

Integrated Technical Writing Instruction in Freshman Engineering

Elisa Linsky, Gunter Georgi.

Polytechnic University, Brooklyn, New York.

Convincing freshman engineering students that acquiring technical writing expertise is critical to their success is central to the mission of the writing program in General Engineering. By deploying writing consultants to each section of our benchmark introductory course, EG 1004, we teach the fundamentals of good writing within the context of regular engineering coursework.

EG 1004 is a survey course designed to introduce various engineering disciplines to our incoming freshmen. Teamwork, the development of presentation skills, and the acquisition of technical writing skills are incorporated into the curriculum. By the end of the semester, our students have improved their time-management skills, become adept at delivering a technical presentation, can prepare a well-written report, and are ready to proceed into their chosen major.

This paper will describe the EG writing program, including each of the four writing styles we teach: lab reports, software documentation, technical presentations, and proposals. It will also include a discussion of the classroom instruction we undertake to introduce each of these assignments and the critical function each writing consultant performs when grading student work.

The key to our success is the delivery of writing instruction within the context of regular engineering coursework. By introducing the importance and relevance of technical communication at the beginning of each student's academic career, in a required engineering course, we are able to overcome the skepticism many young engineers have about how much writing they will need to do. They don't need to come to us, something they incorrectly assume is unnecessary; we go to them.

Introduction

The most effective strategy for teaching technical writing is open to debate. The options can be boiled down to four lines of attack.

1. Technical Writing Course: Students can be required to take an introductory technical writing course, where they learn the fundamentals of the discipline by preparing memos, correspondence, mechanism and process descriptions, progress reports, proposals and the like. Courses like this are taught by technical writing faculty.

2. Writing Instruction Delivered by Technical Faculty: Technical faculty can incorporate writing instruction into the courses they teach. A physics instructor might, for example, introduce the topic of technical writing in his Introduction to Physics course, and grade lab reports and such with these skills taken into consideration.

3. A course co-taught by a technical faculty member and a writing instructor: In this model, technical content is linked to the writing curriculum. For instance, in a General Chemistry course all the technical subject matter is explained and evaluated by a chemistry professor; all the writing instruction is handled by a writing professor. In this model, writing and chemistry each account for half of the curriculum.

4. Writing Consultants: The fourth option is the one we employ; writing instruction is embedded in an existing technical course and administered by a writing consultant, who tailors lessons and assignments to the coursework that already exists.

Each of these instruction models has strengths and weaknesses. The advantage of a technical writing course is that the entire semester is dedicated to the mastery of the discipline. The instructor is afforded the time to properly introduce students to the fundamentals of tech writing. There is also plenty of time to practice. The faculty member teaching a course like this is an expert in the subject matter. The disadvantage here is that unless a course like this is required, very few students will take it. Many engineering majors attempt to avoid writing at all costs. Frequently this is because they just don't like to write and have chosen a technical profession to avoid having ever to do so. While engineering faculty understands the importance of communication skills, as do the accrediting agencies that monitor their schools, students remain skeptical. A demanding curriculum like that required to prepare engineers for their profession frequently doesn't afford the opportunity for students to take Technical Communication courses. Only a motivated few will use an elective to do so.

When technical faculty delivers technical writing instruction, the results vary depending on the competence of the faculty member to teach writing. After all, being a knowledgeable technical writer doesn't necessarily mean one can teach technical writing to others. If the professor is comfortable, the results can be spectacular. More commonly, the technical instructor is unsure of the subject matter and resents the added work load a writing intensive course requires.

The co-teaching model seems like a good one because it aims to provide the best of both worlds by merging technical content with writing instruction. In our example, the chemistry professor delivers the chemistry instruction and designs the lab work. The writing instructor then develops writing assignments that build on the chemistry instruction. Lab reports and the like are graded by both professors for technical content and written expression. The disadvantage of this model is that it requires an enormous amount of co-operation between the instructors. They must prepare all course work, right down to the syllabus, as a team. Even well intentioned faculty can disagree about what constitutes success or failure for example, or what is good writing. Co-teaching is an ambitious goal, that can be enormously effective, but it requires a strong commitment from the instructors and their institution.

