rates for pipe size, currents for conductor size and operation rates for software). Test results are expected and documentation of engineering changes to the design as a result of test shortcomings are encountered. The new rubric is included as the ninth document in Appendix A

2.10 Technical Design Rubric

The technical design grading rubric is used to provide a summary evaluation of the entire two semester project. The rubric is intended to address all major topics in project development and completion, from identification and background research, to determination and implementation of a substantiated project plan, to the final prototype and verification of the design. A separate item with respect to the technical level of the project is present on the rubric to ensure more technically challenging projects are recognized. As with all rubrics utilized in the senior design

sequence, student teams are evaluated in the standard Expert, Practitioner, Apprentice and Novice categories for each of seven criteria.

The original rubric has not been substantially revised, but has been modified to clarify requirements and the distinction between categories of performance. The revised rubric is included as the tenth document in Appendix A

3. Conclusions

The rubrics developed for this Senior Design program are easy for faculty mentors and course instructors to assign a consistent score to student work. These rubrics also are useful for assembling assessments for ABET reports for all departments involved.

While it is too early to measure if the change to these rubrics are successfully affecting the design content of the projects, the faculty feel the students are including more detail on design content and activities in their project documentation.

We will continue to monitor student success in the course and adjust the assignments (and, hence, the grading rubrics) when needed to improve student learning.

4. References

1. James M. Conrad, "Determining How to Teach Project Management Concepts to Engineers," Proceedings of the 2006 ASEE Conference, Chicago, IL, June 2006.

2. James M. Conrad, Daniel Hoch, and Frank Skinner, "Student Deliverables and Instruction for a Senior Design Program Course," Proceedings of the 2007 ASEE Conference, Honolulu, HI, June 2007.

3. James M. Conrad, Daniel Hoch, William Heybruck, Peter Schmidt, Martin Kane, Linda Thurman, and Frank Skinner, "Working with Industry Sponsors in a Multidisciplinary Senior Design Program," Proceedings of the 2008 ASEE Conference, Pittsburgh, PA, June 2008.

4. Estell, John K; Hurtig, Juliet, "Using Rubrics for the Assessment of Senior Design Projects", Proceedings of the 2006 ASEE Annual Conference & Exposition: Excellence in Education; Chicago, IL; USA; 18-21 June 2006.

A. Appendix

Attached to the end of this paper are the actual rubric instruments used for the subject senior design course.

