

## IMPROVING THE ASSESSMENT OF TECHNICAL WRITING IN SENIOR DESIGN

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### ABSTRACT

Technical writing skills can play an important role in the career of an engineer, but helping students develop these skills can be challenging. Senior design courses provide opportunities for students to practice technical writing, but assessing technical writing and helping students grow as technical writers can be daunting, especially for engineering professors. Most engineering professors have little formal training in technical writing, and it is difficult to motivate engineering students to grow as writers. This paper presents the efforts of a mechanical engineering professor and an English professor teaming up to improve how technical writing assignments are communicated to students in mechanical engineering senior design and to refine how those assignments are assessed.

### 1. INTRODUCTION

In the fall of 2008, I (Dr. Krauss) was asked to take over the two-semester senior design sequence on short notice. I had no real training in how to teach this kind of course and my research is not really related to senior design. While planning for the course, I decided to emphasize technical writing. Technical writing had played an important role in my own career, and I felt that it was not emphasized enough in my own undergraduate education. The students did not appreciate this point of emphasis. This was particularly obvious from the student evaluations of my senior design courses. My teaching evaluations were lower in senior design than in my other more traditional and purely technical courses. Specifically, I received low marks on my senior design course evaluations for the question “The grading was fair.” I also received a much higher volume of written comments from students in senior design. Many of these comments complained about the workload for senior design, how their papers were graded, and a lack of clarity in communicating what was expected in their writing assignments.

Technical writing can play a vital role in the career of an engineer (Norback & Hardin 2005, Selinger 2003). Extensive surveys of engineering alumni from the State University of New York at Buffalo and the University of Michigan highlight the importance of technical communication (Sageev & Romanowski 2001, Tryggvason, Thouless, Dutta, Ceccio & Tilbury 2001). Alumni of the University of Michigan were asked to rank the importance of 19 different skill areas on a 1 to 5 scale for how important each skill is in their professional life. A rank of 5 means “always useful” and a rank of 1 means “never used/needed.” Nine of the skill areas were technical and

ten were nontechnical. Interpersonal skills and technical communication were the two areas receiving the highest ranking and both ranked significantly higher than any technical skill. Alumni from SUNY-Buffalo reported spending on average 32% of their time on some form of writing. One prominent theme from the written comment on the SUNY-Buffalo survey is that communication skills help differentiate a young engineer from the pack. One responder wrote that “technical skills are a given; communication skills differentiate” and another noted that “a bad presenter is career-limited.”

Senior design courses provide a great opportunity to incorporate the development of these “soft” skills into an engineering curriculum, especially if the written and oral communication assignments in the course can closely mimic workplace communication (Norback & Hardin 2005). This paper summarizes recent efforts at SIUE to help students grow as technical writers through the senior design sequence. Some of the approaches taken at SIUE are similar to three of the strategies suggested by Walker (Walker 2000): audience analysis, modeling, and assignment interpretation. Walker discusses how these three strategies come under the theoretical framework of genre theory. Audience analysis refers to helping the students consider in detail the specific needs of their audience. Modeling means providing students both good and bad examples of technical writing for them to learn from. Assignment interpretation is helping the students determine exactly what the instructor is looking for. A significant amount of effort has gone into clarifying the documents that are used to communicate technical writing assignments to students in our senior design sequence. The goal is to make assignment interpretation as straightforward as possible for the students.

## 2. CHALLENGES ASSOCIATED WITH SENIOR DESIGN

There are several challenges associated with teaching senior design. It is an important course that can be used to teach students valuable skills related to teamwork and project management. These skills can play an important role in the successful career of an engineer. But the skills needed to succeed in this type of course are typically quite different from those needed throughout the rest of an engineering curriculum. Students with high GPAs and strong theoretical skills may be frustrated by this type of course.

Senior design can also be a very difficult course to grade and assess. The grading is somewhat subjective and cannot be based purely on the technical merits of the various projects. It would be very difficult for small schools to offer multiple, specialized senior design courses. SIUE’s Mechanical Engineering program offers only one section of senior design each semester and the student projects cover a broad range of topics. It is very difficult for one professor to be an expert on all aspects of the Mechanical Engineering field. As a result, it is challenging to grade the projects purely on their technical merits. This is part of what lead to the emphasis on technical writing and presentations as a major basis for the grading in our senior design sequence.

