TECHNICAL COMMUNICATION IN THE MODERN UNDERGRADUATE LABORATORY

Based on surveys made nationally and at Texas Tech it is apparent that renewed efforts need to be directed to the development of technical communication skills in the undergraduate laboratory. This paper reports the findings of these recent surveys and outlines the program developed at Texas Tech to meet the indicated needs. In general, the new emphasis is on a greater amount of instruction on brief communication forms such as memo and letter reports to nontechnical as well as technical audiences. Formal oral presentations are also required. With the assistance of the English Department a guided, self-study manual has been developed and is being tested.

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The importance of effective communication is a fact of life to the practicing engineer. A recent survey of prominent engineers (selected from the 1973 edition of *Engineers of Distinction*, published by the Engineers' Joint Council) confirmed this point (*1*). Here is one key statistic: 95% of the respondents reported that the ability to write effectively is either "very important" or of "critical importance" in their work. A very similar response was obtained as part of a 1978 survey of recent chemical engineering graduates from Texas Tech University (*2*). In this survey, 96% of the respondents answered yes to the question, "Do you consider writing ability to be essential to the performance of your job?" Further evidence for the importance of writing ability can be drawn from the great number of writing courses that employers, professional societies, and other groups offer working engineers as part of their continuing professional development (*3*). Presumably, engineers who received inadequate training in college are making up for their writing deficiencies, while adequately trained writers are improving their skills.

If writing ability is essential to the working engineer, it would seem that, in addition to freshman composition, further undergraduate coursework in technical communication is highly desirable. In fact, 80% of those responding to the Texas Tech survey of its chemical engineering graduates indicated that a course in technical communication should be required of all B.S. graduates. Moreover, the rapid growth of technical communication coursework in American universities demonstrates that a great many people share this view.

What form should a technical communication course take? Much thought was given to this question when, in 1974, the Texas Tech chemical engineering department made plans to initiate a technical communication program for its majors. Since that time, new insights have come from the teaching and modification of that course. We can now offer what we regard as a blueprint for a successful program:

1. The course should be taught within the chemical engineering department and should be a requirement for graduation.
2. The course should be taught by a specialist in the teaching of technical writing.
3. Course assignments should be devised so that students learn to write for different audiences and situations.

We would like to describe the technical communication course we have built from this blueprint and the benefits and drawbacks we have encountered in the teaching of this course.

THE COURSE SHOULD BE TAUGHT WITHIN THE CHEMICAL ENGINEERING DEPARTMENT

Our technical communication course is actually a part of the Unit Operations lab course, a two-semester course taken mostly by seniors. Consequently, the students' engineering assignments—their lab reports—are graded for technical con-

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tent by the chemical engineering professors and for communication by the technical communication professor. The reports are also the focus of the technical communication classes. Bringing the writing instruction into the Unit Ops lab has brought about three very considerable benefits:

1. Communication is taken more seriously. Seniors take a professional interest in their engineering coursework. By adding the study of communication to this coursework, communication is accepted as one more facet of engineering professionalism—not as just one more English course. We should note that the influence of the chemical engineering faculty is crucial in this respect. The students will take their cue from the chemical engineering faculty as to the importance of the communication instruction.

2. We avoid burdening our already overworked students with a set of more or less superfluous writing assignments. Because our students write extensively in Unit Ops and because this writing is the focus of technical communication coursework, they do not need to write another set of assignments for a separate technical writing course.

3. The chemical engineering faculty members also benefit: they receive much more carefully and more skillfully written lab reports.

CONVENTIONAL COURSES

At this point it will be instructive to compare our program with the conventional technical communication courses taught within departments of English. Such courses can be successful. The students, after all, are usually encouraged to write about their own areas of study. Familiarity with and interest in the subject matter will in and of itself improve writing.

The conventional format, however, does reveal several shortcomings when compared to our interdepartmental format. First, although students in the conventional course generally choose assignment topics pertaining to their area of study, the reports are almost inevitably compilations of material in the library and not reports of their own lab work. Second, without a professor from the student's own discipline reading the report, the technical rigor of the work is apt to decline. Third, students in the conventional course come from a variety of disciplines. The course, therefore, may well have to cover the communication formats and conventions of agriculture, the social sciences, and other fields besides engineering, and the instructor will thus have little opportunity either to learn about or to teach the communication formats and conventions of any one field. Fourth, as noted before, without the direct influence of the engineering faculty, engineering students will not accept an English course as a part of their professional training.

ORGANIZATION OF INTERDEPARTMENTAL COURSE

Our interdepartmental course is organized in the following manner. [Descriptions of other interdepartmental courses have also been published (*4, 5*).] We divide the Unit Ops students into groups having a maximum of four members. One chemical engineering professor directs the course, but two others assist by supervising and grading some of the lab groups. The students meet once a week, usually for the entire afternoon. The writing instructor, a technical communication specialist from the English department, gives a 50-minute class at the beginning of each of the lab periods. Thus, over the course of the academic year, the students receive about 30 writing classes. (The content of the classes will be discussed in detail below.) Because Unit Ops is required for graduation, the technical communication course is, in effect, also a requirement. No course credit is given, however. Instead, the technical communication grade is figured into the overall Unit Operations grade.