UNC Charlotte COE Senior Design - Requirements Report Rubric

Project: _____ Date: _____ Score: _____/21

	3 - Expert	2 – Practitioner	1 - Apprentice	0 - Novice
Visual Format and Organization Score: _____	• Group has used the suggested template. • The document is visually appealing and easily navigated. • Appropriate typography and usage of white space are used as appropriate to separate blocks of text and add emphasis.	• Group has used the suggested template. • The document is organized. • Use of white space and typography help the reader navigate the document, although the layout could be more effective.	• Group may or may not have used the suggested template. • Errors in the Table of Contents are present. • Within sections, the order in which ideas are presented is occasionally confusing.	• Group has not used the suggested template. • The document is not visually appealing and there are few "cues" to help the reader navigate the document. • There is no apparent ordering of paragraphs.
Language (Word Choice, Grammar) Score: _____	• Sentences are complete and grammatical. They flow together easily. • Words are chosen for their precise meaning. • Engineering terms and jargon are used correctly. • No misspelled words are present.	• Mostly, sentences are complete & grammatical; they flow together easily. Any errors are minor and do not distract the reader. • Repetition of words and phrases is mostly avoided. • Mostly, terms/jargon are used correctly with some attempt to define them. • There are one or two misspelled words.	• In a few places, errors in sentence structure and grammar distract the reader and interfere with meaning. • Word choice could be improved. • Occasionally, technical jargon is used without definition. • There are a few misspelled words.	• Errors in sentence structure and grammar frequently distract the reader. • There is unnecessary repetition of the same words and phrases. • There is an overuse of jargon and technical terms without definition. • There are many misspelled words.
Capabilities Score: _____	• All items are assigned a unique identifier (i.e. CAP001). • Items represent function-ality of the end product, but are not necessarily bounds on the product. • These are not requirements, constraints, or specifications.	• Many, but not all items are assigned a unique identifier. • Most items represent functionality of the end product, but are not necessarily bounds. • A few capabilities appear to be constraints or specifications.	• Few, if any, items are assigned a unique identifier. • Listed capabilities do not fully describe the desired operation of the system. • Many capabilities appear to be constraints or specifications.	• No items are assigned a unique identifier. • Listed capabilities do not describe the desired operation of the system.
Requirements Score: _____	• All items are assigned a unique identifier. • Functional req.: Specify specific behaviors/ workings of the system: calculations, technical details, sizes, data use and processing. • Non-functional req.: Specify specific behaviors of the system or criteria that can be used to judge the operation of system.	• Many, but not all items are assigned a unique identifier. • For the most part, functional requirements identify the workings of the system. • For the most part, non-functional requirements identify specific behaviors of the system.	• Few, if any, items are assigned a unique identifier. • Specific bounds on the problem are not specified, or are poorly specified. • If specific bounds are offered, many seem unrealistic.	• No items are assigned a unique identifier. • Listed requirements do not bound the desired workings of the system. • If specific bounds are offered, most seem unrealistic.
Demo Test Plan Score: _____	• Plan describes the tests and test steps needed to demonstrate the capabilities of the device. • Each test indicates which capability is being verified. All capabilities are verified by at least one test.	• Plan describes the tests and test steps needed to demonstrate most of the capabilities of the device. • Most capabilities are verified by at least one test.	• Plan describes a few tests and test steps needed to demonstrate some of the capabilities of the device, but the plan in not thorough. • Many capabilities are verified by at least one test.	• Plan describes a very small number of tests and test steps needed to demonstrate a small part of the capabilities of the device. • Tests poorly demonstrate capabilities of system.
Acceptance Test Plan Score: _____	• Plan describes complete test steps needed to verify that the requirements have been met. • Each test verifies at least one specific requirement. All reqmts. are verified by one or more test. • Plan consists of specific tests, each w/detailed test steps, and each noting which requirement is addressed.	• Includes most tests needed to verify that the requirements have been met. • Most requirements have been verified by at least one test. • Most tests have detailed test steps, with each noting which requirement has been addressed.	• Plan describes a few tests and test steps needed to demonstrate some of the requirements of the device, but the plan in not thorough. • Many requirements are verified by at least one test.	• Plan describes a very small number of tests and test steps needed to verify system requirements of the device. • Tests poorly verify the system requirements.
Use of Subject Matter Experts and Sources Score: _____	• Prior work and sources of requirements are acknowledged by referring to people, assumptions, and background.	• With an occasional oversight, prior work & sources of requirements are acknowledged by referring to people, assumptions & bkground.	• On several instances, sources of requirements are not stated when appropriate.	• Little attempt is made to identify the source of requirements.

UNC Charlotte COE Senior Design – Planning Rubric

Project: _____ Date: _____ Score: _____/ 18

	3- Expert	2 – Practitioner	1– Apprentice	0 – Novice
Format and Heading Score: _____	• Group has used suggested format. • Project title, date, and revision number are correct	• Group has not used suggested format or the project title, date, and revision number are incorrect, but report is still readable.	• Group has not used suggested format. Project title, date, and revision number are not correct.	• Effort is difficult to follow due to formatting.
Product Design and Implementation Score: _____	• Sufficient time and good plan are identified for the design. • Sufficient time is assigned for the implementation of the project.	• The time allocated for the design, and the working plans are realistic, but some key tasks are missing.	• The time allocated for the design, and the working plans are not realistic. Minor tasks are identified with the appropriate time.	• The time allocated for the design, implementation, and the working plans are not realistic, and key tasks are missing.
Tasks, Time of effort and Resources Identified Score: _____	• All of the conceivable tasks needed for the project have been identified and listed, and have at least one team member identified as the assigned resource. • All tasks have been given an appropriate amount of effort (man hours) to complete.	• All tasks and resources have been listed, but some are not realistic. • Some tasks have missing team member assigned to the resources. • Estimates are realistic	• While resources and some tasks have been listed, some are not realistic, and some tasks are missing from the effort. • Some estimates are not realistic	• Tasks have not been listed. • Resources are not realistic. • Tasks are missing from the effort. • All tasks have not been given an appropriate amount of effort (man hours) to complete.
Sponsor and Mentor Effort Score: _____	• The appropriate effort (task and time) of the Sponsor and the Mentor have been identified.	• The task and time of the Sponsor has been identified. • Some of the task and time effort of the mentor has been identified..	• The task and time of the Sponsor has been identified. • While the task and time effort of the mentor has not been identified	• The effort (task and time) of both Sponsor and mentor have not been identified.
Item Description and project Flow of the schedule plan Score: _____	• The work breakdown structure and schedule items match. • The correct precedence and project flow have been identified.	• The work breakdown structure and schedule items mostly match. • The correct precedence and project flow have been identified.	• The work breakdown structure and schedule items poorly match. • The project flow is poor and illogical.	• The work breakdown structure and schedule items do not match. • The schedule does not have the appropriate precedence • Project flow is poor and illogical.
Risks and Responses Identified Score: _____	• Appropriate risks have been identified with the appropriate responses. • Risks have been scored based on appropriate probability.	• Appropriate risks have been identified with the appropriate responses. • Some risks have been scored. • Some risks have no response plans.	• Few risks have been identified • Risks have not been appropriately scored. • Some risks have no response plans	• Risks have not been identified