Senior design is also used to assess many of the program outcomes for the Mechanical Engineering department. This is a natural fit because senior design is supposed to be a culminating experience. This need for program assessment adds to the grading challenges of this subjective course. The need to assess some of the less technical program outcomes can lead to extra assignments that the students perceive as busy work. For example, SIUE’s ME program lists these two

outcomes:

Students will gain

- h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i. a recognition of the need for, and an ability to engage in life-long learning

There is not an obvious place to assess these outcomes anywhere else in the curriculum. Senior design is one of a small number of required senior courses, so the assessment burden falls on the senior design instructor. The students are asked to write special papers that discuss these issues.

### 3. TEAMING UP AND GETTING HELP

I endured several years of complaints from students, all the while telling myself that this emphasis on writing was important. I believed that some of the students would one day thank me for helping them grow as technical writers, and I was determined to persevere. However, I also felt that some of the students' complaints were justified and I could do a better job explaining what I wanted from them and helping them develop their writing skills. Knowing how to respond to and assess students' writing is a problem that typically confounds engineering faculty and often causes them to shy away from incorporating writing assignments into their courses (Manuel-Dupont 1996).

SIUE is quite proud of and invested in its senior assignment program. Every undergraduate degree program at SIUE includes a culminating experience in the senior year. Senior design fills this role for all of the engineering programs. A fund has been established for continuous improvement of senior assignment. Funds are awarded on a competitive basis for curriculum development related to senior assignment. Based on this program, a proposal was written for a project where professors from English and Mechanical Engineering would come together to refine how writing assignments are communicated to the students and how they are assessed. Dr. Sharon James McGee graciously agreed to join this project. She is the chair of the Department of English Language and Literature and teaches a course on technical writing.

The project focused on revising the rubrics and other documents associated with the first major writing assignment in the senior design sequence, the project proposal. Based on Dr. McGee's review of all of the materials associated with the proposal writing assignment, she determined that the biggest issue was that the document that explains the assignment to the students needed to be clearer. Additionally, the rubric needed to be edited and extra care needed to be taken to make sure that the rubric and all the other documents were in perfect agreement. Throughout the editing process, the goal was to tell the students as plainly as possible exactly what was expected from them. In the end, the students were given a suggested outline that they were strongly encouraged to follow along with a document that explained what each section of the outline should contain. The students were also given a copy of the rubric that would be used to grade their proposals. Copies of these documents are included in the appendix.

