"SOUL OF AN ENGINEER," USING A NON-FICTION BOOK TO IMPROVE COMMUNICATION SKILLS AND IDENTIFY CAREER GOALS

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Abstract ? Engineering companies continue to want graduates that possess not only a strong technical background but also good reading, communication and teamwork skills. To meet this need, engineering disciplines are always looking for ways to incorporate these non-technical skills into their curriculum. This paper describes the development and implementation of an activity in a required engineering course that focuses on developing these communication skills. The activity, given in a sophomore electrical and computer engineering course, involves having the students read the non-fiction book relevant to their discipline, participate in two in-class discussions on the text, and write an essay answering one of five posed questions. Students that were involved with this activity last year found that the assignments were both enjoyable and beneficial to their development as engineers.

INTRODUCTION

To save both time and money, engineering companies want graduating engineers to have strong communication skills. Consequently, the Accreditation Board for Engineering and Technology (ABET) has made it clear that engineering colleges must provide opportunities for students to develop these skills. There have been many documented approaches to integrate communication skills into the engineering curriculum over the past ten years. Some of these describe an entire methodology for integration such as Writing Across the Curriculum (WAC) [2] while others present specific examples or strategies to improve skills [3] [4]. At Valparaiso University, the development of communication skills falls into two different categories. Technical communication skills are developed in engineering courses and typically involve writing technical reports, keeping engineering lab notebooks or giving oral progress reports for senior projects. Other communication skills, such as reading and analyzing a novel, presenting an opinion or debating a topic, are developed in the student's general education courses. While students are apt to work hard at developing their technical communication skills, they tend to lack motivation when working on communication assignments in their general education courses. Students have stated the main reasons for this apathy is that they either don't care for the topic they are discussing or they don't see the topic's relevance to their career goals. To address this problem, an activity was created and implemented in a required sophomore electrical and computer engineering course that allows students to develop communication skills using a discipline-related non-fiction book. Specifically, the activity involves reading the book, *Soul of a New Machine* [1], and then participating in three different communication building assignments.

The remaining portion of this paper describes the development and implementation of this activity in more detail. The next section gives some background into why this activity was needed in our curriculum and presents the objectives. Then, an overview of all the assignments within the activity is given. This discussion will be followed by details about how the activity was developed and implemented for the first time. Student feedback from the activity is then presented along with improvements. Finally a summary of the activity and how it could be implemented in other engineering programs is offered.

BACKGROUND AND ACTIVITY OBJECTIVES

The electrical and computer engineering curriculum at Valparaiso University is similar to other colleges in that a majority of the courses in the sophomore year involve fundamental topics in either analog or digital design. The main objectives of these courses are to ensure the students have mastered the fundamental principles of circuit design before they begin taking upper-level courses. Typically, there is little development of communication skills in the sophomore year except through laboratories where students write technical lab reports. Students may take one or two general education requirements during that year, but usually their focus is on technical topics. The author, who teaches courses primarily in the sophomore year, perceived the need for students to work on communication skills outside of laboratory assignments. After discussions with colleagues both inside and outside the college, the following activity was developed.

There are two main objectives to the communication assignments surrounding the book *Soul of a New Machine*. The first is to give the students the opportunity to develop their communication skills. In both the electrical or computer engineering curriculum there are few opportunities for students to read subject-related texts, write papers or present arguments in teams. All of the assignments done by students help them develop these non-technical skills. The second objective is to have students begin thinking about their career goals. Even though their college experience is almost half over, many sophomores do not begin considering

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what they want to do or who they want to work for until their senior year, if at all. This book provides one example of the engineering work environment at a company. By having the students respond to events and issues in the book both verbally and in writing, they must begin to focus on their own career goals. While these are the two main objectives, an added benefit of the book is that students are able to learn a little about the history of computer design. They are able to visualize what state-of-the-art was 25 years ago and how far the industry has come since that time.

ACTIVITY OVERVIEW

The *Soul* activity involves four different assignments. Students are asked to read the book, contribute in an informal class discussion on some of the issues raised in the book, participate in a group debate on one topic from the book and write an individual essay. Each of these assignments is explained below in more detail.

Soul is a medium length book (291 pages) that takes students some time to read. Therefore, to make sure they don't simply skim the book at the last minute, the first two assignments involved having the students read part of the book and submit questions they have on various issues that are raised in the reading. Specifically, for each assignment they are asked to submit three to five questions that cover material over a half of the book. To receive credit, the questions they submitted have to be both general and open-ended. Examples of both good and bad questions are presented to the students when the assignment is given.