UNC Charlotte COE Senior Design – Financial Rubric

Project: _____ Date: _____ Score: _____/ 18

	3- Expert	2 – Practitioner	1– Apprentice	0 – Novice
Format and Heading Score: _____	• Group has used suggested format. • Project title, date, and revision number are correct	• Group has not used suggested format or the project title, date, and revision number are incorrect, but report is still readable.	• Group has not used suggested format. Project title, date, and revision number are not correct.	• Effort is difficult to follow due to formatting.
Bill of Material Item Description and completeness Score: _____	• Item description, quantity, price per unit, total price, and vendor name have all been identified in the bill of material. • BOM is complete. It includes all materials that should be in the device and project.	• Almost 75% of the parts needed to complete this project have been identified in the BOM.	• Almost 25% of the parts needed to complete this project have been identified in the BOM.	• Item description, quantity, price per unit, total price, and vendor name have not been specified in the bill of material. • BOM is incomplete.
Bill of Material Total cost Score: _____	• The total cost has been calculated. • The total cost includes the cost of all parts, final assembly, and subassemblies.	• The total cost has been calculated, but it is not complete.	• The total cost includes the cost of some parts.	• The total cost has not been calculated. • The total cost does not include the cost of all parts, final assembly, and subassemblies.
Budget Plan for Development tools and Labor Score: _____	• The Budget plan includes all Labor cost, all development materials (i.e. tools, software, books, etc.) needed to complete the project.	• All labor hours have been included in the budget plan. • Some of the development tools have been listed in the budget.	• Some labor hours have been listed in the budget plan.	• .Development tools has not been identified • Labor hours have not been listed in the budget.
Final Budget plan Score: _____	• Cost from the Bill of Material matches the budget plan cost. • The budget plan includes all Development cost.	• Cost from the Bill of Material matches the budget plan cost. • The budget plan does not include the Development cost.	• . The budget plan includes some of the Development cost.	• Budget plan is not available
Purchase order Score: _____	• All the parts needed to complete the project have been listed in the Purchase order	• Almost all parts needed for the project were identified in the purchase order.	• Some of the parts needed for the project were identified in the Purchase order.	• The Purchase order was not submitted on time.

