How Technical Communication Textbooks Fail Engineering Students

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Twelve currently popular technical communication textbooks are analyzed for their treatment and discussions of the types of writing that engineers produce. The analysis reveals a persistent bias toward humanities-based styles and genres and a failure to address the forms of argument and evidence that our science and engineering students most need to master to succeed as rhetoricians in their fields. The essay ends with recommendations and calls upon instructors to reenvision the service course in technical communication.

For at least the past 20 years, surveys from engineering employers have consistently indicated that although engineering graduates have proficient technical skills, their communication and interpersonal skills are lacking (see Reave, 2004, for an excellent overview of this research). In fact, the Society of Manufacturing Engineers Education Foundation (2007) names both written communication and oral communication on its list of “significant competency gaps among newly hired engineering graduates.” The Accreditation Board for Engineering Technology (ABET, 2003) now lists “an ability to communicate effectively” as 1 of 11 skills that all engineering programs must demonstrate that their students attain. Reflecting this enhanced focus on communication, approximately 50% of engineering programs in the U. S. and 80% of programs in Canada now require a course in technical communication (Reave).

Despite all this recent attention to engineering students’ communication skills, however, evidence of these courses’ effectiveness is mixed. Whereas Sageev and Romanowski (2001) and Kryder (1999) have provided some compelling evidence that technical communication modules tightly interwoven with an engineering curriculum are effective, the effectiveness of stand-alone classes offered through English departments (which is the norm at most schools) is questionable. In a sur-
vey of over 1,500 student aeronautical engineers, only 54% of those who had taken a technical communication course perceived it as helpful (Pinelli, Barclay, Keene, Kennedy, & Hecht, 1995). Although many of these students might change their minds about the course after they acquire some job experience, the suggestion that 46% of students did not perceive their technical communication course as helpful is a cause for concern.

Other research has also questioned what exactly engineering students take with them from stand-alone technical communication courses. For instance, Ford's (2004) research on knowledge transfer across disciplines found that engineering students transferred information primarily about format—issues such as where to position page numbers and how to format memos—rather than higher-order rhetorical concerns such as audience and purpose from their technical communication classes to their writing in engineering settings. One engineering student in Ford’s study went so far as to ask, “What’s the point of taking technical writing when all you are going to do is use templates afterwards?” However, these same engineering students were able to transfer and apply rhetorical knowledge about audience and purpose gained from nonacademic settings (particularly their co-op experiences) to their engineering report writing.

As a result of this conflicting evidence, technical communication is a controversial topic on many campuses. Even while ABET is calling for engineering schools to provide more instruction in communication skills, many engineering students (and engineering faculty) see these courses as irrelevant to their work. There are many possible reasons for this problem: Writing courses tend to be squeezed into the curriculum where they will not interfere with the “hard” content of the primary engineering discipline; they are often taught by teachers who are unaffiliated with the engineering department and have little or no experience with this discipline; and students often have to walk across campus to get to these classes, reinforcing the preconception that writing is something separate from their core course work.

Yet as Freedman and Artemeva (1998) have suggested, another part of the problem is that the writing engineering students do in their technical communication courses bears little in common with either workplace engineering writing or writing in university engineering courses. Beer and Ekberg (1994) similarly claimed that technical communication instructors are often unaware of the needs of working engineers. As I report below, such lack of awareness seems to carry over into our field’s textbooks. Specifically, this essay analyzes 12 popular technical communication textbooks to assess how well they prepare engineering students to negotiate the kinds of documents and rhetorical situations that communication research suggests are central to engineering. In addition to examining these textbooks in the light of others’ research findings, I report on my own discourse analysis of engineering reports and interviews with engineering professionals and faculty. My findings suggest that the most popular
technical communication textbooks on the market focus on rhetorical situations that are far more likely to be encountered by someone with a job title of technical writer rather than one of engineer. Consequently, with some exceptions, such as instructions and proposals, technical communication books simply do not teach many of the genres and conventions that engineering students are or will be called upon to write. Moreover, some of the advice offered in these textbooks contradicts the rhetorical conventions of engineering discourse.

This essay proceeds by describing four areas in which the most popular technical communication textbooks offer advice that conflicts with the knowledge practices and professional values that engineering students are likely to learn in their major course work. These are not the only areas in which current textbooks are insufficient (for instance, see Wolfe 2006), but they are the areas that emerged as most important in the textbooks examined for this study:

1. Privileging of humanities-based guidelines for use of active and passive voice
2. Emphasis on citation practices used in humanities-based disciplines rather than those preferred in the scientific and technical disciplines they claim to serve
3. Failure to leverage current research in relevant fields such as data visualization
4. Lack of attention to the forms of argument and evidence that our science and engineering students most need to master to be successful rhetoricians and writers in their fields

Engineering students, of course, are far from the only audience that technical communication textbooks need to serve, but they are one important audience, and our current textbooks often ignore their needs. This essay focuses on engineering because it is an area with which I have some expertise. However, the arguments made here might also apply to students in the natural or social sciences, who could similarly benefit from more exposure to the genres and types of rhetorical decisions that are most common in their disciplines.