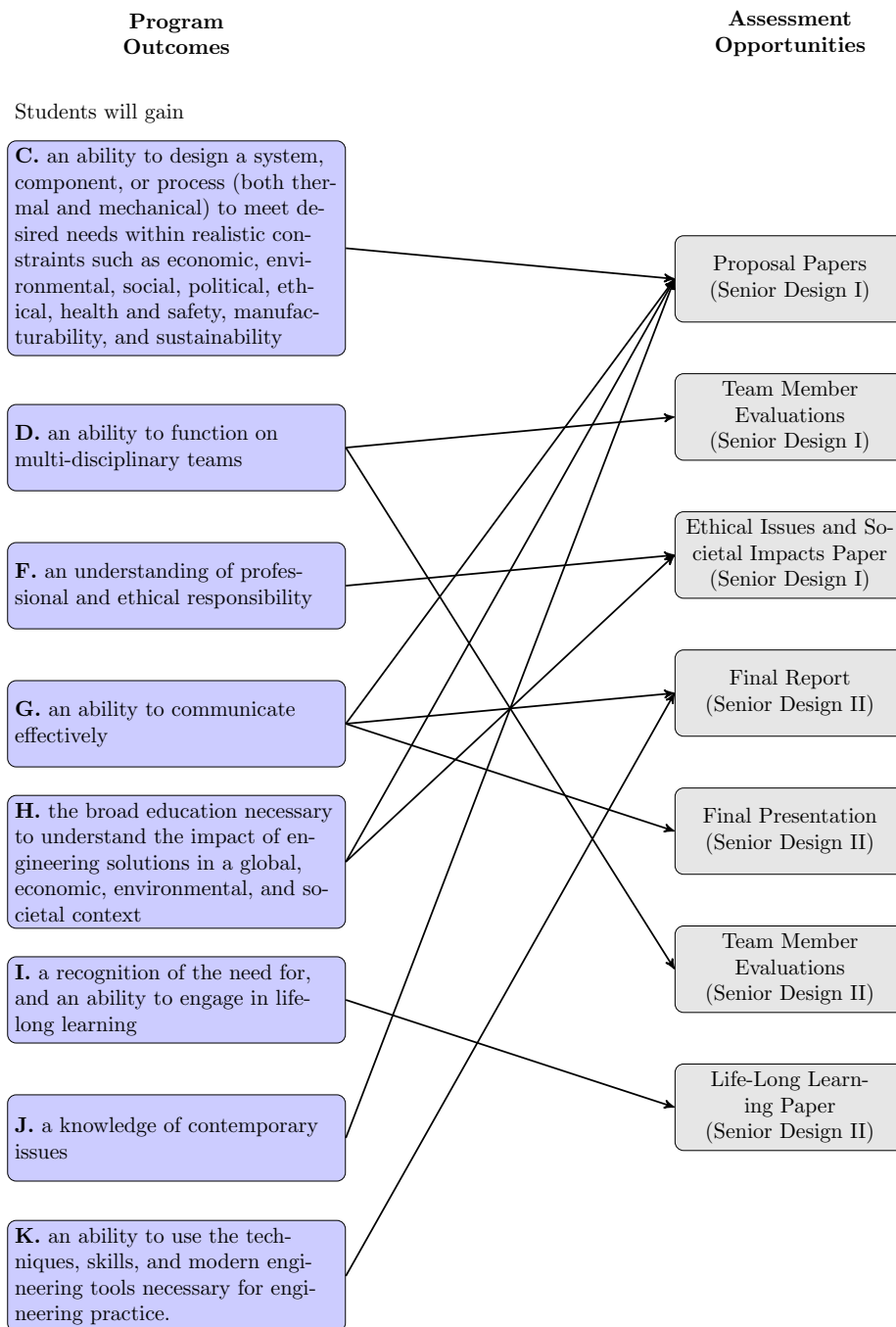


Figure 1: A mapping between the Mechanical Engineering program outcomes that are assessed in senior design and the assignments that are used to assess those outcomes.

#### 4. ASSESSMENT

Figure 1 shows a mapping between the various program outcomes that are assessed in senior design and the assignments that are used to perform the assessments. The proposal papers that were the main focus of this project are used to assess four outcomes. Through the process of refining the proposal assignment and assessment, care was taken to ensure that the assignment was meaningful for the course and would also meet the assessment needs of the program. For example, outcome C (the ability to design a system, component, or process) was broken into three components: developing a design strategy, conducting background research, and accounting for constraints. Each of these components is included in the proposal outline and the rubric for grading the proposals (see the outline and rubric in the Appendix for more details). There are other required sections in the proposal, such as Contemporary Issues, that are used in assessment and specifically addressed in the rubric.

Additionally, two papers have been added to the senior design sequence primarily for the purposes of program assessment. In the first semester of the sequence, each senior design team must write a paper on the ethical issues and societal impacts associated with their project. In the second semester, each student is required to develop his or her own life-long learning plan and write a paper about it.

#### 5. CONCLUSIONS

As a result of this project, students writing proposals in senior design this past fall were given much more specific direction than in previous years. Through the process of refining the rubric for the proposal, I believe I have helped students see more clearly what was expected of them as writers and articulated more clearly how I will grade their papers. Since Dr. McGee and I worked together over the past summer, I have implemented the revised rubric into the senior design course this year. In addition, the concepts we discussed for the proposal rubric have also informed how I have designed the rubrics for other papers in senior design. I have not yet received the student evaluations for the Fall 2011 senior design course, so I do not know if the students appreciate the revised rubric or if this project successfully reduced the student complaints about technical writing. However, the new rubric made grading and assessing the proposals easier than in previous years. (I should have the student evaluations back before the conference and will be glad to talk about them during my presentation).