UNC Charlotte COE Senior Design - Engineering Notebook Rubric

Project: _____ **Date:** _____ **Score:** _____ **/ 24**

	3 - Expert	2 - Practitioner	1 - Apprentice	0 – Novice
Notebook Mechanics Score: _____	• Student name, phone number and email address are included inside front cover • Project sponsor and project year are included inside front cover • Table of contents has been maintained • Entries are sequential and any blank space has been crossed out	• Student name, phone number and email address are included inside front cover • Project sponsor and/or project year have not been included • Table of contents has been maintained • Entries are sequential and any blank space has been crossed out	• Student name, phone number or email address is missing • Table of contents has not been maintained, some content is not referenced • Some blank space has not been properly treated in the notebook	• Most contact information is missing • The table of contents is confusing or not present • The notebook has non-sequential entries • Pages have been skipped in the notebook
Intellectual Property Maintenance Score: _____	• The notebook is written completely in pen • The notebook is legible to the reviewer • All pages have been signed by the author • All entries by the author are dated	• The notebook is written completely in pen • The notebook is not completely legible to the reviewer • All pages have been signed by the author • All entries by the author are dated	• The notebook is not written completely in pen, some entries are in pencil • The notebook is not completely legible to the reviewer • One or two pages are missing either signature or date	• Most notebook entries are in pencil • The notebook is not legible to the reviewer • Three or more pages are missing either signature or date
Supplemental Material Score: _____	• Appropriate supplemental material is included in the notebook • Supplemental material is affixed permanently to the pages of the notebook as described in the course notebook guidelines	• No supplemental material is included • Supplemental material is improperly affixed in one instance • The material has been affixed well enough to stay in the notebook	• Supplemental material is improperly affixed in more than one instance • The material is in danger of being lost, but is included for submission	• Supplemental material is obviously required but not included • Supplemental material is obviously required, was attached and is now missing
Project Progress Score: _____ (x 3) Weighted Score:_____	• The project is well documented in the notebook • The notebook has obviously been maintained as an ongoing project, not rewritten as a secondary exercise • A non-expert engineer could recreate the work done to date and continue the project	• The project is fairly well documented in the notebook • The notebook has been partially maintained as an ongoing project, with some rewriting • A non-expert engineer could recreate the work done to date with some additional research and continue the project	• The project is not well documented in the notebook • The notebook has been rewritten from other notes • A non-expert engineer would have difficulty recreating the work done to date, causing a project delay while recreating missing information	• The project is not documented in the notebook • The notebook is incomplete, confusing or otherwise useless to someone other than the author • A non-expert engineer would have to restart the project to assure proper results
Project Research Score: _____ (x 2) Weighted Score:_____	• There is evidence of basic discovery in the notebook. • Multiple areas of engineering study have been integrated and applied to the project • The technical basis for the project is of high quality, with possibly publishable results	• There is evidence of new engineering that has been done to expand on or integrate undergraduate topics • Undergraduate concepts have been applied properly to the project • A basis for executing the project successfully has been presented	• Some undergraduate level material has been improperly applied to the project • No work to expand student understanding or capability is evident • The notebook does not provide a complete technical basis to execute the project	• No original engineering work is present • Incomplete knowledge of undergraduate courses is evident • The technical content of the notebook indicates little or no effort was made to solve basic problems associated with the project

UNC Charlotte COE Senior Design – Status Report Rubric

Project: _____ **Date:** _____ **Score:**_____/ 21

	3 - Expert	2 – Practitioner	1 - Apprentice	0 - Novice
Visual Format, Organization and Language ***(Word Choice, Grammar)*** **Score: _____**	• Group has used the suggested template. • Sentences are complete and grammatical. They flow together easily. • No misspelled words are present.	• Group has used the suggested template. • Mostly, sentences are complete and grammatical, and they flow together easily. • There are one or two misspelled words.	• Group may or may not have used the suggested template. • Word choice could be improved. • There are a few misspelled words.	• Group has not used the suggested template. • Word choice is poor. • There are many misspelled words.
Work Completed **Score: ___*3=____**	• All previous plans from earlier reports are now completed or at least addressed. • Accomplishments related to the Requirements and Capabilities document have been identified. • Accomplishments are explained thoroughly enough to be reproduced. • Short comings are identified and requirements change requests have been submitted.	• Most of the previous plans from earlier reports are now completed or at least addressed. • Many, but not all, accomplishments related to the Requirements and Capabilities document have been identified. • Many, but not all, accomplishments are explained thoroughly enough to be reproduced. • Many, but not all, short comings are identified and requirements change requests have been submitted.	• Few, if any, previous plans from earlier reports are now completed or at least addressed. • Few, if any, accomplishments related to the Requirements and Capabilities document have been identified. • Few, if any, accomplishments are explained thoroughly enough to be reproduced. • Few, if any, short comings are identified and requirements change requests have been submitted.	• No previous plans from earlier reports are now completed or at least addressed. • No accomplishments related to the Requirements and Capabilities document have been identified. • No accomplishments are explained thoroughly enough to be reproduced. • No short comings are identified and requirements change requests have been submitted.
Issues **Score: _____**	• Problems or road blocks that require the assistance of the faculty mentor, sponsor, or course instructor have been clearly identified. • Risk assessment document has been updated as needed.	• Many, but not all, problems or road blocks that require the assistance of the faculty mentor, sponsor, or course instructor have been clearly identified. • For the most part, the risk doc. has been updated as needed.	• Few, if any, problems or road blocks that require the assistance of the faculty mentor, sponsor, or course instructors have been clearly identified. • Little work has been done to update the risk assessment document as needed.	• No problems or road blocks that require the assistance of the faculty mentor, sponsor, or course instructor have been clearly identified. • No work has been done to update the risk assessment document as needed.
Plans **Score: _____**	• The plans defined in the Gantt and Work Breakdown Structure (WBS) document have been followed and are on schedule. • Adjustments to the schedule and WBS have been made as necessary.	• Many, but not all, of the plans defined in the Gantt and WBS document have been followed and are on schedule. • Many, but not all, adjustments to the schedule and WBS have been made as necessary.	• Few, if any, of the plans defined in the Gantt and WBS document have been followed and are on schedule. • Few, if any, adjustments to the schedule and WBS have been made as necessary.	• None of the plans defined in the Gantt and WBS document have been followed and are on schedule. • No adjustments to the schedule and WBS have been made as necessary.
Communication with faculty mentor and industry sponsor **Score: _____**	• Group has maintained an appropriate amount of communication with mentor and sponsor.	• Group has a made an adequate attempt to communicate with mentor and sponsor.	• Group has made little attempt to communicate with mentor and sponsor. • Mentor has not signed status report.	• Group has made no attempt to communicate with mentor and sponsor. • Mentor has not signed status report.

