EFFECTIVE COMMUNICATION FOR PROFESSIONAL ENGINEERING

Beyond Problem Sets and Lab Reports

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For the past three years, Georgia Tech's School of Chemical Engineering has offered a novel course for undergraduate students. It addresses topics in oral and written communication in the context of a bioengineering case study that simulates the variety of communications encountered in the modern workplace. "Effective Communication for Professional Engineering" features weekly guest speakers from a variety of professional disciplines, ranging from a practicing chemical engineer to an FDA regulator to a patent lawyer. This course is unlike traditional English courses, which are designed to generally broaden literary and composition horizons, and unlike traditional technical communication courses, which usually focus on lab reports and memos outside any "real-world" context.

The innovation of this particular course, which is subtitled "Beyond Problem Sets and Lab Reports," lies in its placement of student assignments in context with realistic professional settings. By bringing in a wealth of outside speakers and information, instructors encourage students to think in more creative ways to solve communication problems beyond the creation of a technically correct report. Students find themselves writing to a variety of audiences in more thoughtful ways, whether they are allaying the fears of a hypothetical public or persuading a corporate boardroom to adopt new technologies. They are required to draft a broad range of written and oral communication, including press releases, abstracts, patent disclosures, and speeches to a Board of Directors. Each new audience builds on a core of technical information common to the previous writing assignments, while lectures on audience analysis focus students on the thought processes involved in tailoring these various communications to different levels of technical understanding and informational need.

The pedagogical approach of this course also differs greatly from the relative anonymity of the larger lab or design class where technical communication is often addressed in chemical engineering curricula.[1,2] The students who sign up for this elective course continually experience a high level of peer and student-to-faculty interaction. Peer critiques of both written and oral presentations allow students to comment on each other's strengths and weaknesses. During the quarter, students are placed in shifting teams of two or three for activities that reinforce both the talks given by outside speakers and the instructors' lectures; these classroom interactions are then incorporated into the writing or speaking assignment due in the following class.

NEED FOR COURSE

Universities generally do well at teaching science and engineering students the fundamentals of their field. Our industrial colleagues tell us, however, that academia needs to do better at teaching students how to talk and write about technical topics to both fellow engineers and non-

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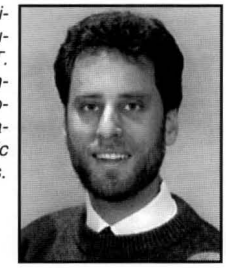

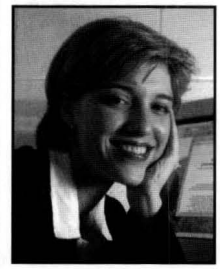

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engineers.[3,4] This course addresses that need in a real and practical way.

Although self-contained, this course also conforms to the broader curricular goals of the department, which include a writing and speaking program within the required unit-operations lab course. The writing aspect of the lab course, however, usually focuses on the technical and written skills necessary to produce just one form of communication—the technical report. And although these technical reporting skills are critical to an engineer's education, by no means will his or her future career as a professional be limited to communicating in only one format or to only one audience type.[5-7] Clearly, a range of communication issues, audience types, and writing and speaking formats should be presented in the undergraduate curriculum to prepare students for their roles as active participants at all levels of the engineering community.

Other communication courses offered outside of engineering are available, but generally have a weak connection with science as practiced in industry.[8] Moreover, we feel that the textbook-driven nature of most technical writing courses, with an emphasis on writing memos and lab reports, does not fully describe the diversity of form and content prevalent in inter- and intra-industrial communication. In contrast, our course provides a broad scope of communication issues and audiences, is based on a case study in context, and is linked to the real experiences of working professionals in the field.

COURSE GOALS

To give students widely applicable tools for written and oral communication, we have emphasized audience analysis and critical thinking[9,10] rather than conforming students to a series of prescribed formats. The goals of the course are to

1. *Provide students with the opportunity to write and speak to a diversity of audiences on at least a weekly basis.*
2. *Bring in outside professionals who work either in or with the engineering industry to discuss what they do and how they communicate.*
3. *Simulate the world of professional engineering by relating oral and written assignments to a common case study.*
4. *Focus on audience analysis as the basic building block of communication.*
5. *Integrate group projects with individual projects to acclimate students to working with others as a team.*[11]

COURSE IMPLEMENTATION

The integrated approach of this course, which seeks to simulate the "life of a professional engineer," is highlighted by extensive in-class discussion with outside professionals, as summarized in the ten-week course outline shown in Table 1.

