Introducing First-year Engineering Students to Reading and Writing about Engineering Practice

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Abstract

The Texas Tech University College of Engineering is introducing first-year electrical engineering students to the relationship that literature and writing can have to becoming well-rounded engineers. Beside being introduced to principles of electronics hardware and conventions of software programming, first-semester students enrolled in Introduction to Engineering and Computer Programming also read *Soul of a New Machine,* by Pulitzer Prize winner Tracy Kidder, and *The Civilized Engineer*, by Samuel Florman. In addition, students enrolled in the honors section of the course read *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, by Michael Hiltzik. Kidder's book reads like a well written novel about the development of Data General's 32-bit computer, and Florman's essays provoke discussions about engineering roles in society. Hiltzik's depiction of the development of ARPANET and the personal computer allows first-year students to identify with engineers who pave the way for most contemporary paradigms in computing. By critically reading and discussing literary depictions of engineering practice, students develop insight into such issues as cultural perspectives regarding engineering, ethical considerations affecting engineers, women in engineering, engineering politics, and various other issues that first-year students rarely have an opportunity to consider. In addition, students have the option of taking a first-year composition course, Essentials of College Rhetoric, that is especially designed to complement the content of the first-year engineering course, in which they examine and write about ethical, political, historical, and technical issues that shape the role of engineering in our culture and specifically focuses on engineers as writers in the workplace. The writing course was developed in collaboration with the TTU English Department and incorporates prevailing composition theory and pedagogy by engaging the students in such collaborative exercises as peer review and group invention strategies. The overarching aim of both of these courses is to incorporate methods and pedagogies from disciplines in the Humanities to help engineering students learn to read, write, and think critically about their own discipline.

Introduction

Students in the Introduction to Electrical and Computer Engineering learn about issues of professional practice by reading award-winning books about engineering written for the general reader and then discussing them in structured on-line synchronous and asynchronous discussions. These books include:

- *The Soul of a New Machine* by Tracy Kidder [1.] This book describes an actual engineering effort by a group of engineers at Data General during the late 1970's to save the company after archrival Digital Equipment beat them to the market with a 32-bit minicomputer. Chapter-by-chapter notes provided by the instructor identify issues in the workplace for practicing engineers. The notes discuss people and events that relate to such issues as the inevitability and practicality of lifelong learning, the vital importance of interpersonal skills, the intrigues of corporate politics, the centrality of teamwork in engineering, the existential pleasures of completed projects, the varieties of motivation for engineering practitioners, the frequent career path transition of engineers from focusing primarily on technical work to focusing on management, the unrelenting pressures on personal life.

- *The Civilized Engineer* by Samuel Florman [2]. This book is a collection of essays in which Florman, a practicing engineer, explores the origins of engineering, engineering ethics, conflicting loyalties, women in engineering, engineering curricula, the existential pleasures of engineering, engineers and management, and technology and societal decisions. These issues, though complex, are accessible to first year students. Encountering them early in the curriculum builds a base for further consideration of them later in the curriculum.

- *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, by Michael A. Hiltzik [3]. This book, read by students in a special honors section of the course, describes a remarkable group of people at the Xerox Palo Alto Research Center (Xerox PARC) who, in the 1970's, pioneered networks (Ethernet) and personal computing (including the use of bit-mapped graphics, icons, the mouse, WYSIWYG word processors and laser printers) and yet were largely unsuccessful in convincing Xerox to bring products based on these developments to market. By understanding something about what went right and what went wrong at Xerox PARC, students in the honors section learn more about engineering and business in the real world.

