The Capstone Design Project:
A Total Integration of Engineering Communications

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A common complaint from industry is that engineers are not good communicators. Although most engineering programs require a speech course and one or more writing courses, these courses generally have two characteristics that prevent them from teaching students to be good communicators. First, they are not focused on technical communications. Oral communication courses cover basic concepts of communication, but do not cover techniques or approaches that are important for technical presentations such as the use of tables, graphs, charts, digital photos and video clips to convey information.

Even technical writing courses fail to offer the student the type of writing experience they need since the courses are often "text-book" rather than "industrial-practice' in their approach and are generally taught in isolation. The essentials of technical writing may be covered, but without a "project or problem" on which to base the report, students often have to use some previous work experience or project or to create a fictitious project to discuss. These courses may require the student to develop a proposal, write progress reports, and develop some type of final report, but all work is written solely for the instructor, as the student does not have a true "client" to which the report must be submitted. In the early 1980's at Bradley, one English faculty member attempted to address this problem by having all 20 students in one class work as a team to try to solve the campus-parking problem. Since no problem solving methodology was imposed and no student wrote more than a small portion of the final report, the result was a poor effort at problem solving, a poorly -written final report, and a minimal writing experience for the student.

Bradley's IMET Capstone Design Project course has attempted to address all of these issues by integrating oral and written communication into the project course. A speech coach who has over 12 years of experience working with the IMET Dept. senior design teams manages the oral communication component. A required co-requisite for the project course is enrollment is English 305, Technical Writing. All students in the senior design course are enrolled in the same section of Technical Writing. The instructor teaching this course is a part-time instructor who has a Ph.D. in technical writing. His full-time position as director of training for the Peoria Fire Department requires him to develop training manuals and other training material. His emphasis in the course is industrial practice, not textbook material. The students are required to use material from their design project as the basis for all proposals, library research, and progress reports. The final report for the project is also the final report for the Technical Writing course. Approximately 35% of each student's final grade in the senior design course is based on the quality of the written report and the oral presentation.

<u>Technical Writing</u>
The integration of writing skills with the IMET senior project begins on the first day of the technical writing course when students learn about writing progress reports. The progress report is the first document that the students will deliver to their client, and its position in the syllabus at the beginning of the semester shows the students that the technical writing course will have immediate benefit to their project. The progress report is short, about a page in length, and students learn how to choose their content that they believe will be most useful to their client. Moreover, the students learn that they cannot merely list what they have done, but that they must explain the significance of their content and how it affects present and future work on the project.

Part of writing the progress report involves choosing a team name and logo for their student-consulting group. The name and logo will appear on the first and subsequent progress reports and on the final semester document, the proposal. Choosing a logo becomes important because it helps the students create a professional identity as they seek to be included in the community of engineers. The selection and design of the logo provides a good starting point to teach the students that the quality of their documents also reflects their professional image. The progress report then becomes the source of the first impression that the students' clients will form. Students are careful in designing a logo that they think will be appropriate to their professional image; likewise they also must learn that their documents are not neutral mediums to convey facts but also and sometimes more importantly reveal their credibility and position in the community of engineers. For the clients, those documents that imitate the appearance and content of other professional documents will cause the clients to consider the students more than just students, but as credible engineers whose judgments and proposals are worth considering.

Students continue to submit progress reports every two weeks to their client, but the next topic in the technical writing course continues the idea of creating a professional presence for the students. In the next week of class, the students are taught library research methods to help them find sources in indexes and catalogs. A research librarian from the university library teaches this portion, and the lessons coincide with an upcoming assignment in the technical writing course, a review of journals. This assignment directs students to become familiar with journals in their field so that they see the document design of journal articles and learn what topics are currently being discussed. For this assignment, students find 12 articles they deem important to their project, list them, and then review two of them, describing how those two articles could benefit their project. Each review is approximately 250 words long.

The journal review assignment then becomes useful for a later, more substantial assignment, the review of research. In this five-to-seven page document, each student describes research that relates to the senior project. Student must use at least seven sources in writing this document. By this point in the semester, the students have seen many journal articles and know how to find sources. Most students then design their review of research to mimic a journal format, and a few students each semester produce reviews that mimic a journal reprint both in appearance and content. The technical writing course also emphasizes the layout of documents because the students have access to computer equipment that allows them to print professional-quality documents. The emphasis on journals, their appearance and content, provides goals toward which students can direct their document design skills on the computer. Computers offer many

choices in affecting document design, but the students must be careful in their choices in the visual domain so that they are consistent with the conventions of their field.