The nine major lab reports written during the year are graded 30% for communication. In addition, a group of supplementary writing projects is assigned and graded by the technical communication professor. From these two grades, the overall communication grade comes out to 41% of the overall Unit Ops course grade.

We like to think that the students' own recognition of the importance of communication skills in their careers provides the primary motivation for carefully written reports and serious work in the writing classes. But, no doubt, for some of the students all of the time and for all of the students some of the time, the 41% communication grade provides the main motivation for good writing.

THE COURSE SHOULD BE TAUGHT BY A SPECIALIST IN THE TEACHING OF TECHNICAL WRITING

Although we believe that technical communication should be taught as a part of the engineering curriculum, we also believe that an English professor—specifically a technical writing specialist—should be brought in to teach it. The greater the investment of instruction time in writing, the more important it is to have a fully trained and fully committed professional doing the job.

There are, we recognize, a great many highly literate engineers in the teaching profession. These individuals write very well, can readily spot student errors, and have no trouble writing in good revisions on student work. However, very few of these individuals are prepared to give a clear linguistic explanation of many of their revisions, to analyze the underlying cause of a student's writing deficiencies, and—most important—to conduct an organized program of writing instruction. There is also the question of inclination. Like almost all engineering professors, the chemical engineering faculty members at Tech prefer to devote most of their lab assistance time and attention to the technical aspects of students' work. The Tech faculty members do—as indeed they should—make comments and corrections whenever they wish. But they are happy to be relieved of the primary responsibility for grading and for teaching writing. We have learned from our experience in earlier years that writing instruction given by engineering faculty members tends to slip into a discussion of technical matters. Bringing in an English professor ensures an emphasis on writing and frees each instructor to do what he does best

and prefers to do. We believe that this part of our blueprint is extremely important and fully justifies the extra effort involved in setting up an interdepartmental program.

COURSE ASSIGNMENTS SHOULD BE DEVISED SO THAT STUDENTS LEARN TO WRITE FOR DIFFERENT AUDIENCES AND SITUATIONS

The course assignments, we believe, must not only satisfy the technical requirements of the chemical engineering professors but must also promote the growth of communication skills. Toward this end, students are required to write reports and supplemental writing projects that address different audiences and situations. The assignments, of course, are actually read by professors but are written as though they were being read by the specific audiences stipulated for each report.

Writing reports for simulated audiences and situations is certainly more challenging than writing a single kind of report addressed directly to the chemical engineering professor. These reports are also in certain respects more difficult for the chemical engineering professor to grade: they may be longer than they would otherwise be, and the chemical engineering professor must adjust for the fact that the reports are not written directly to him. We have, of course, made sure that each kind of report contains all the technical information that the chemical engineering professors require to properly evaluate the students' laboratory performance. Despite the extra effort involved for both students and chemical engineering faculty, we believe strongly in this approach. For one thing, students begin learning to write for the audiences and situations that they will encounter after graduation. But even more important, the students learn to approach communication as a problem-solving activity, almost as a form of engineering. Teaching students to analyze their audience and design communications that are appropriate for particular situations is as important as teaching grammar and sentence structure, and therefore it receives much attention in our course.

Before discussing the actual assignments, we would like to make two observations about them. First, we have required enough assignments to give our students regular writing practice. This, we believe, is crucial: the only way to improve one's writing is to write. In addition, regular assignments enable students to put each new lesson into immediate use and to reinforce their mastery of previous lessons.

Second, our assignments show an emphasis on the shorter forms of writing and on oral communication over the long, formal reports that had been assigned more frequently in the past. Although this emphasis had been developing for some time, an extensive change was made because of comments we received on the Tech survey. Our past graduates told us that the bulk of their writing took the form of short reports and that oral presentations were very frequent in their work. It is our intention to keep our program flexible and as relevant as possible to our students' future careers.

The nine major lab reports and the supplemental writing assignments that we typically assign during an academic year are described below.

LETTER REPORTS

Letter reports are an external communication written for an imaginary individual with a managerial position and background. The report includes a technical attachment written for the manager's technical staff. The students are required to write the letter itself on a semitechnical level and within the context of an imagined industrial situation; the technical attachment, however, is written directly to the chemical engineering professor and contains all the technical information the chemical engineering professor will need to evaluate the student's experimental work. Two letter reports are written during the year.

MEMO REPORTS

Memo reports are written for the engineer's immediate supervisor (in effect the chemical engineering professor). They consist of a cover memo and a short-form report. They are highly technical, and, because the supervisor is presumed to be familiar with the engineer's project, they contain a minimum of background information. Three memo reports are written during the year.