The primary focus of having the students read books like *Soul of the New Machine*, *The Civilized Engineer*, and *Dealers of Lightning* is to introduce them to the professional practice of engineering. Although they are, for the most part, freshman, it is important that they learn about the engineering profession beyond the science and technology that they inherently know they will be studying. From these works, posted notes on the Web site that takes them to additional articles, videos about the profession like *Getting Started: Careers for Electrical Engineers and Computer Scientists* and *What's Out There: Careers for Electrical Engineers and Computer Scientist,* the Sloan Center

Cornerstone Series [4], students have a good chance of learning early in their academic career if engineering, and particularly electrical

Samuel Florman notes that what most engineers enjoy doing is solving complex technical problem, work with collogues who enjoy the same things, and make a contribution to society that is both meaningful and enlightening. But, he points out that all of this can become less meaningful to the engineer if there is a lack of imagination, awareness of domestic and foreign cultures, and a moral sense that what engineers are designing, developing or creating will affect society in a positive manner. [5]

Engineers as Professionals

Florman's view of a well-rounded, civilized engineer, who is well-educated in history, language, and sociology is not the common perception that first year engineering students have about the field of engineering. Although first-year-engineering students enter college with a background in the traditional high school humanities courses, and on the average they are better prepared and above average students, they very rarely see the correlation between practicing engineering and literature. The College of Engineering at Texas Tech University first-semester electrical engineering course is designed for students to learn about issues of professional practice by reading about engineering, discussing issues raised in the books in DaMOO, summarizing their discussions, and posting them on the web in an asynchronous threaded discussion. In addition, students who are enrolled in both the first-semester electrical engineering course and the special-topics Introduction to Composition and Rhetoric course are writing about the issues raised in the readings while learning the modes of composition. These students not only read about the practice of engineering, but they also write about the practice of engineering and what it means to them. By immersing the students in studying about the practice and the professionalism of engineering, students get first-hand knowledge about what is expected of them once they get into the profession and they get a sense of the profession beyond technology.

Introducing first-year-engineering students to the principals and practices of engineering through literature and writing allows the course to have considerable content while at the same time by using the on-line environments all students participate on an equal bases---unrestricted by time or place—and faculty are not overburdened with numerous papers to read and evaluate. In fact, it seems perfectly feasible that by using on-line environments, discussions of any texts in courses can be scaled up to include any number of students as long as there is adequate management of the discussions schedules, meetings, and logs. In this course, peer-mentors handle management for both the synchronous and asynchronous on-line discussions.

These mentors help the students negotiate the technology used for both the synchronous and asynchronous online discussion environments and act as facilitators to help student teams coordinate meetings and to mediate online discussions. Because they have just completed a course the previous semester, these mentors also are available to discuss

homework problems and other aspects of the course. With this arrangement, mentors get valuable leadership experience, and the students get constructive input about the course from advanced student peers. Perhaps most importantly, this arrangement helps students develop the habits and skills necessary for working in teams and requires them to take responsibility for their own learning outside the classroom. The web-based component of the course gives students anytime, anyplace access to an extraordinary amount of information, learning resources, and interactive activities---significantly more so than was possible in the original course developed for the proscenium classroom. However, because these online tutorials, videos, notes, and other materials contain information critical to successfully completing graded assignments, students must spend a significant amount of time outside the classroom working through these content elements on their own in order to pass the course. [6,7]

Online Community of Learners

The online discussions of these books, automatically logged, are designed to help students gain more from their reading by encouraging them to develop their skills for critical reading [8]. These online environments not only allow discussions about various issues to be refined over the course of a semester, but they also require students to engage in a significant amount of writing to express and support their thinking on these issues. engineering and computer science, is what they want to pursue as a career.

Using on-line environments like DaMOO (and educational MOO Multi-user Object Oriented out of California State University—Northridge) students' discussions can be logged, converted to html, posted on the web (http://aln.coe.ttu.edu/ee1305fall/index.htm) and archived. In addition, students post summaries to their discussions over the text on the Allaire Forms threaded discussion list, which archives their summaries but also allows responses to the summaries. Thereby, not only developing a form for the students to capsulate their synchronous discussions, but it allows others students, faculty or invited guests (Allaire Forms is password protected) to make comments on the teams' summation. Using different environments of Web technology, students engage in a much more in-depth discussion than they would in a traditional class. The introductory course for first semester electrical and computer engineering students at Texas Tech University has been designed to introduce students to three aspects of electrical and computer engineering: *software*, *hardware*, and *issues of professional practice*. A significant number of interactive learning environments, accessible to students via the Internet, have been developed to support student learning outside the classroom in each of these areas. Students engage in what Marcia C. Linn might call "knowledge integration" of issues of professional practice by reading the text, while at the same time benefiting from learning from each other through on-line synchronous and asynchronous discussions [10]. Linn points out that students often "learn more discussing ideas and topics with their peers than they do in discussing the same topics with experts because their peers use terms and examples that resonate more closely with their own ideas".[9]

