A Proposed Plan for the Communication Program in Electrical and Computer Engineering

Electrical and Computer Engineering Department, Virginia Tech

Summary and Introduction

This document proposes a plan for the communication program for undergraduates in the Electrical and Computer Engineering Department at Virginia Tech. The program consists of a variety of communication assignments and instruction in a number of required courses that span the three years in which undergraduates are in the Department (in their first year, all engineering students are in the Engineering Education Department). The main feature of the program is that in each of the three years, students have to write and make presentations about topics in their discipline. The two courses in the program that provide the most formal instruction about technical writing and presentations are Engineering Professionalism (ECE 2000), which is taken in the sophomore year, and Technical Writing (English 3764), which is taken the junior year. At least four other courses in the Department include other communication assignments so that students can practice and receive feedback on their attempts to write and present in the discipline.

This document describes this communication program by first giving background on the Department and discussing expectations of communication in the electrical and computer engineering discipline. Then the document details both the learning objectives of the program and communication assignments and instruction in the curriculum to fulfill those objectives. Following that are our on-going efforts at assessment of the program. Given next is a discussion of the strengths and potential weaknesses of the program. Concluding the document are improvements planned for the program.

Background on the Department and Expectations in the Discipline

The Electrical and Computer Engineering Department at Virginia Tech includes 70 faculty and around 800 undergraduates. To meet the requirements of the engineering accreditation board (ABET, Inc.), the Electrical and Computer Engineering Department must show that its graduating seniors have, among other criteria, an ability "to communicate effectively" [1]. Affecting the way that our Department meets this communication criterion is another ABET criterion: that graduates have an ability to collaborate on multi-disciplinary teams.

Since the 1980s, many industry boards that advise engineering colleges have claimed that engineering graduates need more instruction on writing and presentations. Two examples are industry boards at the University of Texas and the University of Wisconsin [2-3]. Echoing these criticisms have been responses from industry boards at Virginia Tech [4]. For instance, the latest College industry board made the following observations about communication abilities of engineering graduates from Virginia Tech:
(1) both oral and written communication of graduates were primary areas needing improvement;
(2) particular improvement was needed in the abilities of graduates to communicate technical information to non-technical audiences;
(3) particular improvement was needed in the command of grammar, punctuation, and usage by graduates; and
(4) participation in senior design projects and in making presentations were valuable educational experiences for graduates.

Learning Objectives and Outcomes in the Department’s Program

Given in Table 1 are the learning objectives and corresponding assignments of the communication program in the Electrical and Computer Engineering Department. These assignments occur in at least six different courses spread out over three years. Note that prior to entering the Electrical and Computer Engineering Department, students are enrolled for one year in the Engineering Education Department, which provides some instruction and assignments on engineering communication. Moreover, during that freshman year, the ECE curriculum calls for students to take 6 hours of Freshman English, which provides students with much instruction and practice in writing and significant instruction and practice in making presentations. Given in Table 2 are the expected learning outcomes for the students for both the sophomore year and the senior year. These two years were chosen because there is a clear difference in expected outcomes between these two years.

<table>
<thead>
<tr>
<th>Learning Objective</th>
<th>Corresponding Assignments</th>
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<tbody>
<tr>
<td>Students should know how to target an audience, purpose, and occasion in an</td>
<td>Each student will write more than ten documents</td>
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<tr>
<td>engineering document</td>
<td>to at least four different audiences in at least five different courses</td>
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<tr>
<td>Students should know how to collaborate on the writing of an engineering document</td>
<td>Students will collaborate on at least three documents</td>
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<tr>
<td>Students should know the differences between strong and weak engineering writing</td>
<td>in two different courses</td>
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<tr>
<td>Students should learn how to complete long engineering documents in a timely</td>
<td>Students will discuss many examples in more than twenty class periods of guided instruction</td>
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<tr>
<td>fashion</td>
<td>Students will revise four documents after receiving comments on those reports</td>
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<tr>
<td>Students should know how to make a professional presentation about a technical</td>
<td>In one course, students will receive feedback on one document and then write a similar</td>
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<tr>
<td>subject</td>
<td>document to that same audience</td>
</tr>
<tr>
<td>Students should know how to create a set of presentation slides to</td>
<td>Students will meet deadlines for at least three long documents (more than 12 pages</td>
</tr>
<tr>
<td>communicate technical information</td>
<td>double-spaced)</td>
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<td></td>
<td>Students will participate in at least two formal presentations</td>
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<td></td>
<td>Students will formally critique at least two presentations</td>
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<td></td>
<td>Students will help prepare at least one set of presentation slides that must 60% serve</td>
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<td></td>
<td>a presentation and stand alone as a set of notes</td>
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</table>
Table 2. Expected learning outcomes in the Department’s communication program.