The course starts by introducing students to technical aspects of our bioengineering case study, based on the Nicoderm transdermal nicotine patch developed by the Alza Corporation.[12,13] During the first two weeks, while digesting this technical information, students write a series of short reports on a current technical topic of broad interest, using information easily found on the Internet (*e.g.*, we used Viagra this year and the ValuJet crash last year). These reports are not formally graded, but are critiqued to help students start thinking about the effective communication of technical information to a variety of audiences.

Once the bioengineering case study begins in earnest, students are required to prepare a written and/or oral assignment every week (see syllabus excerpts in Table 2 and a sample assignment in Figure 1). Each written assignment is turned in to the instructors as well as to an anonymous classmate for peer critique.[14] The oral assignments are followed by immediate feedback from the instructor and from students (additional student self-assessment using a video tape of the presenta-

TABLE 1
Course Overview

Week 1	To set the stage for our case study, you are hired to develop a transdermal drug delivery system to safely and effectively administer nicotine across the skin.
Week 2	To learn first-hand about our case study, we will meet a **bioengineer from industry** who actually developed the first transdermal nicotine patch.
Week 3	Congratulations! You have invented a new transdermal delivery system. We meet with a **patent lawyer** and prepare an invention disclosure.
Week 4	Patent protection allows you to talk publicly about your work. We have a discussion with the **editor of a scientific journal,** prepare an abstract, and present a scientific talk.
Week 5	Your presentation was a great success and has attracted a lot of attention. We talk with a **science journalist from the popular press,** write a press release, and give a short presentation to concerned citizens.
Week 6	Now that you have figured out how to deliver the drug according to federal guidelines, we speak with a **government regulator** and prepare a brief for the FDA.
Week 7	Manufacturing your new device involves difficult procedures that the plant workers dislike. We meet with a **business manager** and prepare a memo for disgruntled employees.
Week 8	To bolster public support for the company based on your life-saving invention, we talk with a **graphic designer** and create an advertising campaign.
Week 9	You develop a second-generation technology that is more effective, but costs more to make. To convince your superiors to invest in this technology, we speak with a **corporate CEO** and prepare a talk for the Board of Directors.
Week 10	Your success has led to new job possibilities. We meet with a **career counselor** and a **professional interviewer,** prepare a resume, and have a mock job interview.

tion would also be helpful, but is not something we have yet implemented). By getting feedback from their peers as well as their instructors, students can simulate the roundtable discussions of teams in the workplace and implement suggestions for the next assignment.

While lectures by the instructors provide general lessons on communication relevant to the topic at hand, each guest speaker gives a detailed look at the requirements of his or her job and the communication issues arising from that job. Follow-up assignments permit students to put lessons from both lectures into practice.

KEY FEATURES OF THE COURSE

A number of features of this course distinguish it from other engineering and writing courses and have been critical to the course's success. Many of these features are not by themselves new, but their combination provides a novel approach to integrating concepts often missed in a conventional engineering curriculum.

- ***Academic, Industry, and Community Involvement*** Lectures are given not only by an engineer (Prausnitz) and a writing specialist (Bradley), but also by industry professionals who visit the class on a weekly basis. Moreover, we have involved newspaper journalism students from a local high school to attend some lectures and critique our students' press releases and oral presentations.
- ***Case-Study Format*** By following a single case study through the whole course, students have a sense of continuity and can focus on communication issues without having to learn new technical information each week. This approach also simulates the long-term development of projects found in industry.
- ***"Real-World" Context*** This course is as much about introducing students to the broad scope of life as a professional engineer as it is about communication. This helps students understand why good communication needs to be an integral part of their professional careers.
- ***Frequent, Short Writing and Speaking Assignments*** To build student confidence in communicating effectively, written or oral assignments are due in almost every class. Most assignments are short: 1000 words written or 4 minutes spoken.
- ***Emphasis on Audience Analysis*** Assignments and classroom discussion emphasize selection of content and format tailored to the intended audience to achieve the

