AC 2010-1215: FOSTERING ENTREPRENEURSHIP WHILE TEACHING DESIGN

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Fostering Entrepreneurship while Teaching Design

Abstract

Rowan University has a unique 8-semester Engineering Clinic sequence. This sequence helps develop professional skills identified in the ABET A-K criteria though project-based-learning. The Freshman Engineering Clinics are an introduction to the profession, teamwork, and measurements. The Sophomore Engineering Clinics provide an introduction to technical communication and engineering design principles, and in the Junior/Senior Engineering Clinics, students work in multidisciplinary teams on real research and design projects. Most Junior/Senior Engineering clinics are sponsored by companies, or federal or state government agencies.

As a secondary objective, the Engineering Clinic supports entrepreneurship in engineering students. The College of Engineering has a long-standing program that allows students to apply for funding to pursue their own entrepreneurial ideas through the Junior/Senior Engineering Clinics. However, the program has been utilized by very few students. Recently, two new assignments- an entrepreneurial design project and a white paper- have been added to the Sophomore Engineering Clinic sequence. This paper describes these new assignments and discusses how entrepreneurship provides an excellent framework for meeting the main pedagogical objectives of the course: teaching technical communication and engineering design. It will also give an assessment of whether the new assignments have been effective in causing more students to pursue entrepreneurship in the Junior/Senior Engineering Clinic.

I. Background and Introduction

Project-based learning has been gaining popularity in engineering curricula to address the professional skills component (or A-K criteria) introduced by ABET in the 2000 criteria. [1] The College of Engineering at Rowan University has adopted a sequence of courses, known as Engineering Clinics, throughout the engineering curriculum. In this sequence, engineering students progress from limited scope projects freshman year, to ill-posed and open-ended projects that reflect professional practice in the Junior and Senior years. Indeed, most Junior- and Senior-year projects are externally sponsored. The College of Engineering faculty believes that this progression is logical, taking full advantage of project-based learning and allowing students to develop toward professional practice throughout their studies.

Like many engineering programs, Rowan University is also striving to develop a sense of entrepreneurship in their students. The College of Engineering has established a venture capital fund that allows undergraduate students to pursue entrepreneurial ideas, and has been developing contacts with faculty from the College of Business Administration. A recently developed tech park that is affiliated with Rowan University has incubator space that is devoted to small businesses started by students. However, only a few engineering students have taken advantage of these opportunities in recent years.

Recently, we have realized that the primary goals for the engineering clinic sequence are well-aligned with fostering entrepreneurship. The purpose of this paper is to discuss the engineering clinic sequence, and show how deliverables for these courses have been developed to encourage students to consider entrepreneurship.

The entrepreneurial program for Junior/Senior Engineering Clinic has existed for 10 years. This paper presents efforts to integrate entrepreneurship into the Sophomore Engineering Clinic, presenting projects that support the design and communication goals of Sophomore Engineering Clinics, and increasing the interest in the existing entrepreneurial program. It details two specific assignments that challenge students to generate ideas for new products and research their feasibility: a semester-long entrepreneurial design project and a white paper. The paper discusses how these entrepreneurial activities lay the groundwork for more students to pursue entrepreneurial Jr/Sr Clinic projects, while also providing an excellent mechanism for achieving the primary educational objectives of Sophomore Clinic.

II. The Engineering Clinics at Rowan University

Rowan University has an eight-semester Engineering Clinic program that provides Engineering students with experience solving practical, open-ended engineering problems. The sequence culminates in the Rowan Junior/Senior Engineering Clinic, in which students work on real engineering research and design projects. Project teams work with close faculty supervision and usually consist of 3-4 students; sometimes drawn from a single discipline and sometimes representing several, depending on the needs of the particular project. Most projects are externally sponsored, either by local industry or government agencies. However, students also have the opportunity to propose their own entrepreneurial clinic projects, and have them funded by the college, as described in section III.

The Freshman and Sophomore Engineering Clinics are intended to provide a foundation of engineering skills needed for Junior/Senior Engineering Clinic. The goals of the Sophomore Engineering Clinic consist of teaching engineering design principles and technical communication (technical writing in the fall, public speaking in the spring). The Sophomore Engineering Clinic is an integrated course, team-taught by Communication and Engineering faculty. There are two 75 minute lecture periods and one 160-minute lab period each week. Students work on design problems during lab periods, which are supervised by a team of 5-6 engineering faculty representing all four Rowan engineering departments (Chemical, Civil & Environmental, Electrical & Computer, Mechanical). Lecture periods are supervised by Communication faculty. Many of the deliverables in the course are reports and presentations about the engineering design projects, which are graded by both the Engineering and Communication faculty. Over the years, numerous design problems have been used in the course, including: baseball stadium design [2], improving energy efficiency of campus buildings [3], making rockets from 2-L soda bottles [4], designing and building trusses for cranes [5], and the optimization of wind turbines. [6] Currently, the two Sophomore Engineering Clinics integrate a sequence of three design projects of increasing complexity, as illustrated in Table 1.