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## A. EXAMPLE MATERIALS

### A.1. *Suggested Proposal Outline*

- Abstract
- Introduction and Problem Statement
  - Introduction
  - Problem Statement
  - Design Goals
  - Testing Plans
  - Constraints
  - Background Research and Literature Review
  - Contemporary Issues
- Design Strategy
  - Preliminary Design Ideas
  - Discussion of Risks
  - Backup Plans
  - Design Methodology
- Analysis
  - Analysis Plans
  - Preliminary Analysis
  - Feasibility Calculations
  - Connection to Decisions
- Timeline
- Budget
- Computers and Software
- Conclusions

A.2. Proposal Grading Rubric

**Technical Writing: Quick Read (10%)**

Item	Excellent	Good	Needs Works
Abstract	Abstract grabs the readers interest, accurately summarizes the document, and is grammatically flawless	Abstract is fairly interesting, summarizes the document reasonably well, and has only a few grammatical problems	Abstract is not engaging, does not summarize the document well, or has more than three grammatical problems
Introduction	Introductory paragraph of the main document is engaging and grammatically flawless	Introductory paragraph is fairly interesting and has only one or two small grammatical issues	Introductory paragraph is boring or has more than two grammatical problems
Conclusion	The conclusion is grammatically perfect and convincing	The conclusion has a couple of small grammar or spelling problems and is mostly convincing	The conclusion has more than two grammar problems or is not convincing

**Introduction and Problem Statement (20%)**

Item	Excellent	Good	Needs Works
Problem Statement and Formulation	Problem clearly stated and well-defined; concepts and ideas are clearly articulated and formulated	Problem statement is mostly clear and fairly well-defined; concepts and ideas are formulated with minor error	Problem statement is unclear or poorly defined; concepts and ideas are poorly articulated and formulated
Design Goals	Goals are clear, concise, and measurable; goals are challenging but achievable	Goals are mostly clear and concise; most of the goals are measurable; goals might be slightly too hard or too easy	Goals are vague and/or difficult to measure; goals are too hard or too easy
Testing Plans	Clear and effective plans are presented for testing all of the project goals	Good plans are presented for testing most of the goals	Either the testing plans are poorly conceived or more than half the goals will not be tested
Constraints	Identifies and clearly presents the constraints and accounts for them in developing the design strategy, including economic, ethical, social, cultural, and environmental constraints	Identifies the constraints and accounts for them in developing the design strategy with minor error or ignores one or two economic, ethical, social, cultural, or environmental constraints	Does not identify the constraints or does not account for them in the design strategy or ignores more than two economic, ethical, social, cultural, or environmental constraints



### **Literature Review and Background Research (5%)**

Item	Excellent	Good	Needs Works
Literature Review	Finds 5 or more scholarly articles that are closely related to the project; thoroughly discusses the connection between those articles and the project	Finds 3 or more scholarly articles closely related to the project and at least two other sources that are either not scholarly or not closely related; discussion of sources is fairly thorough	Finds less than 3 closely related scholarly articles or the discussion of the articles is cursory
Background Research	Clearly understands the historical context of the problem and what work has already been done in this area	Understands most of the historical context and recognizes most of the work that has already been done	Is not at all familiar with the historical context of the problem nor is he/she familiar with the work that has already been done in this area

### **Contemporary Issues (5%)**

Item	Excellent	Good	Needs Works
Contemporary Issues	Identifies the contemporary issues associated with the project and discusses these issues thoroughly in the proposal	Identifies most of the contemporary issues associated with project, but misses some; discussion of the issues in the text is not completely thorough	Fails to recognize key issues or the discussion is cursory

## Design Strategy (20%)

Item	Excellent	Good	Needs Works
Design Strategy	Carefully plans and sets goals/objectives and how to achieve them; uses alternative methods/back-up plans when necessary	Plans and sets goals/objectives, but how to achieve them is not clearly stated; proposed alternative methods are somewhat weak	Does not have a working design strategy
Preliminary Design Ideas	Preliminary designs are clearly explained and seem feasible	Explanations of the preliminary designs are mostly clear and the designs are fairly feasible	Explanations of the preliminary designs are unclear or the designs do not seem feasible
Discussion of Risks	Thoroughly discusses the risks associated with completing the project successfully and on time	Discussion of the project risks is fairly thorough	Discussion of risks is cursory and many of the risks associated with completing the project are overlooked
Backup Plans	Back-up plans are well thought out and cover all of the areas of greatest risk	Back-up plans are fairly good and cover most of the risks	Back-up plans are poor and show a lack of planning for the things that might go wrong with the project
Design Methodology	Presents a clear and detailed plan for how the design work will be done and how design decisions will be made	The plan for doing the design work is fairly clear and reasonably detailed; it is fairly clear how decisions will be made	The plan for doing the design work is unclear and lacks detail; it is unclear how important decisions will be made