UNC Charlotte COE Senior Design - Poster Presentation Evaluation Rubric (Semester 1)

Project: _____ **Date:** _____ **Score:** _____ / 18

	3 - Expert	2 - Practitioner	1 - Apprentice	0 – Novice
Poster Mechanics Score: _____	• The poster is exceptionally attractive in terms of design, layout, and neatness. • Graphics are easily viewed and are related to the topic, making the material easier to understand. • There are no grammatical mistakes on the poster.	• The poster is acceptably attractive. • Most graphics are easily viewed and relate to the topic. • There is one grammatical mistake on the poster.	• The poster is a bit messy. • Many graphics are not clear or are too small. • There are two grammatical mistakes.	• The poster is distractingly messy or very poorly designed. It is not attractive. • Graphics do not relate to the topic. • There are more than two grammatical mistakes on the poster.
Technical Details Score: _____	• High level of relevant detail is presented to allow the audience to make judgments about the content. The details are not so elaborate that the presentation becomes tedious.	• Sufficient technical detail is included to enable the audience to understand the nature of progress.	• In places, the information was too detailed or was lacking.	• Significant amounts of technical detail are lacking or inadequate so that the audience cannot appreciate the progress that has been made.
Design and Planned Implementation Score: _____	• Presentation includes thorough description of design and planned implementation of the design, including expected results.	• Presentation includes sufficient information to assess the value of the design.	• Presentation does not include enough information to assess design.	• Design seems disorganized and not well conceived.
Presentation Level Score: _____	• The audience's interests are piqued and well considered. • The audience's attention has been drawn and engaged.	• The audience's knowledge level and interests have been considered. • The audience's attention has been maintained.	• Some opportunities for adjusting the presentation level for the audience have been missed. • The audience's attention is weak.	• The knowledge level of the audience has not been considered. • The audience is not paying attention.
Handling of Questions Score: _____	• Presenters demonstrate full knowledge of the material and can explain and elaborate on expected questions.	• Presenters have sufficient knowledge of the material to answer expected questions.	• Presenters have difficulty answering expected questions beyond a rudimentary level.	• Presenters cannot answer expected questions.
Professional Interaction Score: _____	• All team members are dressed in a professional manner, as would be expected for a job interview • Team members are polite and engage the reviewer with appropriate conversation	• One team member is dressed inappropriately • Team members are polite and engage the reviewer with appropriate conversation	• More than one team member is dressed inappropriately • Team members are impolite, make inappropriate comments or otherwise make the reviewer uncomfortable speaking with the group	• Anyone from the team makes a derisory, sexist or otherwise unprofessional comment that could lead to disciplinary action when employed