III. The College of Engineering Venture Capital Program

The Rowan Undergraduate Venture Fund (RUVF) was created from National Collegiate Innovators and Inventors Alliance (NCIIA) grants and private donors to fund entrepreneurial clinic projects. Proposals are accepted from student teams that meet these criteria:

1. Teams must include engineering students from at least two disciplines.
2. Teams must appoint a project director from the College of Engineering and an advisor from industry.
3. Teams must propose an original product idea that can be successfully designed and prototyped in a single semester.
4. Teams must identify the business opportunity associated with their product idea.

Each proposal includes a patent search, a description of the invention and development plan, and a budget. The director of the RUVF works with students to refine each proposal before and after submission. Funding up to $2500 per team is awarded each semester. Teams can win several awards to support their ideas through multiple semesters.

IV. Mapping Entrepreneurship onto the Engineering Clinic Sequence

The Venture Capital Program described in section III has existed for over 10 years but relatively few students have taken advantage of it. In the past two years, the Sophomore Engineering Clinic instructors have implemented new assignments intended to promote entrepreneurship. With these new assignments, it is possible for a student to pursue an entrepreneurial idea through several semesters of Clinic, as illustrated in Table 2. The following sections discuss the role of each course in more detail.

A. Sophomore Engineering Clinic I

SEC I is an integrated course in which engineering design is taught concurrently with technical writing. Most of the graded deliverables in the course are written reports (both individual and team) stemming from the design projects completed in lab. However, the course has also always included an individual Literature Review assignment. Students chose a societal problem (e.g., reducing global warming, preventing serious injuries and fatalities in auto accidents, preventing or curing diseases, etc.) which are, or could be, at least partially addressed by technology. Students wrote a literature review on the current state of knowledge and current implementation of technological solutions, as well as the prospects for future developments. Topics were required to be approved in advance by the writing instructor. This assignment served an important role in the course because it gave students experience with literature research and introduced them to standard research techniques beyond the simple web search. It has historically also been the only major writing assignment which wasn't directly related to the team design projects completed in lab. Thus the assignment ensures that all students develop a complete document from start to finish.

Subsequent to developing the "Create Your Own Entrepreneurial Project" for SEC II, the faculty team revised the Literature Review assignment into a White Paper assignment. Students are asked to identify a product that is not currently available, but could be developed in the near future. Alternatively students could propose a cheaper or more efficient version of an existing product, or a better way of making a currently available product. The assignment challenges students to propose their idea, present research on related, currently existing technology, and outline future steps necessary to develop the proposed product. As in the Literature Review assignment, topics were required to be approved in advance by the writing instructor.

The White Paper assignment fills all the pedagogical goals of the literature review assignment, with the additional benefit that successful white papers can be readily used as a basis for elevator pitches for SEC II, and/or entrepreneurial Junior/Senior Clinic projects (Table 2).

B. Sophomore Engineering Clinic II

For each of the last 11 years, Sophomore Engineering Clinic II has offered two different semester-long design projects. Both projects are presented on the first day of class and students choose one. A new project was introduced in the spring of 2007 [7] as one of the two options: the "Create your own entrepreneurial project." Every student proposes to their classmates an idea for a semester-long entrepreneurial project. Based on student interest, as indicated from a selection sheet, and faculty perceptions of feasibility, 20-25% of these projects are chosen by the faculty, and a team of 4-5 students is assigned to each. The project timeline is as follows:

<u>Week one</u>: The structure and expectations of the entrepreneurial project, as well as the alternative design project, are presented to the students, and they make their selection. Table 3 summarizes the statistics for project selection for the four years the entrepreneurial project has been offered.

<u>Week three</u>: Each student gives a 90 second elevator pitch describing their idea for a semester-long entrepreneurial project to their classmates; typically, an idea for a new product. Each student also submits a one-page summary of their proposed project. Based upon the elevator pitches, the students rank the proposed projects (besides their own) in which they would be interested in participating.

<u>Week four</u>: The faculty announce which projects will run and which students will be assigned to each. A primary faculty mentor is assigned to each project. In both 2009 and 2010, a total of 18 different entrepreneurial projects ran, and three engineering faculty members supervised six projects each. The other two engineers on the faculty teams supervised the wind turbine project.