The idea of using a writing consultant embedded in a technical course takes the co-teaching idea and modifies it just enough to make it more feasible. The writing consultant is responsible for writing instruction, but it is limited to brief mini-lessons targeted to address important technical

writing topics. Instruction is reinforced through the careful grading of written work. Here the writing consultant has the opportunity to point out areas where improvement is needed. The success of this model lies in its focus on incorporating writing instruction, with a limited introductory scope, in an existing technical course. By helping students to understand the importance of effective technical communication in the context of an engineering course, we are laying a foundation for future study.

Polytechnic's EG 1004 Writing Program

EG 1004 is Poly's introductory engineering course. It is required for all engineering majors. It is described in the university catalog like this:

EG 1004 Introduction to Engineering and Design 1:3:2:4

An introduction to selected aspects of the history, philosophy, methodology, tools, and contemporary topics in engineering. Basic engineering experimentation and data analysis. Team design project. Analysis and presentation of engineering data and designs.

The course is composed of a weekly three hour lab, a two hour recitation and a one hour lecture. The teaching team for each section (there are usually between 13 and 15 sections each semester with 16-18 students per section) is composed of an instructor, who manages the recitation each week and is responsible for the semester-long design project, a writing consultant, who attends the second hour of recitation and delivers a 10-minute mini-lesson and then circulates among the students as they work on their independent projects, and three teaching assistants, two for lab and one for recitation.

History

In the spring of 1998, with Gateway Coalition support, an applied writing component was added to the existing EG program to help students develop the writing skills needed in the technical professions. Faculty from Humanities and General Engineering collaborated to develop curricular goals for the writing component of the course. Students were provided with individual and group instruction on the structure and format of lab reports and proposals. Professional writing style and the use of Standard English were also addressed. Writing Consultants from the Humanities Department were assigned to each section of the course, initially, the Writing Consultants did not grade student writing or present a lesson on a writing topic. Their role was in a support capacity.

Each semester, modifications to the writing program were made. The writing consultants began to grade all student writing for professional style and use of Standard English. This change substantially improved student writing. By providing writing consultants the opportunity to consistently point out and correct errors, students were able to incorporate these lessons into their weekly writing.

The writing program was also provided 10 minutes each week during the Recitation session to deliver a mini-lesson on a writing topic. Subjects like grammar and punctuation, taking lab notes,

the use of persuasive language in proposal writing, objectivity and the use of the passive voice in technical writing, and the correct use of secondary sources are taught. The writing consultants were given latitude to decide what lessons will be most beneficial to their students.

Recent Improvements

In the summer of 2003, substantial improvements to the program were made thanks to the generous financial support of the Engineering Information Foundation (EIF). The mini-lessons were standardized and presentations were prepared using Microsoft's PowerPoint. This provided two distinct advantages. The first was that because we employ so many writing consultants, we needed to ensure consistent instruction when introducing new assignments. By supplying the writing consultant with this tool, we were able to make sure they were all on the same page. They also allow us to instruct our students by providing a good example. Each lab team presents their experimental results in recitation; they use PowerPoint to do this. Our presentations adhere to the rules professionals use when preparing technical talks. So, when we present we provide an example of an effective presentation for the students to follow.

The EG 1004 Lab Manual is modified each semester in order to incorporate changes into the curriculum. Because of this, its format had suffered. In addition, the editorial style varied from lab to lab, and its content needed refreshment. The manual was redesigned, and all of its content reviewed and rewritten. The resulting document is a substantial improvement over the old book. It is filled with useful information presented in a pleasing style. A technical communication section was added to supplement our other writing instruction. Now, we can direct students to the manual for help with specific writing questions.

An assessment program was added beginning in the fall of 2003, again with the help of the EIF grant. While we were sure anecdotally that our students were better writers when they had completed EG, we wanted to develop ways to measure what our students were learning and also to engage them in a systematic program to get them thinking about their writing. If changes in content or delivery were required we needed a way to find that out.