Evaluator: _____

UNC Charlotte COE Senior Design – Written Report Rubric – Semester I

Project: _____ **Date:** _____ **Score:** _____/24

	3 - Expert	2 – Practitioner	1 - Apprentice	0 - Novice
Content Score: _____	• Content of the report conveys all of the detail of the project and device. • An engineer can build the project based on the report.	• Content conveys most of the project detail. • An engineer might be able to build the project based on the report.	• Content conveys much of the project detail. • An engineer would have difficulty building the project based on the report	• Content conveys little of the project detail. • An engineer would not be able to build the project based on the report
Visual Format and Organization Score: _____	• The document is visually appealing and easily navigated. • Appropriate typography and usage of white space are used as appropriate to separate blocks of text and add emphasis.	• The document is organized. • Use of white space and typography help the reader navigate the document, although the layout could be more effective.	• Errors in the Table of Contents are present. • Within sections, the order in which ideas are presented is occasionally confusing.	• The document is not visually appealing and there are few "cues" to help the reader navigate the document. • There is no apparent ordering of paragraphs.
Language (Word Choice, Grammar) Score: _____	• Sentences are complete and grammatical. They flow together easily. • Words are chosen for their precise meaning. • Engineering terms and jargon are used correctly. • No misspelled words are present.	• For the most part, sentences are complete and grammatical, and they flow together easily. Any errors are minor and do not distract the reader. • For the most part, terms and jargon are used correctly with some attempt to define them. • There are one or two misspelled words.	• In a few places, errors in sentence structure and grammar distract the reader and interfere with meaning. • Word choice could be improved. • Occasionally, technical jargon is used without definition. • There are a few misspelled words.	• Errors in sentence structure and grammar frequently distract the reader. • There is unnecessary repetition of the same words and phrases. • There is an overuse of jargon and technical terms without definition. • There are many misspelled words.
Technical Details	• High level of relevant detail is provided to allow other engineers to understand the design, re-create the choices made and to continue the development of the solution if necessary	• Sufficient detail is provided to allow another engineer to continue development with some minor backtracking necessary.	• An accomplished engineer would have difficulty carrying forward the design without significant work to understand what has been done.	• Significant amounts of detail are missing. An engineer would have little use of the report to continue the project.
Design and Documentation	• There is a thorough description of the theory of operation, design details (CAD Drawings, Schematics, Pseudocode/flow charts) • Easy and ready to implement	• Drawings and design details are present but a description of the theory is insufficient. • Can be implemented	• Not enough design documentation to carry forth the design without significant investigation • Difficult to implement	• The design as documented may not work. • Implementation plan is lacking.
Equations, Numerical Usage, and Illustrations Score: _____	• All equations are clear, accurate, and labeled. All variables are defined and units specified. Discussion regarding the equation development is stated. • All figures, graphs, charts, and drawings are accurate, consistent with the text, and of good quality. They enhance understanding of the text. • All items are labeled in accordance with engineering standards and are referred to in the text.	• Most equations are accurate and clear. Most variables are defined and units specified. With some minor exceptions, adequate discussion regarding the equation development is stated. • For the most part, illustrations are accurate, consistent with the text, and of good quality. • All items are generally labeled in accordance with engineering standards and are referred to in the text.	• Most equations are accurate. Too many variables are not defined. Discussion regarding the development and usage of the equation is unclear. • In some cases, illustrations are not conveying information clearly. • While items are labeled, references to these items are missing.	• There may be inaccuracies within the equation. Little or no attempt is made to make it easy for the reader to understand the use of an equation or its derivation. • Figures, graphs, charts, and drawings are of poor quality, have numerous inaccuracies and mislabeling, or may be missing. • There is no corresponding explanatory text for included items.
Use of references Score: _____	• Prior work is acknowledged by referring to sources for theories, assumptions, quotations, and findings. • References are exact with author, journal, volume number, page number, and year.	• With an occasional oversight, prior work is acknowledged by referring to sources. • With some minor exceptions, references are exact with author, journal, volume number, page number, and year.	• On several instances, references are not stated when appropriate. • Bibliographical entries are not complete.	• Little attempt is made to acknowledge the work of others. • Most references that are included are inaccurate or unclear.
Use of appendices Score: _____	• Information is placed appropriately in either the main text or an appendix. • Appendices are documented and referenced in the text.	• Appendices are used when appropriate. • Selection and/or extent of material in appendix may not be optimal.	• While appendices are present, material in appendix is not referred to properly in text. • Content in appendix is not complete.	• Appendices were not utilized when appropriate. • There is unnecessary inclusion of detailed information in the main body of the text.

UNC Charlotte COE Senior Design - Project Presentation Evaluation Rubric (Semester 2)