<u>Finals week</u>: Each student team gives a ~10 minute final presentation on their project to their classmates, and submits a written final report to faculty.

The following sections provide more detail on specific aspects of the project.

The Elevator Pitch and Project Selection

The elevator pitch is a practical and challenging assignment for engineering students; they have only 90 seconds to persuade the audience, their peers, that their product is feasible, that there is a market for their product, and that it would be an exciting project to work on.

Sophomore Engineering Clinic II is an integrated course in which engineering design is taught concurrently with public speaking. Consequently, all past SEC II design projects have incorporated presentations as major deliverables. However, the elevator pitch assignment is unique in that for typical presentation assignments there is nothing at stake beyond the grade. The elevator pitch, in addition to being a graded assignment, largely determines whether or not the student's proposed project will run.

In selecting projects, faculty used how popular the project was with peers as the major criteria, but reserved the right to not run a project if it appeared infeasible for sophomore-level students to make substantial progress on the project in a semester, or if the project required resources that were unavailable. Appendix A gives the grading rubric for the elevator pitch. Faculty evaluation of the presentation, as scored using the rubric, was 2/3 of the assignment grade. The other third was determined by the number of classmates requesting to work on the project. Consequently, if a popular project was vetoed by faculty for practical reasons, the student proposing it was still graded as one who had made a successful elevator pitch.

The students whose proposed projects did not run were assigned to other projects based upon their ranked list of preferences. Consequently, even though fewer than 25% of students had the opportunity to explore their own idea, every student had the opportunity to participate in an entrepreneurial project of their own choosing.

Examples of projects that ran in the Spring of 2009 include:

- Design of a rain-catch irrigation system for use in a third world country
- Design of a kitchen appliance for carbonation of fruit
- Development of an improved campus transportation system for Rowan University
- Invention of a new musical instrument
- Design of a small, non-permanent water wheel for powering small electric devices
- Development of a water purification system that doesn't require access to an electric grid

Final Deliverables

Each team gave a final presentation and submitted a final report. The full grading rubrics for these assignments are given in Appendices B and C. Note that because engineering design and technical communication are the primary objectives of the course, the grading rubrics emphasize effectiveness of writing and soundness of design process, while the "success" of the project in an entrepreneurial sense (quality of original idea, economic potential, etc.) figures less prominently in the grading. Specifications for the final deliverables included that the report should be a comprehensive description of the project, with detailed calculations supporting all quantitative results. Presentations by contrast would be no more than 10 minutes long and would focus on the team's most convincing evidence that the proposed product was feasible, had a market and was worth funding for further development. Thus, the project provided a realistic example of the roles of these two different forms of communication. The entrepreneurial project also offered an advantage over many previous SEC II design projects in that each presentation covered a unique problem; a more interesting and pedagogically sound situation than 15 or more teams presenting their solutions to the same problem.

In grading the final reports, the three engineering faculty graded the report three different ways: one read the entire report, one read the report excluding the appendices, and one read only the abstract and conclusions and looked at the figures and tables. This grading scheme was meant to reflect the way real technical reports are read, and give students a strong incentive to think carefully about practical aspects of report organization: e.g., what is necessary information vs. supplemental information that can be placed in an Appendix, what needs to go in an effective summary, how to write captions in sufficient detail that the Figure stands on its own, etc.

V. Discussion of Exemplar Projects

Sophomore Engineering Clinic I: The White Paper Assignment

Examples of White Paper topics in the Fall of 2008 included:

- "Smart Alarm Clock." The student author presented research demonstrating that it is better to wake up from REM sleep than from other stages of sleep, and proposed a programmable alarm clock. The user would enter a window of time during which he/she wanted to wake up, and the clock would monitor the person's sleep state and wake him/her up at an optimal time during the window. The student's research demonstrated that it is possible to determine a person's sleep stage knowing his/her heart rate, and that inexpensive heart rate monitors are available. He therefore concluded that a smart alarm clock could be constructed by interfacing commercially available components with each other and writing a program that would interpret the heart rate data and determine the optimal wake-up time. This paper was the basis for a successful elevator pitch, and became one of the 18 projects run in the spring of 2009 in Sophomore Clinic II.

- "Kayak Lighting." The student, an avid kayaker, noted that there are no commercially available kayaks equipped with warning lights sufficiently powerful to make the kayak visible at night to larger boats and ships. The student did research on optics and the intensity of light needed to be visible at specific distances, did research on safety issues related to having active electrical circuits in a small boat, and presented a reasonable estimate of how much cost and weight would be added to a kayak if warning lights were installed. While this was a strong white paper, the student opted to pursue a different product for her elevator pitch in SEC II.

These examples illustrate the intended spirit of the assignment.