Using BlackBoard, the course content software Poly employs, a combination of surveys, one-minute papers, and a portfolio review were designed and implemented. The assessment program was designed to find out what our students know coming in, what they learn in the course, and most importantly, what they think about what they are doing and learning in the EG writing program. Including self-assessment as a goal makes this tool more than just a way of measuring performance. The assessment program itself teaches writing by getting students engaged in a discussion of the topic and by encouraging them to consider how they have improved. Chris Leslie, the EG assessment coordinator, has prepared a paper for this conference. It is document 2004-1744, entitled *Writing Self-Assessment for First-Year Engineering Students: Initial Findings* Chris Leslie, Elisa Linsky in the Liberal Education Division. Please review Chris's paper for more information on EG's assessment program. See Appendix A, attached here, for data from our assessment program.

In addition to these initiatives, a PowerPoint style guide was prepared to help our students master the fine points of technical presentations. By specifying fonts, type faces, spacing, and

suggesting color schemes, among other recommendations, we have simulated the specifications technical professionals use in industry. We also created a lecture on technical communication to be presented to the entire cohort of EG students. This presentation highlights the communication breakdown that occurred between NASA engineers and their managers during the last flight of the shuttle Columbia. While many factors led to the tragedy, the final report on the crash included this failure to communicate as a contributing factor.

Integrated Writing Instruction

Incorporating writing instruction into an existing technical course is a very viable way to teach technical communication skills to engineering students. In EG 1004, embedding writing consultants in *Introduction to Engineering and Design* allows students to develop their writing skills in a way that is relevant to them. By teaching them how to write lab reports, software documentation, proposals and PowerPoint presentations, the essentials of effective technical communication are passed along in a way that makes them add up to more than just an academic exercise.

The success of the program depends upon the co-operation of Poly's technical faculty. Without their support, this program would not work, but without question, our outstanding writing consultants are the lynchpin. Without their dedication to teaching the craft of writing, all our preparation would fall flat.

In the future, we would like to apply the lessons we have learned in EG to other writing intensive technical courses, like Physics and Chemistry. By structuring the program as we have, we've built in the flexibility necessary to do this.

ELISA LINSKY, Instructor, Undergraduate Advisor -Technical Writing Program, is coordinator of the Writing Consultant program for EG 1004. She is the co-author of the grant which supported this project.

GUNTER W. GEORGI

Gunter W. Georgi is an Industry Professor at Polytechnic University. He received his BS from Cooper Union and his MS and professional M. E. Degrees from Columbia University. He is a registered Professional Engineer. He has worked for many years in the aerospace industry in design, analysis and management functions, including Thermal Mission Analysis of the Lunar Module from Apollo Project.

Appendix A: Assessment Data, from Document: 2004-1744, Writing Self-Assessment for First-Year Engineering Students: Initial Findings, Chris Leslie, Elisa Linsky

Preliminary results of the assessment program are encouraging. Students participated in the components with a minimum of difficulty. A minimum of students responded with antagonism to some of the assignments, but the effect was to remind the writing consultants that not every student finds writing an enjoyable task and that some would much rather be spending their time elsewhere. A good deal of previous preparation for the course was demonstrated by students, and students in the control section showed a lower improvement in their attitude toward writing and less apprehension of writing lessons.

A. Skills Survey

The skills survey demonstrated that the more we ask students to think about what they are writing, the better they do on their assignments. Some results suggest that we need to use the assessment program to focus students' attention on the engineering aspects of their assignments.

1. Asking students to reflect on the projects they completed had a definite impact. Students in the assessment sections were able to identify more types of scientific communication at the end of the semester, by a factor of 2 or 3.

	<i>Section E3</i>	<i>Section D</i>	<i>Control</i>
Exit survey # types	1.9	2.6	1.6
Entry survey # types	1.0	0.8	1.2
Average change	0.9	1.8	0.4

2. All students showed significant learning in the sections of a lab report. The writing consultant program in general effectively teaches students what types of information belongs in each section, but this was not a specific target of the assessment program.