The review of research then supports student work on their final assignment, their proposal. The students must convince their client that their proposal is worth considering and that they are credible engineers whose work is valid. The review of research can provide students with a context for their own work because the student work has not occurred in isolation but is possible because of the work of other engineers. Circumspect students then will include parts of their review of research in their proposal to show the clients that the students know the related work and applications that are similar to their own work. The resulting proposals often mimic proposals prepared by professional consulting teams. Student proposals have four-color printing and professional layouts that support the idea that the student work is on par with that of professional consulting groups. The typical format is two-columns per page with all visual material integrated into the report. The team is encouraged to use visual material such as graphs, charts, tables, and digital photographs in the proposal rather than concentrate on written descriptions. The content of the report must include an appropriate problem definition, sufficient problem analysis to convince the client that the team understands the problem parameters and the context in which the problem occurs, alternatives developed and evaluated, and recommendations. A detailed cost-benefit analysis is also required. Moreover, students must demonstrate textual competency learned during the course through lessons in writing style.

These assignments in the technical writing course show the students that the process of writing is not an end in itself or a feature of mere sentence grammar and syntax. Instead, students see the concurrent discourses occurring in textual, visual, and social domains. The technical writing course then becomes a means for acculturating students among engineers as the students seek to join its community by showing competence in the many realms of its communication mediums. The process shows the benefit of integrating courses from other fields toward preparing students to be sensible, informed participants of professional communities.

Oral communications

A former member of the speech faculty meets with all the teams as a group before the midterm presentations to present general guidelines for making a good technical presentation. Examples of previous presentations are presented to the teams. The expectations for the midterm presentation, including the topics to be included are also covered. The midterm presentations are videotaped and critiqued by the speech coach. Each student is given written feedback concerning the strengths and weaknesses of his/her presentation.

During the last three weeks of the semester, the speech coach and an IMET faculty member meet with each team to critique the team presentations. Since each team will be given only 25 minutes to present their project during the on-campus presentations, one objective of these sessions is to help the teams identify the major information that needs to be presented and then to help the teams organize their presentations. For the initial practice session, the team presentation may range from 10-15 minutes for those teams lacking adequate content and preparation to as long as 90 minutes for those teams that don't understand that the presentation is a summary, not a presentation of every detail developed during the semester. An emphasis is also placed on making the presentations as visual as possible. Students are encouraged to replace sentences

with bulleted lists, to develop charts and graphs to convey information, and to highlight the portions of tables or spreadsheets that are important for the audience. The idea is to help the audience understand what is important, not just present information. The challenge facing the speech coach and the IMET faculty is to help each team to get their presentation to the 20-25 minute range. This effort usually requires 3 team practice sessions prior to the on-campus presentations.

For each practice session, the team is required to bring copies of their Powerpoint slides, printed 6 to a page. Feedback is provided to the team on these pages. Teams are critiqued on appropriateness for the audience, organization, grammar, use of visual material and completeness. The bottom-line question that is always considered by the speech coach and IMET faculty member is "Would I buy the teams recommendations if I were the client?" If the answer is "no", then what are the items that need to be addressed in order to sell the recommended solutions. In extreme cases where an individual lacks even basic speaking skills, the coach will meet will the individual to help them overcome their fear of public speaking and to assist them with the organization of their material. For one individual, this one-on-one coaching resulted in the student progressing from being unable to present a complete thought without pausing to being able to deliver a coherent 3-minute introduction to the project.

The on-campus presentation is a formal "dress-rehearsal" for the client presentation and is given to an audience of fellow students, departmental faculty, and other invited guests. The formal presentation is followed by a short question and answer period. This presentation is also videotaped and critiqued by the speech coach and the technical writing instructor. Students are provided with written feedback that can be used to modify their presentation before giving it to the client

Information Given to Client
The final report is printed in color and is bound before presenting copies to the client. Multiple copies are provided so every member of the project steering committee has a copy. The client copies of the final report are delivered at least 48 hours before the client presentation. If possible, individual copies are delivered directly to members of the steering committee. If this is not done, the primary contact person will often wait until the presentation to hand out the copies. This prevents the steering committee from being able to read the report before the presentation. When all members of the steering committee have read the report, the client presentation becomes an overview and not a detailed presentation. Time is always allowed after the presentation for questions and discussion. Other material given to the client includes a CD containing all Powerpoint slides, a complete copy of the final repost, plus other supporting files and documentation that might be useful to the client. These files are important, as often the client may need to reanalyze data collected. Giving the client a copy of the PowerPoint slides is also important, as the primary contact may need to repeat the presentation to upper management or other interested groups. This past semester, one team also developed a complete procedures manual and a training video that could be used by the client to train the eventual implementers of the proposed recommendations.

Summary
To be effective communicators, engineering students need to be aware of the audience to whom they are presenting, able to identify what needs to be presented, and have a knowledge of how to present the material in a manner that will help the audience understand what is being recommended and why. Providing this type of training as part of a real-world project as opposed to a strictly academic course certainly gives students experience that can be translated into the requirements of their first job. This level of student team communication proficiency also results in high client satisfaction and greatly reduces the difficulty of securing funded projects.

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