Each white paper was graded by one writing instructor and one engineering instructor. Among the most common shortcomings of white papers observed in fall 2008 were:

- Presenting an interesting idea but only cursory research.
- Failure to locate readily available and clearly relevant literature or patents.
- Presenting an existing product as if it were a new product.
- Presenting notions, but not a clearly defined product.

For the fall 2009 offering of SEC I, new grading rubrics, shown in Appendix B, were introduced, along with an explicit requirement that every white paper must include at least five references. The new rubrics were intended to communicate explicitly the importance of research and of distinguishing the proposed product from existing products. The fall 2009 white papers still showed wide variation in the rigor of the research, but the faculty consensus was that student understanding of the assignment was improved: every white paper at least contained a clearly defined product idea that was legitimately distinct and unique.

Sophomore Engineering Clinic II: The Create Your Own Entrepreneurial Project

Because every project was unique, specific research and design tasks varied widely from one project to another. The "Invent a New Instrument" team, for example, had a working prototype of a novel musical instrument by the end of the semester. For most projects, however, development of a working prototype in the course of a semester was not feasible. Specific goals and expectations were determined for each project through dialog between the team and the primary project faculty mentor. However, to ensure that the level of rigor of all projects was comparable, the faculty team established an overall goal applicable to all projects: by the end of the semester, the team should be able to make a case for the project to receive funding. Following are examples of how specific teams met this criterion for success:

- "Rain-Catch Irrigation System." The team chose to focus on a particular village in The Gambia, where most of the population is comprised of subsistence farmers and essentially all of the annual rainfall occurs within a 4-5 month period. The team identified a community building with a corrugated metal roof suitable for a gutter system, researched costs of specific building materials available in The Gambia, and designed a rain-catch system and concrete water storage facility using available materials. They presented research regarding the time and water required to grow pumpkins and squash, and quantified the number of acres that could be irrigated during the dry season for this length of time using the volume of water collected.

- "At-Home Carbonator." The team did market research demonstrating that there is demand for carbonated fruit, which is currently only available through bulk production processes. The team did heat transfer calculations showing that a crock-pot sized device that was charged with dry ice could maintain a temperature cold enough for a time long enough to produce carbonated fruit. They also submitted a reasonable device cost estimate.

- "Campus Transit System." The team investigated the cost of options such as buses, shuttle vans and golf carts. They surveyed Rowan students regarding useful routes for a centralized transportation system, and the price and wait time that would make such a system more attractive than walking or driving. The team produced a proposal recommending a set of routes for golf carts, estimating the costs of obtaining the carts and hiring drivers, and recommending a fee for the transportation service that would allow it to break even.

All 18 teams did a reasonable job of demonstrating a demand for their proposed project. The most common shortcomings of less successful teams included:

- Lack of a clear plan for furthering the project (i.e., how would the funding, if received, be used?)
- No economic/cost analysis of any kind
- No practical engineering benchmarking (e.g., reasonable estimate of the amount of power that a water wheel could produce.)

Successful student teams, in addition to receiving good grades, were encouraged to apply for entrepreneurial grants and continue their projects through the Junior/Senior Engineering Clinic.

VI: Assessment

The primary pedagogical goals of the Sophomore Clinic are providing instruction in engineering design principles, technical writing and public speaking. As a secondary goal, the projects described here are intended to foster entrepreneurship in undergraduate students and increase the number of students who take advantage of the Venture Capital Fund program.

There is some evidence that the white paper assignment, as a first introduction to entrepreneurship, is an effective vehicle for encouraging students to pursue entrepreneurship further. SEC II has long offered students a choice between two design projects. The spring 2007 and spring 2008 SEC II students had the option of doing the "Create Your Own Entrepreneurial Project", but did not have the prior experience of the white paper assignment, which was introduced in the fall of 2008. Table 3 shows that in the spring 2009 and 2010 cohorts of SEC II students, who experienced the white paper, 157 of 237 (66%) chose the entrepreneurial project, compared to 98 of 201 (49%) in the previous cohorts which did not experience the white paper. Further, a survey was administered to the spring 2010 SEC II class, and the results are summarized in Tables 4 and 5. Notable results include:

- 47% of Sophomore Clinic II students said that their experience with the White Paper made them more likely to choose the Entrepreneurial SEC II project; only 9% said that their experience with the White Paper made them less likely to select it.
- 50% of student reported choosing the Entrepreneurship project specifically because they liked the idea of doing something new and unique.
- Despite the inherent uncertainty in the Entrepreneurship project only 9 students (8%) reported avoiding the Entrepreneurship project because it was too unclear.