<table>
<thead>
<tr>
<th>Year</th>
<th>Expected Learning Outcome</th>
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| Sophomore | For a general technical audience, students should be able to write a coherent description of a technical principle or design  
For a general technical audience, students should be able to write a short report that analyzes a technical problem—that report should have an introduction that orients the reader to the problem, a middle that is logical, and a conclusion that emphasizes key points  
For a general technical audience, students should be able to make a long presentation that analyzes a technical problem—that presentation should have an introduction that orients the listener to the problem, a middle that is logical, and a conclusion that emphasizes key points  
For a technical presentation, students should be able to create a set of presentation slides that communicates the most important principles to the audience, that stands alone as a set of notes for the presentation, and that someone else in that person’s group could pick up and use to make an effective presentation on that same subject |
| Senior  | For a specific technical audience, a general technical audience, or a non-technical audience, students should be able to write a coherent description of a technical principle or design  
For a specific technical audience, a general technical audience, or a non-technical audience, students should be able to write a long report that provides a solution to a problem—that report should have an introduction that orients the reader to the problem, a middle that is logical, a conclusion that emphasizes the solution, and appendices that address secondary audiences or issues  
Students should be able to incorporate illustrations and equations into a technical document—those illustrations and equations should be properly formatted and should aid readers in understanding the technical principles presented  
For a specific technical audience, a general technical audience, or a non-technical audience, students should be able to argue effectively for a technical principle or design  
Students should be able to assess whether a technical document written by someone else succeeds in communicating the principles to the intended audience, with the intended purpose, and for the intended occasion  
For a specific technical audience, a general technical audience, or a non-technical audience, students should be able to make a long presentation that communicates a solution to a technical problem—that presentation should have an introduction that orients the listener to the problem, a middle that is logical, and a conclusion that emphasizes the solution  
For a technical presentation, students should be able to create a set of presentation slides that communicate the most important principles to the audience, that stand alone as a set of notes for the presentation, and that someone else in that person’s group could pick up and use to make an effective presentation on that same subject  
Students should be able to work together in a team to complete a long report or presentation |

Description of the Communication Program

Responding to criticisms by industry, the Electrical and Computer Engineering Department has incorporated instruction and assignments on engineering writing and presentations in each year of the curriculum. At the heart of this instruction are two required courses: Engineering Professionalism, which is taught in the sophomore year; and Technical Writing (English 3764), which is taught in the junior year. In addition, students practice writing
and speaking in the discipline in at least four other courses: ECE Circuits Lab (ECE 2274); Introduction to Computer Engineering (ECE 2504); Microprocessor Design (ECE 3534), which is taken during the junior year; and a senior design course, which is taken during the senior year. Linking all the ECE courses is the popular web-site Writing Guidelines for Engineering and Science Students, for which the College of Engineering serves as the host [5]. This web-site receives more than 30,000 visits a month [6] and is linked to by more than 200 sites. The Google search engine lists this site first under the topic of engineering writing (out of more than 8 million sites) and first under the category of scientific writing (also out of more than 8 million sites) [7].

This section describes in chronological order the communication instruction given to students in the Department’s curriculum. Given the large number of students in any one graduating class (more than 300 some years), not all students take each course in the sequence discussed. In addition, about half of the students have a specific major in electrical engineering, while the remaining half have a specific major in computer engineering—these two different majors take the same courses involving communication instruction and application in the sophomore and junior years and significantly different courses in the senior year. Appearing in Figure 1 is a visual depiction of communication assignments for the courses.

**Sophomore Year.** In the first semester of their studies in Electrical and Computer Engineering, students begin learning how to communicate in their discipline. The main course in which students face this challenge is Engineering Professionalism (ECE 2000). In this course, the students learn about many professional aspects of the discipline, including adherence to professional ethics and communication of engineering principles. In this course, the students submit two correspondence assignments, write one long report (10 pages double-spaced), and collaborate on a 20-minute presentation.