## Analysis (20%)

Item	Excellent	Good	Needs Works
Analysis Plans	The plans for analysis are clear, the level and types of analysis are appropriate	Some of the plans for analysis are slightly unclear or the level and types of analysis are slightly inappropriate	The plans for analysis are vague or the analysis is inappropriate
Preliminary Analysis	Presents detailed preliminary analysis that sets the project on a good initial direction	Preliminary analysis is a bit unclear and lacks detail	Very little preliminary analysis is presented or what is presented seems irrelevant
Feasibility Calculations	Presents results of feasibility analysis that confirms that the project is feasible and the goals are achievable	Feasibility calculations are slightly unclear or there seems to be some small issues with the goals being achievable	No feasibility calculations are presented or the ones that are presented are not convincing
Connection to Decisions	clearly explains how the analysis will drive decisions during the project	most of the important decisions appear to be driven by analysis	the analysis will not drive decisions during the project

### Miscellaneous (5%)

Timeline	The timeline is detailed; the items that must be completed in series and those that can be done in parallel are clearly identified; the timeline is thoroughly discussed within the document; the timeline is specific to the project and not just a list of deadlines from the syllabus	The timeline is missing a few details and some aspects of completing tasks in series or parallel have been glossed over; timeline is fairly specific and the discussion of it is fairly thorough	The timeline lacks thought and detail; the idea of tasks being done in series and parallel has been ignored; presents a timeline graphic with little or no discussion of it; timeline is not specific to the project and is made up only of due dates from the syllabus
Budget	The budget has been carefully thought out, is detailed, and seems realistic; discusses the budget thoroughly within the text	The budget has missed a few items or is slightly vague or unrealistic; budget discussion is fairly thorough	The budget overlooks significant items or is fairly vague or unrealistic; presents a budget graphic without discussing it
Computers and Software	Computer-based tools and technical software will be extensively utilized in the project; has a solid plan for learning any new software	Computer-based tools and technical software will be somewhat utilized; the plan for learning new software is reasonable	Technical software will not be utilized; no plan for learning new software is in place

### Technical Writing: Slow Read (15%)

Item	Excellent	Good	Needs Works
Organization and Flow	Materials are organized in logical sequences with headings, sub-headings and paragraphs, making it easy for the reader to go through and understand; flow of ideas through the document is logical	Materials are organized in logical sequences but some sections and sub-sections are not clearly identified or out of place, and some paragraphs combine multiple thoughts; some small problems with the flow of ideas	Poor organization: headings and sub-headings are not properly used, paragraphs are not logical units, or the flow of materials and thoughts is not logical
Clarity and Tone	The document is clear and it is written in a professional tone	There are a few portions of the document that are unclear or where the tone is not professional	There are significant portions that are unclear or where the tone is not professional
Format/Style	All figures and tables are numbered and have captions; all equations are numbered; section and sub-section headings are easily identifiable; all formatting is consistent; proper use of references to figures, tables, equations, and citations in the bibliography; overall a professional looking document	some small formatting problems; a few improper uses of references to figures, tables, equations, and citations in the bibliography; a few instances of inconsistent formatting; overall the document looks fairly professional	Inappropriate use of figures, tables, captions, references, bibliography, and appendices; many formatting inconsistencies; not a professional looking document
Technical Language	Technical language is used correctly, is appropriate for the audience, and is explained correctly when necessary	There are a few incorrect uses of technical language or places where the language is not appropriate for the audience or not explained thoroughly	Technical language is often used incorrectly or is not explained at all or is not appropriate for the audience
Grammar and Spelling	Correct	Minor mistakes	Many mistakes