The authors also investigated whether SEC II elevator pitches which stemmed directly from SEC I white papers on the same topic were more successful than those that did not. To address this, each elevator pitch was assigned a "feasibility" score and a "student interest" score, each on a scale from 1-3, with 1 being the best. Table 6 shows how student interest was defined; a project that was a "first choice" selection of at least 4 students, for example, clearly had sufficient interest to run and received a 1 on this scale. Feasibility was assessed primarily from the one-page writeup that accompanied each elevator pitch, rather than from the pitch itself. To be considered "feasible," a project proposal should:

- Provide a compelling statement of the need for the proposed product.
- Outline a logical, effective approach to the project.
- Define a scope for the project that makes completion of a prototype plausible within 3 semesters of work by a team of 3-4 students.

Table 7 shows the rubric that was used to assign ratings of 1-3 to the "need", "approach" and "scope" of each proposed project. Since a project was considered infeasible if it was weak in any of these three respects, the "feasibility" rating of each proposed project was considered equal to the *highest* of the three individual ratings for "need," "approach" and "scope."

Table 8 summarizes the results for the spring 2010 SEC II cohort. Exactly one-third (24/72) of the students gave an elevator pitch on a topic that was identical to, or closely related to, the topic of their elevator pitch. Notably:

- 42% (10/24) of the students whose elevator pitch was based upon the white paper earned a feasibility rating of 1, compared to 17% (8/48) of the students whose elevator pitch was unrelated to the white paper.
- 46% (11/24) of the students whose elevator pitch was based upon the white paper earned a student interest rating of 1, compared to 29% (14/48) of the students whose elevator pitch was unrelated to the white paper.
- 38% (9/24) of the students whose elevator pitch was based upon the white paper had their projects selected to run, compared to 19% (9/48) of the students whose elevator pitch was unrelated to the white paper.

It is too early to determine conclusively how effective the new assignments have been at promoting a sustained interest in entrepreneurship lasting beyond the Sophomore Engineering Clinic. As a preliminary indicator, the "Create Your Own Entrepreneurial Project" was first run in the spring of 2007. Two teams of students from this cohort went on to pursue entrepreneurial Junior/Senior Clinic projects, funded by the college. Both teams also applied for NCIIA funding, although neither were awarded this funding. One project ultimately resulted in a publication [8]. The other project led to a start-up company, formed by a May 2009 Rowan graduate; which is continuing the product development that began in the Junior/Senior Engineering Clinic.

VII: Summary and Conclusion

Two entrepreneurial assignments have been integrated into a multidisciplinary sophomore design course, and have been found to provide an effective framework for meeting the primary pedagogical goals of the course: teaching engineering design and technical communication. In addition, the assignments are intended to stimulate a sustained interest in entrepreneurship. One assignment, introduced in spring of 2007, is a semester-long project that challenges students to conceive of new products and work in teams of 4-5 on preliminary designs. To date few of these students have gone on to pursue entrepreneurial projects as juniors and seniors, though the few who have done so have experienced good success. The other assignment, introduced in the fall of 2008, challenges students to envision a new product and write a white paper outlining the need for the product and describing the technical challenges associated with its development. When this assignment was introduced, it resulted in a larger fraction of students choosing to pursue the semester-long entrepreneurial project option in the spring.

VIII. References

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Table 1 – Schematic schedule for SEC I and II

Course	**Design Project**		**Communications Instruction**
Sophomore Engineering Clinic I	4 week design project		Technical writing
	10 week design project		
Sophomore Engineering Clinic II	14 week entrepreneurial project	Other design project option	Public Speaking

Table 2. Ideal Timeline for Entrepreneurial Projects

Course/Time Period	Course-related Deliverables	State of Project
SEC I (fall)	White paper	Perception of need, understanding of physical principles
SEC II (spring)	Elevator pitch	Perception of need, understanding of physical principles
Summer after SEC II	Draft proposal for Rowan venture capital fund	Concept
JrEC I & II	Determined by Project Supervisor	Working prototype
SrEC I & II		

Table 3. Numbers of students in SEC II projects

Semester	Entrepreneurial Project	Alternative project
Spring 2007	46	51
Spring 2008	52	52
Spring 2009	85	38
Spring 2010	72	42

Table 4: Spring 2010 SEC II student responses to the question "Would you say your experience with the White Paper assignment made you more interested, or less interested, in doing an entrepreneurial clinic project?"

Response	# Students	% Students
More interested	**49**	**46.7%**
Less interested	**9**	**8.6%**
No effect	**47**	**44.8%**

Table 5: Results of survey regarding reasons why students selected a design project.