In addition to providing formal instruction and assignments on writing, this sophomore course addresses the design of slides for presentations. This course devotes an entire lecture to the design of slides and uses examples from research presentations given by faculty and students in the Department. As exemplified in Figure 2, the design advocated by the program calls for a sentence headline, rather than a phrase headline, that states the main assertion of the slide. That assertion is then backed up by images and by necessary words. Because writing sentence headlines and creating images are more demanding than writing phrase headlines and bullet lists, this design is more difficult than typical designs, yet the results are worth the effort. Our students require fewer slides, those slides communicate information more memorably, and those slides reveal the organization of the talk more readily.

**Junior Year.** During the junior year, students continue learning to write and speak about their discipline. The primary course for instruction is Technical Writing (English 3764). This course introduces students to a variety of different documents (correspondence, proposals, instructions, and formal reports) and requires students to write examples of each. This course makes sure that students learn the value of rewriting, because each of the major assignments calls for a submission that receives comments and then a resubmission that responds to those comments. In addition to documents, this course also calls upon students to make a formal presentation.
Also in the junior year, students take Microprocessor Design I (ECE3534), which requires students to collaborate on three reports. At one time a writing-intensive course, this course has a significant amount of instruction materials online, including sample documents, a course style guide, and format templates that have imbedded writing tips.

Sophomore Year

Engineering Professionalism (ECE 2000)  
EE Circuits Lab (ECE 2274)

Junior Year

Technical Writing (English 3764)  
Microprocessor Design I (ECE 3534)  
Electronics Lab (ECE 3274)

Senior Year

Senior Capstone Design

Figure 1. Visual depiction of communication instruction and assignments for several required courses in the Electrical and Computer Engineering curriculum. Each year of the program, students write several documents and participate in at least one formal presentation.

Senior Year. In the senior year, the main writing and presentation instruction for Electrical Engineering majors will come in a capstone design course. In this course, students working in teams will have to create a formal report and make a formal presentation. In addition, students will have to update their project advisors with a progress report or presentation during the semester. For Computer Engineering majors, the writing and presentation instruction will either take place in a capstone design course or in a grouping of design courses that will require at least one formal report and one formal presentation.
Power passive modules perform the same functions as discrete circuits but with smaller volumes

82 cm³

168 cm³

The total volume is cut by more than half

Figure 2. Example slide from an ECE presentation [11]. The body of this slide is a reflection of the visual communication that ECE students learn in the Department’s program.

Efforts for Assessment

Assessment of the program will occur in three ways: (1) surveys of the students in the classes, (2) feedback from faculty, and (3) surveys of alumni who have gone through the program. This input will be used to continually improve the program with most of the changes being formulated over the summer breaks.

Feedback from Students. Much of the formal surveying for the communication program will occur in the first course in which students receive formal instruction on communication: Engineering Professionalism. In this course, students will complete an end-of-semester survey that will be used to make course adjustments before the next semester’s offering. In addition, exit surveys for seniors will be used to determine student perceptions of their own learning about communicating in the disciplines. Such surveys have already been used to identify a problem in the current program—that students do not believe that “oral presentations were enhanced by class presentations.” In 2003, only 54 percent strongly agreed (12 percent) or agreed (42 percent) with that statement. That number was significantly lower than the average for the College of Engineering (85 percent). The program proposed in this document addresses this problem, particularly in the Engineering Professionalism course.
Feedback from Faculty. In the past, feedback from the faculty has occurred informally with faculty relaying comments about the writing and speaking of the students to the communication coordinator. In the future, though, this feedback will occur more formally with a faculty survey to be given at the end of each calendar year to solicit feedback from all instructors who have had writing and speaking assignments that semester in their undergraduate classes. In the future, faculty feedback will serve to provide a check on how well students are meeting the learning outcomes defined in Table 2.

Feedback from Alumni. Finally, assessment of the communication program will also occur through surveys of alumni and from comments relayed by the Department's Visiting Board. Such feedback has already been used [4] to support changes in the communication program, such as emphasizing communication to non-technical managers and emphasizing the importance of proper grammar, punctuation, and usage in formal documents.

Summary of the Program's Strengths and Weaknesses

Given the commitment by so many faculty members in the Department to teach communication skills and the requirement of the English Department's excellent course in technical communication (English 3764), the program includes a number of strengths. On the other hand, given the large numbers of students in the Department, the program faces stiff challenges in preparing its undergraduates to write and speak in the discipline. A summary of these strengths and potential weaknesses appears in Table 3.

Strengths of Program. The main strength of the program is that the students gain much experience writing and speaking in their discipline over the three years that they are in ECE. That experience begins with formal instruction and practice the first year that they are in the Department. Equally important, the students are called upon to write documents and make at least one formal presentation in each of the three years, thereby ensuring that skills learned remain honed.