Once the students have completed the book, two class periods are used for discussion. The first class period is devoted to an informal discussion of the book based on questions submitted by the students. From the entire list of submitted questions, 15 are chosen and handed out to students at the beginning of the class. Then one question is selected by a person in the class to begin the discussion. Depending on how the discussion evolves, the instructor can prompt further dialog or move to a new question. The second class period involves a team activity in which each team must argue a position. For *Soul*, teams are randomly selected and assigned one group of people in the book (engineers, project managers or the company). Then they have to develop reasons and provide supporting quotes from the book to argue why that group was primarily responsible for the success of the Eagle project.

The final assignment involves writing a three to five page essay answering one of five questions. The questions are worded so that the students had to take a position on a topic or issue and then extend the discussion to their personal experience. Two of the questions used in the essay assignment include:

? What values does Data General display as a company? Are they effective? What values does Tom West display as a manager? Are they effective? Would you like to work for a company like Data General? Would you like to work for a manager like Tom West? Draw evidence from the book and relate your personal responses to that evidence where appropriate.

? What do you think the motivation was for the different groups associated with the Eagle project: engineers (Hardy Boys and Microkids), management (Tom West), and the company (Data General)? Do you find their motivation more similar or different? What is your main motivation in becoming an engineer right now? Do you think that motivation will change when you start working or as you advance in your career? If so, how?

ACTIVITY DEVELOPMENT AND IMPLEMENTATION

When the author began developing this activity he had very limited knowledge on what assignments would be effective when analyzing the book. As a graduate student, he had participated in a previous informal discussion about the book with undergraduate students but didn't feel that the students learned anything from the activity because they had only one class for the discussion and it was poorly structured. To ensure that the students would feel this activity was valuable, the author sought help from colleagues in the English Department. During the development of the activity, the author collaborated with one professor in that department who provided some background to what the students had done in their literary courses and gave recommendations to make each of the assignments more effective. For example, to make the overall activity meaningful, the professor suggested that the author not only include the reading and group discussion, but also some form of individual reflection. The professor also had a number of specific recommendations for each of the assignments. These included having the students compile questions as they were reading the text, incorporating a second day of discussion where students could work in teams and debate one issue, and structuring the informal discussion so that actual questions from the students were discussed. In regard to the individual reflection, the professor suggested the students write an analytical essay in which they would take a position on a given question and then also respond to it in some personal manner. The advantage to this type of essay was that it would be familiar to the students because it was similar to what they had done in previous literary courses. The professor was also instrumental in helping the author frame questions to ensure the students could write a good essay in three to five pages, and she suggested adding an additional question that gave the students the option to write their essay as a case study. The wording of that question was:

? Write a case study about a person from the book. Describe his personality, motivation, and impact on the

project. What relationship do you see between that person and yourself? In his place what do you think you would be doing today?

Many of the recommendations made the assignments more effective because they helped motivate the students by having them reflect on why they wanted to be an engineer. By collaborating with this professor, the author learned not only how to create non-technical assignments but also other techniques for motivating students.

This activity was given for the first time to 38 sophomore students in the Advanced Logic Design course in the spring of 2002. Overall, the students found the assignments to be both enjoyable and beneficial. In the first two assignments, a majority of the questions the students submitted while reading the book were well thought out and involved a specific issue they wanted to address. Some of their questions included:

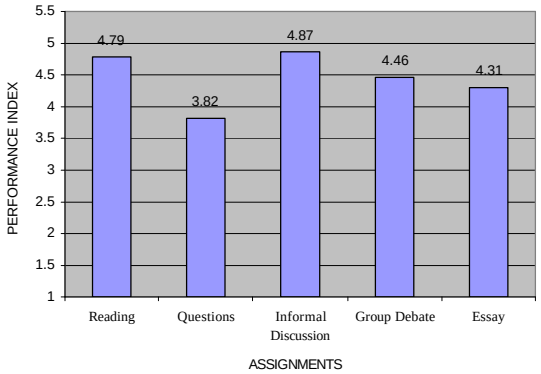
? The employees of Data General were not paid for overtime and often worked ungodly hours each week to complete a project. It was also discussed that, in order to work at Data General, on the Eagle project, the new young kids would have to love working more than anything else in their lives, more than family even. Are computer companies still "expecting" this from its engineers today?
? Is it true that most engineers get out of the technical side of it at about 30?
? On page 215 it says, "Like every one else on the team, he started becoming an engineer at about the age of four." If we were NOT engineers by the "age of four" are we behind? How many in our EE class/age group were "engineers" at an early age?
? Do you agree with Chuck Holland and his negative feelings about making computers for the military? Would you work on something for more money if you knew it was going to be used for bad purposes?
? Not everything worth doing is worth doing well." is a quote in Tom West's office. How does one balance doing the "quick and dirty" job that works and the more complete and thorough design?