Although cooperative and collaborative working environments are common place in the corporate world, schools have not met implemented cooperative work in and out of the classroom in order to prepare students for a lifetime of collaboration. And although the perception is that technology will allow and determine that we work more in isolation than ever before, the opposite is actually true. The very nature of Internet technology promotes interaction; in fact, Internet technology exists only because of shared information and environments like MOOs, one of the earliest forms of Internet environments, where interaction and collaboration are the backbones to the synchronous discussions. Internet technology should be used a as teaching partner and not as an intruder into the classroom or another element to be dealt with. For Linn and Hsi's pedagogical principals in their Knowledge Integration Environment, helping students to learn from each other and promoting lifelong science learning is two of the four segments of tenets that form the foundation for KIE. Within the section, "Helping students learn from each other," are the basis for forming community learning environments: learning from each other, social activities for respective interactions, designing criteria and standards, and employing multiple social activity structures. [10] While it is obvious that Linn and Hsi's tenets would work in a traditional classroom or an online classroom, they seem to be basic fundamentals for online discussion of literature and developing a sense of community in which ethics and respectability play a significant role because as practicing engineers, our students will be learning from those with whom they work, and those may or may not be engineers. In fact, it is very likely that our students, when they become practicing engineers, will be learning from accountants, project managers who could very well be technical communicators, sociologists, etc. Florman says that in some ways engineers have engaged in a form of reverse snobbism since shedding the Platonic stigma of engineering being a dirty-hands and muddy-boots profession, and that they often label "non-technical learning as effete and without substance". [11]

Mature engineers are acutely aware that they play a significant role in the moral health of society. Edmund G. Seebauer and Robert L Barry [12] point out that the words moral and ethical overlap because even though "moral" generally refers to human action and "ethical" generally refers to action within a profession, both ideas play a significant part in how we address our responsibility to society and to ourselves. They assert that the heavy impact that engineers have on society and the well-being of human life, engineers should not only hold strong ethical and moral standards, but should be very aware of other cultures ethics and other moral views. Ethical issues will inevitably arise in one form or another during a specific project, but how a novice engineer handles those ethical issues can depend much on his or her exposure to actual cases of engineering ethics. Introducing students to case studies like the Challenger accident and discussing the issues that existed for the engineering involved in the incident helps them to address ethical issues. Because students, especially Texas college students, can relate closely to the bonfire at Texas A&M University in 1999 where 11 students were killed, the incident is a good case for discussions on both moral issues and ethical issues because the construction was an engineered pyramid design, and part of the controversy has been should professional engineers have supervised the construction of the pyramid. Case studies are valuable tools for class discussions around moral and ethical issues, as well as

managerial issues. However, addressing these issues in a mature manner generally requires some personal or literary experience

However, by developing a novel-like experience in books like Kidder's *Soul of the New Machine* where the students get to know the people involved and have strong positive or negative personal feelings about the people involved brings moral and ethical issues closer to a real world experience.

For instance, through online discussion about the managing techniques of Tom West at Data General brought to light that students did not all perceive West in the same way. Most felt that he was cold, withdrawn and did not care about the MicroKids who were working on the 32 bit computer. Others, however, pointed out that he was doing his job as manager of the project whereas Carl Alsing was the liaison between West and the Micro kids. Although Data General was not developing life-threatening projects, the discussion of the Challenger accident and the Texas A&M bon fire accident produced more controversial discussions because of equating the role of West and Alsing to possible roles at Mortion-Thiokol and Texas A&M administrators. In other words, it is easy to play Monday quarterback and point a finger to someone or something to blame. It is an entirely different role when immersed in the problem as portrayed in both *Soul of the New Machine* and *Dealers of Lighting*.