Another strength is that students will continually be referred to the Writing Guidelines web-site (http://writing.eng.vt.edu/), which will provide a unifying thread to the instruction and assignments that the students receive. A third strength is that we are aiming higher in our expectations for presentations, particularly the slides of presentations, than other engineering departments in the country. Yet a fourth strength concerns the varied audiences that the students experience—general technical audiences in Engineering Professionalism, non-technical managers in Technical Writing, and technical audiences in Microprocessor Design.

A final strength is the expertise and dedication of the faculty providing instruction. In addition to the excellent technical writing faculty from the English Department, the ECE Department has faculty members who have published in technical communication. For instance, Robert Hendricks has co-authored a book on technical communication, and Michael Alley has authored two texts in the field [9-10]. More important, though, is the commitment of the Department to improve the writing and
presentation skills of its students. One example is that the Department created the Engineering Professionalism course (2 credits) to address this issue.

Table 3. Strengths and potential weaknesses of the Department’s communication program.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Potential Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students gain much experience writing and speaking—they have assignments in eight courses spread over 3 years</td>
<td>Because 325 students are in each graduating class, giving individual attention is difficult</td>
</tr>
<tr>
<td>The Writing Guidelines web-site provides a unifying thread for the instruction</td>
<td>Because so many faculty and GTAs are involved, the potential exists for instructional cross-talk</td>
</tr>
<tr>
<td>The expectations for presentation slides are significantly higher than what other engineering students have</td>
<td>Because the program’s slide design is different, students must have the confidence to stand apart</td>
</tr>
<tr>
<td>Students receive much practice in targeting various audiences</td>
<td>Graders bear much responsibility in evaluation, which is difficult, even for those with experience</td>
</tr>
<tr>
<td>Our faculty includes experts in technical communication</td>
<td>Because so many students and graders are involved, quality control of the grading is difficult</td>
</tr>
</tbody>
</table>

**Potential Weaknesses in Program.** As shown in Table 3, the principal weakness of the program lies in the large number of students—between 200–250 in each graduating class. Given this large number, few students receive much individual attention from faculty on their writing and speaking, except perhaps in Technical Writing (English 3764).

Given the large numbers of students, a second potential weakness of the program lies in having graders bear most of the responsibility for evaluating the students. Evaluating technical reports is difficult, even for someone who has much experience. However, our Department is not in a position to have experienced evaluators cover all the assignments. Instead, we will have to use GTAs and, in some cases, senior graders. These senior graders will be ECE students who have excelled in their technical work and in the communication of that work. To achieve success with these graders, we will have to provide them with instruction before and during the evaluation of assignments. Such a scheme has worked for several semesters in Microprocessor Design I. One interesting advantage of using senior graders is that they understand both the content of the assignments and the realistic levels of depth that the students should achieve on those assignments. In a sense, these graders provide the role of a technical manager in a company—someone who has worked his or her way up from the engineer level and now has the responsibility of evaluating the engineers in the group.

**Future Improvements**

Through analysis of our program, we have decided upon several improvements that we would like to make in the program. These changes are summarized in Table 4. One needed improvement is foster communication among the Department faculty members who include communication assignments in their undergraduate classes. Because these faculty members evaluate the writing and speaking of the students, they are in an excellent position to assess how well the program is teaching these skills to the students. Securing input from these faculty members is needed. Our plan is to use a web survey to solicit their input in May. Yet a second means to foster communication among the program’s faculty involves
sending an updated version of Table 1 and Figure 1 to the faculty each August. Updates to this figure would be gathered in the surveys in May. Using Table 1 and Figure 1, we will help faculty members realize how their communication instruction fits into the program.

Table 4. Needed improvements to the Department’s communication program.

<table>
<thead>
<tr>
<th>Needed Improvement</th>
<th>Plan for Incorporation</th>
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<tbody>
<tr>
<td>Survey faculty who include communication assignments</td>
<td>Have writing coordinator administer surveys in May</td>
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<tr>
<td>in undergraduate courses to assess progress made</td>
<td></td>
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<tr>
<td>by students</td>
<td></td>
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<tr>
<td>Update faculty annually on status of Department’s</td>
<td>Provide update in August; solicit information about</td>
</tr>
<tr>
<td>communication program</td>
<td>changes in May (in survey)</td>
</tr>
</tbody>
</table>

References