TABLE 2
Syllabus Excerpts

Week 3: Communicating with Lawyers

Guest Speakers
Patrea Pabst, Arnall, Gregory, and Golden
Stephen Dorvee, Arnall, Gregory, and Golden

Assignment
Invention disclosure (see Figure 1)

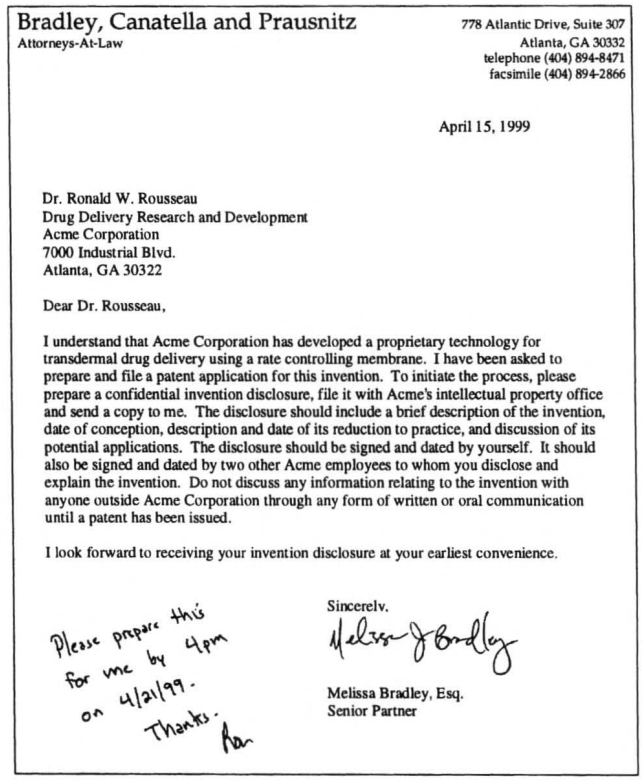
Reading Materials
- "Patents: What, Why, and How," M.H. Heines, *Chem. Eng. Prog.*, pp. 79-85, July (1992)
- *Do's and Don'ts for Keeping Lab Notebooks,* Fish & Richardson, P.C., Boston, MA
- "Copyright and Permissions," B.F. Polansky, in *The ACS Style Guide,* J.S. Dodd, ed., American Chemical Society, Washington, DC, pp. 137-143 (1986)
- "Subsaturated Nicotine Transdermal Therapeutic System," J.L. Osborne, et al., U.S. Patent No. 5,364,630 (1994)
- *Material Evaluation Agreement,* Georgia Tech Research Corporation, Atlanta, GA
- *Proprietary Information Agreement,* Georgia Tech Research Corporation, Atlanta, GA
- *Product Development and Commercialization Agreement,* ALZA Corporation, Palo Alto, CA

Week 5: Communicating with the Public

Guest Speakers (Only one speaker per course offering)
Ann Kellan, CNN
James Pilcher, Associated Press
David Jarmul, Howard Hughes Medical Institute

Assignments
Press release
Presentation at community meeting

Reading Materials
- *Communicating Science News: A Guide for Public Information Officers, Scientists, and Physicians,* The National Association of Science Writers, Greenlawn, NY
- *Headline News, Science Views II,* David Jarmul, ed., National Research Council, Washington, DC
- "Marion Merrell Dow Inc. Introduces First Nicotine Patch for Smoking Cessation," press release from Marion Merrell Dow, Kansas City, MO, Nov. 8 (1991)
- "Heart Attacks Reported in Patch Users Still Smoking," S.L. Hwang and M. Waldholz, *The Wall Street Journal,* p. B1, June 19 (1992)



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April 15, 1999

Dr. Ronald W. Rousseau
Drug Delivery Research and Development
Acme Corporation
7000 Industrial Blvd.
Atlanta, GA 30322

Dear Dr. Rousseau,

I understand that Acme Corporation has developed a proprietary technology for transdermal drug delivery using a rate controlling membrane. I have been asked to prepare and file a patent application for this invention. To initiate the process, please prepare a confidential invention disclosure, file it with Acme's intellectual property office and send a copy to me. The disclosure should include a brief description of the invention, date of conception, description and date of its reduction to practice, and discussion of its potential applications. The disclosure should be signed and dated by yourself. It should also be signed and dated by two other Acme employees to whom you disclose and explain the invention. Do not discuss any information relating to the invention with anyone outside Acme Corporation through any form of written or oral communication until a patent has been issued.