Statement (students were instructed to circle all statements they agreed with)	**Number who agreed**	**% of total students (114)**	**% entrepreneurial students (72)**
I chose the entrepreneurial project because I have a specific idea I want to pursue	35	31%	49%
I chose the entrepreneurial project because I like the idea of doing something new and unique	57	50%	79%
I chose the entrepreneurial project because I want a change from last semester	52	46%	72%
I chose the entrepreneurial project because the wind turbine isn't very related to my major	21	18%	29%
Statement (students were instructed to circle all statements they agreed with)	**Number who agreed**	**% of total students (114)**	**% wind turbine students (42)**
I chose the wind turbine project because I am interested in renewable energy	18	16%	43%
I chose the wind turbine project because I became excited about the topic last semester	8	7%	19%
I chose the wind turbine project because I don't have an idea for an elevator pitch	23	20%	55%
I chose the wind turbine project because the entrepreneurial project is too unclear	9	8%	21%

Table 6. Meaning for student interest score

Score	Level of Interest
1	Clearly sufficient to develop a team
2	Might be sufficient to develop a team
3	Insufficient to develop a team

Table 7. Rubric for feasibility score

Score	Need	Approach	Scope
1	Clearly defined	Reasonable prospect for success	Could lead to a prototype in 3 semesters with available resources
2	Vaguely defined	Likely will need significant re-thinking	Will need a significant breakthrough to succeed
3	Can be met with other, clearly superior solution that is already available	Not technically feasible	Requires resources that will not be available

Table 8. Feasibility and student interest scores from pitches resulting from white papers compared to pitches that did not result from white papers.

Feasibility Score	**Topic from white paper (24 total)**			**Topic not from white paper (48 total)**		
	Student interest score			**Student interest score**		
	1	**2**	**3**	**1**	**2**	**3**
1	7 (29%)	2 (8%)	1 (4%)	4 (8%)	1 (2%)	3 (6%)
2	4 (17%)	5 (21%)	2 (8%)	4 (8%)	6 (13%)	11 (23%)
3	0	0	3 (13%)	6 (13%)	7 (15%)	6 (13%)

Appendix A: Elevator Pitch Evaluation Sheet.

Speaker's Name: ______________________________ **Speech Time:** ____________

E = Excellent G = Good A = Average P = Poor U = Unacceptable

Presentation (2/3 of the overall grade)

Content E G A P U

- Introduction gained audience attention and developed interest
- Project was introduced and described clearly.
- Main points were appropriate to the specific purpose.
- Content appeals to the audience.
- Presentation has a clear ending.
- Presentation ended with a memorable closing statement.

Organization E G A P U

- Overall, the presentation was easy to follow.
- Transitions used effectively throughout the speech.
- Presentation contained a clear intro, body and conclusion.

Style E G A P U

- Language choices create a persuasive tone
- Language choices create interest, communicate enthusiasm
- Language choices were clear and accurate.

Delivery E G A P U

- Employed an extemporaneous style
- Maintained eye contact
- Used voice effect. (vocal variety, volume, rate, articulation, pronunc.)
- Used physical action effectively (gestures, posture, body movement)
- Adhered to the time limit (90 seconds)

Overall E G A P U

- Presentation developed a strong persuasive appeal and approach.
- Presentation was adapted to the audience.
- Presentation effectively communicated student enthusiasm.
- Preparation and rehearsal is evident.

Student Response (1/3 of the overall grade)

- Student interest indicated quality of presentation.

Presentation Grade:

_______/ 100

Response Grade:

______/50

Appendix B: Final Presentation Evaluation Sheet.

Team Name:________________________________

Speaker's Names:________________________________ **Speech Time:**______________

E = Excellent, G = Good, A = Average, P = Poor, U = Unacceptable

Presentation (90 Points)

Content – Introduction E G A P U

- Project was introduced and described clearly.
- Need for design was presented clearly
- Constraints were presented clearly
- Criteria were presented clearly
- Function was presented clearly

Content – Design Ideas E G A P U

- Competition identified, as appropriate.
- Governing principles and available technology discussed.
- Significant ideas from brainstorming discussed

Content – Proposed Next Steps E G A P U

- Ideas were evaluated based on criteria
- Remaining efforts discussed
- Reasonable assessment of status given

Organization E G A P U

- Presented outline of talk.
- Overall, the presentation was easy to follow.
- Transitions used effectively throughout the speech.
- Presentation contained a clear intro, body and conclusion.
- Leads viewer to stated conclusions.