FORMAL REPORTS

Formal reports are long and highly organized documents. Because they serve as the organization's permanent record of a research project, they must be extremely complete. Because they may be used by a variety of individuals in an organization—from engineers to managers to the marketing and legal staffs—they must be carefully organized to present information in forms that will be useful to all the members of a varied audience. Two formal reports are written during the year. The students in each lab group prepare these reports jointly, except that each student must submit his own discussion section.

ORAL REPORTS

In Unit Ops the oral report audience is mixed. The chemical engineering faculty members and students make up a technically trained audience. The technical communication professor role-plays a manager with only a modest technical background. The emphasis of our instruction is that the speaker must be able to alter his presentation in response to the feedback he receives from the audience. The reports, which last about 30 minutes, are given jointly by the members of each lab group. A rigorous question-and-answer period follows each report. Visuals, especially transparencies, are used extensively in these reports, and they make up an important part of the grading. Two oral reports are presented during the year. The reports are prepared and delivered jointly by the members of each lab group.

SUPPLEMENTAL ASSIGNMENTS

In addition to these major reports, the students prepare various other, generally smaller, assignments.

Because chemical engineering seniors begin looking for jobs in the fall, the course includes an early unit on general business correspondence and on letters of application and resumes. At

least one individual conference is held with each student on resumes. The resumes must be effectively designed and perfectly executed before the assignment is considered complete.

In addition, several short progress reports are assigned during the year. Apart from informing the chemical engineering professors about the students' progress on the Unit Ops experiments, these reports provide the students with writing practice during the weeks when no major reports are due.

Finally, several assignments consist of explaining a technical concept to the layman. This year, as one of these assignments, students prepared explanations of the *R*-factor and other topics relating to insulation for the benefit of homeowners who had been calling the department with questions on this subject.

In addition to teaching students how to write different kinds of lab reports and, more generally, how to design communications for various situations, we covered a variety of other topics in the technical communication classes. Some of these topics pertain to the actual process of writing; in effect, they are a review of freshman English. These topics include grammar and punctuation, efficient sentence structure, precise and jargon-free word choice, tight organization of paragraphs, and the appropriate patterns for organizing larger units of writing.

Other topics pertain specifically to technical writing. These include the use of graphs and other visuals, the understanding of the technical divisions of lab reports (what is a conclusion, what belongs in the discussion section, and so on), report documentation, the use of the active and passive voices in technical writing, the use of abbreviations, and the use figures and spelled-out numbers.

This year we introduced a report-writing manual written specifically for the course. It gives instructions for the preparation of the different kinds of reports and covers some other aspects of technical communication. A separate division covers mathematical treatment and the graphic and tabular presentation of data. The contents of the manual are shown in Figure 1. The manual makes it possible for students to study much of the course material on their own, and so much more material can be covered during the year.

EVALUATION AND CHANGE

We believe that our program has proven successful. We have been pleased with the writing and speaking ability of most of our students at the end of the year. The students themselves seem to accept the writing program as necessary, and graduates who return on visits seem downright grateful to have had the work.

Despite our apparent success, we have had and continue to have some difficulties. Most of these occur because more than one faculty member is grading each report. Also, having three different chemical engineering professors (who are changed periodically) involved in the course makes things more complex. Our main problems are these:

1. Because each report is read twice, there have been delays in returning them to the students.
2. Our grading system with its weighting of technical and communication report grades and its separate English grade is very cumbersome.
3. All of the professors involved in the course have had

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Fig. 1. Contents of report-writing manual.

some different ideas about good writing style and about correct report format. This problem was, until recently, by far the most severe. Students often received conflicting instructions from different professors and were graded down by one professor for following the instructions of another. (This tended to hurt morale!) This problem, however, has been greatly alleviated through the introduction of the report-writing manual. The manual has provided standards for students to follow and for professors to grade by. To gain maximum acceptance for the manual from the chemical engineering faculty, a draft was circulated through the department and suggestions were solicited. These were incorporated into the final version whenever possible. Some conflicts still arise, especially as new chemical engineering professors join the course. But the problem is now manageable.

One problem we have not had is a problem that would have been insurmountable: this course could not work without the strong support of the chemical engineering faculty. These professors must be willing to share class time and grading input, to work closely with an outsider in coordinating both the instruction and the administration of the course, and to work at convincing—and reconvincing—the students that communication is a vital part of engineering and that the technical communication program is regarded by the engineering faculty as an important part of the students' professional training.

SUMMARY

If solid support from the chemical engineering faculty will be forthcoming, we can strongly recommend our blueprint for an interdepartmental technical communication program:

1. The course should be taught within the chemical engineering department and should be a requirement for graduation.
2. The course should be taught by a specialist in the teaching of technical writing.
3. Course assignments should be devised so that students learn to write for different audiences and situations.

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