Project: _____ **Date:** _____ **Score:** _____ / 27

	3 - Expert	2 - Practitioner	1 - Apprentice	0 – Novice
Poster Mechanics Score: _____	• The poster is exceptionally attractive in terms of design, layout, and neatness. • Graphics are easily viewed and are related to the topic, enhancing the presentation • There are no grammatical mistakes on the poster.	• The poster is acceptably attractive. • Most graphics are easily viewed and relate to the topic. • There is one grammatical mistake on the poster.	• The poster is a bit messy. • Many graphics are not clear or are too small. • There are two grammatical mistakes.	• The poster is distractingly messy or very poorly designed. It is not attractive. • Graphics do not relate to the topic. • There are more than two grammatical mistakes on the poster.
Technical Details Score:_____ (x 2) Weighted Score:_____	• High level of relevant detail is presented to allow the audience to make judgments about the content. The details are not so elaborate that the presentation becomes tedious.	• Sufficient technical detail is included to enable the audience to understand the nature of progress.	• In places, the information was too detailed or was lacking.	• Significant amounts of technical detail are lacking or inadequate so that the audience cannot appreciate the progress that has been made.
Design and Planned Implementation Score:_____ (x 2) Weighted Score:_____	• Presentation includes thorough description of design and implementation of the design, including results.	• Presentation includes sufficient information to assess the value of the design and its implementation.	• Presentation does not include enough information to assess the value of the design and its implementation.	• Design and implementation seems disorganized and not well conceived.
Presentation Level Score: _____	• The audience's interests are piqued and well considered. • The audience's attention has been drawn and engaged.	• The audience's knowledge level and interests have been considered. • The audience's attention has been maintained.	• Some opportunities for adjusting the presentation level for the audience have been missed. • The audience's attention is weak.	• The knowledge level of the audience has not been considered. • The audience is not paying attention.
Handling of Questions Score: _____	• Presenters demonstrate full knowledge of the material and can explain and elaborate on expected questions.	• Presenters have sufficient knowledge of the material to answer expected questions.	• Presenters have difficulty answering expected questions beyond a rudimentary level.	• Presenters cannot answer expected questions.
Project Demonstration Display Score: _____	• A model, prototype, documentation set or computer simulation is present that enhances the reviewer's understanding and augments the presentation of results	• A model, prototype, documentation set or computer simulation is present that supports the presentation of results	• A model, prototype, documentation set or computer simulation is present but it is unclear to the reviewer that it is relevant to project results	• There is no work product displayed by the team
Professional Interaction Score: _____	• All team members are dressed in a professional manner, as would be expected for a job interview • Team members are polite and engage the reviewer with appropriate conversation	• One team member is dressed inappropriately • Team members are polite and engage the reviewer with appropriate conversation	• More than one team member is dressed inappropriately • Team members are impolite, make inappropriate comments or otherwise make the reviewer uncomfortable speaking with the group	• Anyone from the team makes a derisory, sexist or otherwise unprofessional comment that could lead to disciplinary action when employed

Evaluator: _____

UNC Charlotte COE Senior Design – Written Report Rubric – Semester I

Project: _____ **Date:** _____ **Score:** _____/24

	3 - Expert	2 – Practitioner	1 - Apprentice	0 - Novice
Content Score: _____	• Content of the report conveys all of the detail of the project and device. • An engineer can build the project based on the report.	• Content conveys most of the project detail. • An engineer might be able to build the project based on the report.	• Content conveys much of the project detail. • An engineer would have difficulty building the project based on the report	• Content conveys little of the project detail. • An engineer would not be able to build the project based on the report
Visual Format and Organization Score: _____	• The document is visually appealing and easily navigated. • Appropriate typography and usage of white space are used as appropriate to separate blocks of text and add emphasis.	• The document is organized. • Use of white space and typography help the reader navigate the document, although the layout could be more effective.	• Errors in the Table of Contents are present. • Within sections, the order in which ideas are presented is occasionally confusing.	• The document is not visually appealing and there are few "cues" to help the reader navigate the document. • There is no apparent ordering of paragraphs.
Language (Word Choice, Grammar) Score: _____	• Sentences are complete and grammatical. They flow together easily. • Words are chosen for their precise meaning. • Engineering terms and jargon are used correctly. • No misspelled words are present.	• For the most part, sentences are complete and grammatical, and they flow together easily. Any errors are minor and do not distract the reader. • For the most part, terms and jargon are used correctly with some attempt to define them. • There are one or two misspelled words.	• In a few places, errors in sentence structure and grammar distract the reader and interfere with meaning. • Word choice could be improved. • Occasionally, technical jargon is used without definition. • There are a few misspelled words.	• Errors in sentence structure and grammar frequently distract the reader. • There is unnecessary repetition of the same words and phrases. • There is an overuse of jargon and technical terms without definition. • There are many misspelled words.
Technical Details	• High level of relevant detail is provided to allow other engineers to understand the design, re-create the choices made and to continue the development of the solution if necessary	• Sufficient detail is provided to allow another engineer to continue development with some minor backtracking necessary.	• An accomplished engineer would have difficulty carrying forward the design without significant work to understand what has been done.	• Significant amounts of detail are missing. An engineer would have little use of the report to continue the project.
Design and Documentation	• There is a thorough description of the theory of operation, design details (CAD Drawings, Schematics, Pseudocode/flow charts) • Easy and ready to implement	• Drawings and design details are present but a description of the theory is insufficient. • Can be implemented	• Not enough design documentation to carry forth the design without significant investigation • Difficult to implement	• The design as documented may not work. • Implementation plan is lacking.
Equations, Numerical Usage, and Illustrations Score: _____	• All equations are clear, accurate, and labeled. All variables are defined and units specified. Discussion regarding the equation development is stated. • All figures, graphs, charts, and drawings are accurate, consistent with the text, and of good quality. They enhance understanding of the text. • All items are labeled in accordance with engineering standards and are referred to in the text.	• Most equations are accurate and clear. Most variables are defined and units specified. With some minor exceptions, adequate discussion regarding the equation development is stated. • For the most part, illustrations are accurate, consistent with the text, and of good quality. • All items are generally labeled in accordance with engineering standards and are referred to in the text.	• Most equations are accurate. Too many variables are not defined. Discussion regarding the development and usage of the equation is unclear. • In some cases, illustrations are not conveying information clearly. • While items are labeled, references to these items are missing.	• There may be inaccuracies within the equation. Little or no attempt is made to make it easy for the reader to understand the use of an equation or its derivation. • Figures, graphs, charts, and drawings are of poor quality, have numerous inaccuracies and mislabeling, or may be missing. • There is no corresponding explanatory text for included items.
Use of references Score: _____	• Prior work is acknowledged by referring to sources for theories, assumptions, quotations, and findings. • References are exact with author, journal, volume number, page number, and year.	• With an occasional oversight, prior work is acknowledged by referring to sources. • With some minor exceptions, references are exact with author, journal, volume number, page number, and year.	• On several instances, references are not stated when appropriate. • Bibliographical entries are not complete.	• Little attempt is made to acknowledge the work of others. • Most references that are included are inaccurate or unclear.
Use of appendices Score: _____	• Information is placed appropriately in either the main text or an appendix. • Appendices are documented and referenced in the text.	• Appendices are used when appropriate. • Selection and/or extent of material in appendix may not be optimal.	• While appendices are present, material in appendix is not referred to properly in text. • Content in appendix is not complete.	• Appendices were not utilized when appropriate. • There is unnecessary inclusion of detailed information in the main body of the text.