Style and Delivery E G A P U

- Language choices were clear and accurate.
- Employed an extemporaneous style
- Maintained eye contact
- Used voice effect. (vocal variety, volume, rate, articulation, pronunc.)
- Used physical action effectively (gestures, posture, body movement)
- Effectively used the allocated time (12 minutes)

Overall E G A P U

- Introduction gained audience attention and developed interest
- Main points were appropriate to the specific purpose.
- Presentation was adapted to the audience.
- Presentation effectively communicated student enthusiasm.
- Preparation and rehearsal is evident.

Graphics E G A P U

- Font size big enough to see.
- Each slide had a digestible amount of information.
- If used, animations are effective, not distracting.
- Graphs have labels on all axes.
- Pictures complement spoken words.

Persuasion (10 Points)

Based on this presentation, I would be willing to advise this project next semester. Y N

Presentation Grade: _______**/ 100**

Appendix C: Grading Rubrics for Final SEC II Report

Grading Criteria for Final Report: Reader 1 – entire document

Demonstrates awareness of audience and purpose	**15**	
❑ Abstract succinctly and accurately summarizes paper		
❑ Employs appropriate technical style and tone for designated audience.		
❑ Includes appropriate level of detail in the body of the report for designated audience and genre.		
Demonstrates understanding of the design problem	**25**	
❑ Demonstrates need for design.		
❑ Describes specific and rational constraints.		
❑ Describes specific and rational criteria.		
❑ Criteria enable design ideas to be ranked.		
❑ Function of design is well defined.		
Demonstrates understanding of environment for design	**20**	
❑ Gives complete and thorough description of competition that allows assessment against own design ideas.		
❑ Describes off-the-shelf technology available for incorporating into design.		
❑ Demonstrates understanding of governing principles used in design.		
Demonstrates thoughtful design approach	**15**	
❑ Identifies several different reasonable design ideas.		
❑ Uses criteria to select one of more ideas as best.		
❑ Comparison of design ideas are made at the same level of Dixon's taxonomy.		
❑ Suggest rational approach for continued effort.		
Makes persuasive case for follow up support	**10**	
❑ Convinces reader that additional effort and support will be worthwhile. (Y/N)		
Demonstrates ability to follow document specifications and meet requirements	**15**	
❑ Organizes content according to specified subsections and follows appropriate conventions for each (content, tense, grammatical structure)		
❑ Follows document format instructions (font, page limit, etc.)		
❑ Tables and Figures have titles and are numbered appropriately		
❑ Proofreads and corrects errors (spelling, grammar, punctuation)		
Total		

Sophomore Clinic II – Design Competition
Grading Criteria for Final Report: Reader 2 – No Appendices

Demonstrates awareness of audience and purpose	**15**	
❑ Abstract succinctly and accurately summarizes paper		
❑ Employs appropriate technical style and tone for designated audience.		
❑ Includes appropriate level of detail in the body of the report for designated audience and genre.		
Demonstrates understanding of the design problem	**25**	
❑ Demonstrates Need for design.		
❑ Describes specific and rational Constraints.		
❑ Describes specific and rational Criteria.		
❑ Criteria enable design ideas to be ranked.		
❑ Function of design is well defined.		
Demonstrates understanding of environment for design	**20**	
❑ Gives effective summary of competition that allows assessment against own design ideas.		
❑ Summarizes off-the-shelf technology available for incorporating into design.		
❑ Utilizes governing principles in design.		
Demonstrates thoughtful design approach	**15**	
❑ Identifies several different reasonable design ideas.		
❑ Uses criteria to select one of more ideas as best.		
❑ Comparison of design ideas are made at the same level of Dixon's taxonomy.		
❑ Suggest rational approach for continued effort.		
Makes persuasive case for follow up support	**10**	
❑ Convinces reader that additional effort and support will be worthwhile. (Y/N)		
Demonstrates ability to follow document specifications and meet requirements	**15**	
❑ Organizes content according to specified subsections and follows appropriate conventions for each (content, tense, grammatical structure)		
❑ Follows document format instructions (font, page limit, etc.)		
❑ Tables and Figures have titles and are numbered appropriately		
❑ Proofreads and corrects errors (spelling, grammar, punctuation)		
Total		

Sophomore Clinic II – Design Competition
Grading Criteria for Final Report: Reader 3 – Abstract, Figs, Tables, Conclusion