	<i>E3</i>	<i>D</i>	<i>Control</i>
Exit survey # correct	8.5	9.1	9.3
Entry survey # correct	5.4	6.5	5.1
# change	3.1	2.6	4.2

3. Most all students in both assessment and control sections view the format of a scientific report as a means to allow the report to be written and/or read easily. This is a clear indication of wash back---due to the current teaching and assessment methods, most students are concerned with filling out a report as an exercise and do not worry about the overall report. This is something that the assessment program should address in future iterations.
4. Students with a better attitude about scientific writing pay more attention to writing consultant lessons and take better care in preparing their reports. All students had a relatively high opinion of communications skills before they began the course. However, the attitude of students in the assessment sections improved dramatically as compared to the control sections.

	<i>E3</i>	<i>D</i>	<i>Control</i>
--	-----------	----------	----------------

Exit survey attitude (of 5)	4.6	4.9	4.5
Entry survey attitude (of 5)	4.0	4.0	4.6
# change	0.6	0.9	0.1

5. Students in section E3 participated in an online exercise about the presentation of scientific information in addition to a minilesson by the writing consultant. This section performed much better on the exit survey than the other sections.

	<i>E3</i>	<i>D</i>	<i>Control</i>
Exit chart (of 5)	2.79	2.38	1.93
Entry chart (of 5)	2.00	2.88	2.14
# change	+0.79	-0.50	-0.21

6. Students in all sections felt they already had basic word-processing and writing skills before they entered the class. Other than that, however, students felt that they learned a variety of lessons from the writing program, indicating that they learned a variety of lessons in EG. Writing software documentation, design solutions, and teamwork tended to be the highest-rated. While this does not reflect a trend related to the assessment program per se, it does show that special projects were a new experience and a definite benefit to the program.
7. When asked if the writing assignments were relevant to their major or planned career, most students in each section said yes.

	<i>Yes</i>	<i>Somewhat</i>	<i>No</i>
Section E3	8	5	1
Section D	7	3	3
Control	9	3	2

Despite this apparent success, students' reasons for this answer were alarming. 6 students in section E3, 6 in section D, and 5 students in the control section (about half of the respondents) based their answer on the scientific content of the course, not the engineering content. In other words, a CS major would say that the course was only somewhat relevant because there were some CS-related projects; an EE or ME major would say that the course was relevant because there were many such projects. This result demonstrates that a large number of students are not valuing the engineering aspects of the projects we ask them to do and their relationship to writing projects, such as progress reports, proposals, and reports that comment on the effectiveness of a design.

8. Many students commented that they did not know that engineers had to write so much; this was a significant change they reported in their understanding of engineering/computer science.
9. The writing lessons students took away from the course were varied, as could be predicted. Most answers fell into three main categories: writing process (including time management and revision), writing for a purpose (including different styles for different situations) and describing scientific experiments (including writing with precision).

B. Results of One-Minute Papers

Students completed the one-minute papers with a minimum of fuss and grumbling. Because we did not have Blackboard access from the beginning of the semester, we began with e-mail or paper assignments which students had trouble doing (e-mails bounced, attachment failures). When we switched to the online bulletin board, some were hesitant to participate but would not explain the reason. The online process, however, seemed to be the best route and all one-minute papers should be converted to discussion board topics or Blackboard quizzes.

One of the greatest successes in the “one-minute” papers was one that sought to prepare students for the final proposal for their independent semester project, which is supposed to be a persuasive document. This “one-minute” paper asked students to identify a common product, describe its features, and explain the benefit it confers to the consumer. This project was designed to direct students away from proposals that were simply descriptive in their approach and instead begin to think about how they might sell their ideas to a client.