Technology allows for virtual simulation of actual events so that students can experience some issues before facing issues in their profession. Ironically, that is what fiction, drama, and poetry have done for centuries---given the reader a "virtual" experience while outside of the experience itself. Both *Dealers* and *Soul* depict actually events for practicing engineers, but Hiltzik and Kidder approach the events and the development of their works such as a novelist like Michner or Kipling develop the sequence of events in order to develop a story line that leads to some climatic event. In both the non-fiction work and the fictional work, the characters/players face moral and ethical issues that must be dealt with or, at least, addressed.

Reading non-fiction and fiction and experiencing the events of the characters/players addresses the issues of morality and ethics, but does not engage the student in controversial views of ethics and morality. Theoretically, class discussion is designed to promote addressing issues, but in a class of 70+ students, class discussion diminishes to a few students voicing opinions, and if a teacher is lucky, some students expressing opposing views. The number of students participating in discussions in a traditional classroom is less than 10% whether it is a literature course or an engineering course.[13] However, by developing prompts for on-line synchronous discussions where teams of 4-7 can dialogue about controversial issues that arise in the book, students to have an opportunity for an equal voice, and the on-line environment allows for more in-depth discussion as well as an extensive variety of opinions.

It is these discussions over issues or morality and ethics that students are able to voice their personal views on controversial issues, and they discover that everyone does not

share their views. Generally entering freshman students have limited personal experience dealing with moral and ethical issues on the scale of the Texas bonfire accident. However, they can engage in "virtual" events in fiction and non-fiction that affect moral judgment of characters in the book by simply reading and discussing specific issues, and then when they are ready to discuss the Texas A&M bonfire case, they have point of references to make regarding ethical and moral issues.

With a combination of reading literature in the engineering course, discussing the issues found in the literature, analyzing the content in relationship to their own experiences, and then writing about the literature in the composition course, students are integrating knowledge about engineering, about writing, about humanity, and about themselves.

As with other forms of literature, in books like *Dealers* and *Soul,* the students encounter situations that depict the experience of characters but more importantly, they encounter people who practice engineering. Far to often many disciplines have so much to cover in their own field that allowing the students the luxury of discovering about the human-side of the field is too time-consuming, not to mention the fact that students frequently see no relationship to the "technical" discipline and the people they are encountering within the text. Although the essence of engineering can be found in numerous literary works, first-year-engineering students are not directed to engineering in literature. First of all, traditionally, freshman-writing courses focus on composition and not literature, but are, for the most part, taught by English majors whose own experience with engineering is close to nil or extremely limited. This is no way lays blame on English and composition faculty whose discipline is as rigorous as any other is. However, there are faculty who look for thematic elements in literature which relate to the student's own interests. By introducing first-year-engineering students to books like Kidder's *Soul* and Hiltzik's *Dealers,* students have the opportunity to read about engineering while at the same time reading good non-fiction literature, and they get a broader view of the impact engineering has on society, and the important responsibility they will have to society as practicing engineers.

Because students read non-fiction literature about practicing engineers like Tom West and Carl Alsing at Data General, and Paul Taylor and Allan Kay at Xerox PARC, and Samuel Florman, they have a better chance understanding the role literature plays in their educational and professional careers as engineers because they have an opportunity to discuss issues of professionalism within the frame or classroom of their own discipline.

Conclusion

The design of the first-semester electrical engineering and computer science course evolved over time, and the team teaching of faculty from engineering departments and English departments made feasible the implementation of teaching reading and writing along with hardware and software. Continue assessment and evaluation needs to be done on using Web technology to engage first semester engineering students in "integrating

knowledge" and developing team skills while introducing them to the issues about professionalism through literature and writing.

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