UNC Charlotte COE Senior Design II – Technical Design Rubric

Project: _____ Date: _____ Score:_____/ 30

	3 - Expert	2 – Practitioner	1 - Apprentice	0 - Novice
Identification of the problem or task Score: _____	The problem statement is clear, concise and complete and is fully substantiated with supporting factual evidence.	A problem statement has been articulated and some evidence has been provided.	The problem statement is ambiguous and has weak support.	Problem has not been stated clearly and lacks any supporting evidence.
Research and information gathering Score: _____	Existing solutions to the problem, including their strengths and weaknesses, have been thoroughly investigated, analyzed and discussed.	Existing solutions have been stated. Additional discussion may be warranted in places.	A review of existing solutions and research related to this problem is not adequately presented.	Connection between references and what is written is not clear. Little or no research has been performed.
Definition of the project Score: _____	• There are clear expectations of the specific outputs or deliverables for the project. • A complete set of measurable performance objectives has been created.	• Mostxpectations have been stated. • Some objectives may not be measurable.	• Some expectations have been stated. • Most objectives are not measurable.	• Expectations are not clear or are missing. • Objectives are not measurable or are missing.
Execution of the plan Score: _____	• All major points of the project were completed. • 100 to 90 percent of the requirements were met.	• Most major project points of the project were accomplished. • 89 to 80 percent of the requirements were met.	• Few of the major project points were accomplished. • 79 to 70 percent of the requirements were met.	• None of the major project points were accomplished. • Less than 70 percent of the requirements were met.
Verification of the design *2 Score: _____	The prototype/model has been tested/simulated against the performance requirements listed in the definition of the project and has successfully met criteria.	The prototype/model has not been fully developed or tested/simulated.	Little verification of design was accomplished.	No verification of design was accomplished.
Project Scheduling Score: _____	A complete plan stating the cost, completion date, and required resources has been presented. Gantt charts and a budget spreadsheet have been thoroughly maintained and updated.	Some aspects of the plan have not been fully developed and some of the plan was not followed.	Few aspects of the plan have been developed and much of the plan was not followed.	Lack of planning is evident. A plan was not used.
Technical level of project *3 Score: _____	A significant portion of this project involves technical information or expertise which is an extension of the undergraduate curriculum.	Several technical aspects were new to the students and required research for successful completion.	This project contains some research but mostly involves technical information taught at the junior and senior levels.	This project did not challenge the students to perform much research, as it relied mainly on information taught within the curriculum.