Abstract Conveys Main Idea	**25**	
❑ Succinctly summarizes the paper		
❑ Conveys Need for design.		
❑ Conveys Function of design.		
Demonstrates understanding of the design problem	**20**	
❑ Constraints are summarized in table.		
❑ Criteria are summarized in table.		
❑ Criteria enable design ideas to be ranked.		
Demonstrates understanding of environment for design	**15**	
❑ Figures convey design ideas.		
❑ Tables or Figures used to convey several different ideas that were considered.		
❑ Rational for decision conveyed graphically.		
Demonstrates thoughtful design approach	**15**	
❑ Identifies several different reasonable design ideas.		
❑ Uses criteria to select one of more ideas as best.		
❑ Comparison of design ideas are made at the same level of Dixon's taxonomy.		
❑ Suggest rational approach for continued effort.		
Makes persuasive case for follow up support	**10**	
❑ Convinces reader that report may contain evidence that additional effort and support will be worthwhile. (Y/N)		
Demonstrates ability to follow document specifications and meet requirements	**15**	
❑ Tables and Figures have titles and are numbered appropriately		
❑ Titles for Figures and Tables allow them to be interpreted as stand alone images		
❑ All axes are labeled and have units		
Total		

Appendix D: Grading Rubrics for SEC I White Paper Assignment

Grading criteria for Technical Writing reader: 2/3 of overall grade.

Sophomore Clinic I – Fall 2009
Grading Criteria for Assignment 2: White Paper on an Engineering Problem

Abstract ▪ Explains purpose, scope, and content of the document ▪ Omits extraneous information	5	
Introduction ▪ Makes a compelling case for the need to solve the problem ▪ Identifies the purpose of the document ▪ Provides an overview of the content and organization of the document	15	
Definition of the Problem ▪ Defines the attributes of an effective solution to the problem ▪ Identifies the physical phenomena that can be applied to the solution of the problem ▪ Focuses the problem so that it is appropriate to the scope of the white paper ▪ Provides an appropriate level of technical detail for an engineering audience	20	
Discussion of the Potential Solution ▪ Identifies the status of the solution (innovative; in development; adaptation of existing solution; new application of existing solution; scaled implementation of existing solution; etc.) ▪ Offers a technological solution as appropriate to the status of the problem (outlines a specific approach to a new solution; proposes a solution to a specific component of the problem; suggests a specific way to achieve a solution that is in development; explains how an existing solution will be adapted, applied, or scaled; etc.) ▪ Provides an appropriate level of technical detail for an engineering audience	20	
Conclusions ▪ Summarizes the problem and the need for a solution ▪ Summarizes the progress that has been made toward the solution in the white paper ▪ Provides recommendations for next steps that will move the idea forward	10	
Use of Sources ▪ Cites at least 5 scholarly or substantive sources ▪ Provides evidence from sources to document the need and/or problem as appropriate ▪ Provides evidence from sources to support the solution ▪ Cites patent information relevant to the problem and/or solution discussed in the white paper to acknowledge similar solutions, identify different solutions, and/or demonstrate originality as appropriate ▪ Demonstrates an effective research process, including use of a variety of library databases and effective search terms (documented in the RESEARCH RECORD) ▪ Provides justification for each source by identifying the specific information it provides (documented in the RESEARCH RECORD) ▪ Summarizes and paraphrases appropriately; did not "cut and paste" ▪ Refers to all sources listed in the bibliography ▪ Correctly incorporates IEEE or Author/Date citations into sentences ▪ Lists references at the end in correct IEEE or Author/Date format	20	
Document Format, Mechanics, Style, Grammar, and Conventions ▪ Follows document specifications ▪ Uses clear and concise language ▪ Follows conventions of technical style, including tone and voice ▪ Uses correct spelling, grammar, and punctuation	10	
Total (67% of grade)	100	

Grading criteria for Engineering reader: 1/3 of overall grade

Sophomore Clinic I – Fall 2009
Grading Criteria for Assignment 2: White Paper on an Engineering Problem
Reader 2

Analysis of the Engineering Problem (Introduction and Definition of the Problem)	50	
▪ Makes a compelling case for the need to solve the problem		
▪ Defines the attributes of an effective solution to the problem		
▪ Identifies the physical phenomena that can be applied to the solution of the problem		
▪ Focuses the problem so that it is appropriate to the scope of the white paper		
▪ Provides a level of technical detail appropriate for an engineering audience and includes citations for all factual information		
Presentation of the Solution (Discussion of the Potential Solution and Conclusions)	50	
▪ Identifies the status of the solution (innovative; in development; adaptation of existing solution; new application of existing solution; scaled implementation of existing solution; etc.)		
▪ Offers a technological solution as appropriate to the status of the problem (outlines a specific approach to a new solution; proposes a solution to a specific component of the problem; suggests a specific way to achieve a solution that is in development; explains how an existing solution will be adapted, applied, or scaled; etc.)		
▪ Accurately summarizes the progress that has been made toward the solution		
▪ Provides recommendations for next steps that will move the idea forward		
▪ Provides a level of technical detail appropriate for an engineering audience and includes citations for all factual information		
General Comments		
Total (33% of grade)	100	