STUDENT FEEDBACK

After the activity was completed, the students evaluated all of the assignments associated with the activity. In the evaluation, the students were asked their level of agreement with one statement concerning the enjoyment and benefit of each of the assignments. The students could respond with Strongly Agree, Agree, Tend to Agree, Tend to Disagree, Disagree, and Strongly Disagree. As an example, the students were asked the following statement regarding the reading itself: *I enjoyed the book because the content was interesting, applicable and easy to read.*

The average scores for each of the assignments are given in Table I where a score of six represents Strongly Agree and a score of one represents Strongly Disagree.

TABLE I
EVALUATION SUMMARY OF THE "SOUL" ACTIVITY



The table shows that the students overall felt that the activity were beneficial and enhanced the course. They gave very high marks for reading the book and for the day spent informally discussing issues raised in the book. In fact, many even commented that they wanted more class time to discuss issues raised in the book. Surprising to the author was the score of the essay evaluation question. It has been his experience that most engineering students do not enjoy writing assignments especially those that involve non-technical topics. But in this case, the students seemed to find the writing beneficial. From the evaluations the students said that they didn't mind writing the essay because it actually applied to what they were learning. Since the essays also involved responding to a question in some personal way, the author also developed a deeper understanding of his students. He learned about their background, why they wanted to be engineers, what was important to them, what they were motivated by, and how they perceived themselves. The author feels that he can be a more effective educator when he better understands his students.

The evaluation also asked students if they felt they learned anything from the book. Over 90% stated that they did indeed learn something from the book. Other student comments about the assignment or what they learned include:

? I loved it. It was a break from the normal routine but I still learned some valuable lessons about computer engineering.
? Engineering is more "real" now.
? It added variety, and proves we're more than numbers and circuits, plus it got me pumped to go work.
? The book certainly allows one to examine their motivations in becoming an engineer.

? (I learned) the dedication needed for a cutting-edge project in order to get it out the door.
? First book I've read for a class that can actually be applied to the class.
? (I) gained a deeper understanding into what engineers actually do.

Many of the positive comments focused on either how the activity was able to relate to topics they were covering in classes or how it was able to help them visualize what an engineering job would be like. A majority of the negative comments were directed to the organization or implementation of the assignments. There were a few students, however, who did not like the assignments and wanted the course to stick to technical topics.

This spring the activity will be given to a new group of students. From the experience last year and the student evaluations, a few improvements will have been made. These include:

? Better communication with the students regarding the objectives of the activity and assignments.
? More accountability as the students read the book. This includes better direction and focus on what questions are valid and small multiple-choice quizzes periodically over specific chapters.
? More time for both the informal discussion and group activity.
? Rewording two of the five essay questions that the students can write on.
? To improve activity assessment, students will be asked separately if they enjoyed the assignment and if they felt the assignment was beneficial.

CONCLUSIONS

This paper described the assignments surrounding the book *Soul of a New Machine* that was given to sophomore students in a required electrical and computer engineering course. The objectives of the assignments were to give the students another opportunity to develop their non-technical skills and to have them begin thinking about career goals. After the activity was completed, the students acknowledged that the book and the assignments enhanced the course. They stated that they not only enjoyed the book but also learned more about engineering and what it would be like working for a company.

While *Soul* focuses on topics in electrical and computer engineering, the assignments presented in this paper are general enough that they could be duplicated for non-fiction books in other disciplines. Informal discussions, group debates and written essays could be assigned for books that focus on historical engineering topics, current designs or trends, or design failures. Depending on the book chosen, the objectives for a similar activity might include identifying career goals, analyzing ethical issues, understanding social or cultural differences, exploring design differences or summarizing a historical perspective. Any of these objectives would be a valuable addition to an engineering course because it could motivate student learning by linking what they are studying in the course to a real application.

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To improve with communication skills, take an improv class. Get out of your comfort zone. Join a book club where you have to speak up every week.Â Authors of the ten articles focus on one or more components of a process by which to pitch a brilliant idea successfully, connect with any audience, establish and then sustain credibility, inspire others to â€œseeâ€ and embrace your vision, adapt to any audienceâ€™s decision-making style, frame goals around shared interests, build consensus and obtain concessions, and neutralize stressful conversations. 6. The Secrets of Successful Communication: A Simple Guide to Effective Encounters in Business (Big Brain vs. Little Brain Communication), by Kevin T. McCarney, 2011.