I look forward to receiving your invention disclosure at your earliest convenience.

Please prepare this for me by 4pm on 4/21/99. Thanks. Ann

Sincerely,

Melissa Bradley, Esq.
Senior Partner

Figure 1. *Sample assignment for invention disclosure.*

desired effect rather than reiterating grammatical and generic stylistic rules already covered in freshman English courses.

- ***Instructor and Peer Critique of All Assignments*** All students receive written and oral feedback from both their instructors and their classroom peers on every written and oral assignment. Peer critiques are educational to the recipient as well as to the person offering the judgment.[14]

COURSE EVALUATION

The course's impact has been assessed by students in the course, guest speakers who visited the course, and the instructors. Results from Georgia Tech's standard anonymous student evaluation form, supplemented by a course-specific written evaluation, showed that students were very supportive of the course and strongly recommended it to others. Figure 2 shows responses to questions about overall effectiveness of the course. These responses suggest that the speakers, reading materials, and emphasis on written assignments were all well received. As indicated in the figure and in other comments, students felt a stronger emphasis on oral communication would be helpful, and following this suggestion, we will replace some of the written assignments with oral assignments in future course offerings. Also, the peer critiques were not perceived to be as useful as instructor feedback. To address this, we now require that peer critiques be at least a half-page long and that they identify specific problems and suggest concrete solutions.

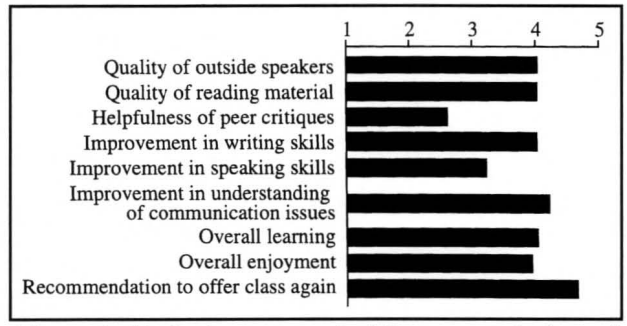

Figure 2. *Student assessment of the course. A class of 14 students was surveyed and asked to rate different aspects of the course on a scale of 1 (terrible) to 5 (excellent).*

Guest speakers have been uniformly supportive of the course and frequently commented that they wish they could have taken a similar course when they were students. All of them liked the guest-lecture format and found the approach relevant to their careers and their interactions with engineers.

As instructors, our assessment of the course is that it met the objectives we set out to achieve and has been beneficial to students, guests, and instructors alike. We believe that the guest speakers, who are coached in advance, have been critical to the course's success because they broaden the scope of the course and ensure its relevance to "real-world" issues. To maintain the sense of continuity necessary to the case-study course format, it was also important for us to continually clarify the connections between speakers, reading materials, and overall course objectives by providing follow-up presentations.

Despite the strongly positive reviews from students and guest speakers, it is difficult to get many students to sign up for the course in view of Georgia Tech curriculum requirements. Because this course cannot count toward any graduation requirement other than free elective credits (which most students do not need), the only students who have taken the course are those with enough interest and who are far enough ahead of the curriculum to fit it into their schedules. Thus, each course offering has attracted a small group (8 to 14) of strong, motivated students out of a chemical engineering graduating class of 120 to 150. In an attempt to expose a larger fraction of students to communication issues, we plan to offer the course on a 1-unit pass/fail basis (guest lectures only) in addition to the regular 3-unit graded option. We are also permitting graduate students to take the class and advertising the course more intensively outside of chemical engineering.

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