After a short presentation in class about persuasive language, students submitted their “one-minute” papers using Blackboard’s discussion board feature. The first few students who responded, as was expected, simply described the features of the project. At this point the writing consultant entered the discussion and praising the descriptions but explaining that the part of the assignment was to hypothesize for the consumer what benefits the product would confer. Subsequent posts tied many features into many benefits, which was a significant improvement but was unfocused. After a second post from the writing consultant, praising the benefits but noticing the unfocused nature of the posts, two of the remaining students were able to provide focused posts that described the features and the benefit they confer. While not every student was able to get the point of the exercise right away--after all, it is not a simple thing to do--through the group process the class as a whole was able to see an appropriate response and understand the complexities of obtaining one.

We found an unexpected result of the “one-minute” papers in the section where the Blackboard discussion board was utilized. On the board, separate folders were set up for each paper, and general folders were created as well that solicited input from students on areas of the writing component they did not understand and questions about writing reports. When these general folders were established, several students availed themselves of the opportunity to question the writing consultant on a variety of topics, from how to achieve an objective tone to how to capitalize a title. This simple mechanism proved to be a valuable communication tool, and allowed the writing consultant to further assess his students’ understanding and modify his instruction accordingly.

C. Results from Midterm Portfolio

The opportunity to revise a report was a successful component of the assessment program. Several students noted in surveys that this was the first time they had carefully considered the written comments from the writing consultant. They appreciated the opportunity to learn from their errors, and benefited from using their experience of writing five lab reports to revise one from earlier in the semester.

A number of students did not complete the portfolio. While this was disappointing, some found it difficult to gather the necessary materials and submit them, even when granted an extension. This was unfortunate, but did not result in large negative impact. They lost five points on the associated lab report, and while they did not get a chance to improve their lowest lab report, they did not receive a significant negative impact for failing to complete the report.

One interesting phenomenon observed in this aspect of the program was that the students who wrote the best reports tended to put the greatest effort into the portfolio project. Students who were struggling with basic language skills showed a great attention to the portfolio as well. The ones who responded poorly to the portfolio were those who demonstrated a negative attitude to the communication component of EG 1004 in other areas.

In the assessment meeting, the writing consultants briefly presented the best and worst reports from their sections to the group. We discussed what makes a good report, and offered each other ideas on how to improve those who were struggling. One particular discussion was the efficacy of written comments; while not directly a portfolio issue, this issue was important to those who attended the meeting. In addition, we discussed the objectives and mechanics of the “one-minute” paper. Thus one of the beneficial aspects of the portfolio process was a reason and a forum for instructors to trade information about their sections and to discuss techniques they find useful in instruction.

D. Midterm Evaluation

One surprising result of the midterm evaluation was that the different sections showed varying preferences for different aspects of instruction. In general students highly valued receiving written feedback from the writing consultants, which is a time-consuming aspect of their job but apparently valuable. The students also valued personal discussions with the writing consultants, leading us to believe that making ourselves more available and encouraging students to discuss their reports with us would be valuable.

Two interesting results related directly to the assessment project, specifically the portfolio and the “one-minute” papers. The comments on these items showed students had very strong opinions both in favor and against these items, but over all they rated them lowly. Some students noted that the “one-minute” papers helped focus their attention on the lab reports or aspects of writing that were important; others mentioned that they found it difficult to remember to complete them on time. Students in Section D noted that the “one-minute” papers would add stress to the class, which was an unusual response given that students in that section were completing them during class time. Several students found the portfolio project to be worthwhile, and liked to review their improvement over time and to have a chance to capitalize on their learning. Overall, however, this item was one of the least favorite items in the class.

This mixed result points the vexing nature of using student satisfaction to guide course development. One problem demonstrated is that students have varying responses to course objectives, and some students may get the most out of assignments that others find to be tedious. In terms of feedback, however, this information was invaluable. Coming at midterm, it allowed writing consultants to reevaluate their approach to their teaching methods, indicating that certain

aspects of the course needed to be “sold” better to the students. In addition, it demonstrated that there may be a problem in understanding what are the names and purposes of varying assessment components; this will certainly improve in time as writing consultants become more proficient in the program but perhaps could be helped from greater direction from the assessment coordinator.