I focus on textbooks because so many of the instructors in the service technical communication course around the country are English graduate students and adjuncts who do not have educational or professional backgrounds in engineering. Such instructors often rely heavily on the textbook, and thus, technical communication textbooks—perhaps even more than other textbooks—often drive the curriculum. Apart from what the textbook transmits, technical communication instructors often receive little training or preparation for teaching students in disciplines with values and discourse styles that differ widely from the discourse communities in which they receive their training.
Before proceeding, I do want to acknowledge the difficulty inherent in writing technical communication textbooks, which are called upon to please so many audiences. Not least among these audiences is the publisher who might pressure authors to cover the same material as their competitors. In fact, it is not only difficult to distinguish among different technical communication textbooks but also among textbooks meant to serve technical, professional, and business communication courses. Graduate students at my institution frequently ask exactly how these courses differ, and they describe technical communication as business communication plus instructions. My primary goal in mounting this critique is to provide current and would-be textbook authors with both ideas and ammunition for productively reenvisioning a technical communication curriculum.

**DATA SOURCES AND ANALYSIS**

Twelve technical communication textbooks published between 2001 and 2006 were selected for this analysis. Ten of these textbooks had a generalist focus and were selected based on their longevity and popularity: The average generalist textbook examined was in its sixth edition, a factor that attests to these books’ continued popularity in the classroom. (In fact, several of these textbooks have come out with updated editions since the analysis reported here was conducted.) The remaining two textbooks were selected because of their specific engineering focus. Table 1 lists the 12 textbooks examined.

These textbooks were analyzed for their treatment of four aspects of technical communication: active versus passive voice, citation practices, data visualization, and presentation of data and results. I chose these four areas after interviewing colleagues in engineering about their expectations for student writing, reading extensively in both technical communication and applied linguistic research on engineering, and conducting my own preliminary discourse analyses of engineering documents. This preliminary field research suggested these categories as four areas in which technical communication textbooks commonly contradict or fail to address important parts of engineering rhetorical practice.

As a means of triangulating my preliminary field research, I also conducted a brief analysis of 10 engineering documents, including 5 industry/government-produced technical reports totaling 314 pages and 5 academic journal articles totaling 90 pages. The industry/government documents were culled from open-access technical report servers such as the National Transportation Library (http://ntl.bts.gov) and the Defense Department Science and Technical Information Network (http://stinet.dtic.mil/index.html).¹ Selection of the academic journal articles was

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¹See the Virtual Technical Reports Center for more organizations with open-access technical reports: http://www.lib.umd.edu/ENGIN/TechReports/Virtual-TechReports.html
based on recommendations from engineering colleagues. The 5 industry/government documents and the 5 academic documents are listed in Appendices A and B, respectively. These documents were analyzed for the types of arguments they contained, their use of visual representations, their format, and their use of data as a source of evidence.

Throughout this essay, I also refer to interviews conducted with four professional engineers about their writing as well as conversations with three engineering faculty about what type of writing instruction their students most need. These conversations have both shaped and reinforced some of my views on what writing instructors outside a scientific or technical department can provide to engineering students. All policies governing human subjects research at my institution have been followed.

Problem 1: Injunctions to Avoid Passive Voice

A casual comparison of technical communication textbooks over time quickly reveals that, since the 1980s, the amount of space devoted to sentence-level language or style issues has steadily decreased. In this diminishing terrain, however, sections dedicated to the use of active and passive voice have retained a relatively prominent place. All 12 of the textbooks reviewed here contained such a section, which in all cases was easily located through specific entries in the index.
Although the force with which the injunction is made varies greatly, the authors’ primary concern seems to be to warn students away from the use of passive voice. For instance, Houp, Pearsall, Tebeaux, and Dragga (2002) wrote, “We urge you to use the active more than the passive,” and they justified this claim by warning students that “although the passive voice has its uses, too much of it produces lifeless and wordy writing” (p. 93). This advice is echoed by Pfeiffer (2006), who concluded, “In modern business and technical writing, strive to use the active voice” (p. 617). Anderson (2003), Gerson and Gerson (2003), Lannon (2003), Riordan and Pauley (2002), and Sims (2003), all used bold section headings to announce that active voice is the preferred style. Some authors offered more nuanced advice. For instance, Markel (2004) advised students “to recognize that the two voices differ and to use each of them where it is most effective,” (p. 251), and Burnett (2005) urged writers to “consider your purpose and audience” (p. 247) when choosing between active and passive voice. But the overall message in 7 of the 10 generalist textbooks is that passive voice should be avoided. The two engineering textbooks reviewed are exceptions to this general trend. For instance, Sorby and Bullett (2006) stated, “The passive voice is still preferred” in technical reports, “although this practice may be changing” (p. 23), and “when in doubt, use the passive voice” (p. 24). This advice obviously stands in direct contrast to the generalist textbooks’ frequent injunctions to use active voice.

Such preferences for active voice reflect the humanities backgrounds of the authors. As a humanities discipline, English studies is people oriented: Humanities scholars write about authors, actors, historical figures, and other individuals or groups. Professional technical writers are similarly people oriented, writing for end users, customers, and clients. In contrast, engineering is an object-oriented discipline, focusing on physical objects and material entities. Linguistic analyses of engineering writing suggest that material objects and entities occupy the subject positions in the majority of engineering sentences (Ding, 2001; McKenna, 1997). This object orientation is high even when compared with other technical or scientific disciplines. For instance, Ding found that 63% of the grammatical subjects in engineering documents referred to concrete material objects, compared with only 45% of the grammatical subjects in scientific articles.

Passive voice is useful—and often necessary—for focusing readers’ attention on a material object. For instance, if a writer wanted to focus on catalytic converters, it would be distracting to write “The technician installed the catalytic converter” instead of “The catalytic converter was installed.” The first, active voice version dilutes the focus on the object and—contrary to what many textbooks imply—is less concise than the passive voice version. Passive voice consequently dominates many engineering documents: Ding (2001), for instance, found that 67% of the 780 transitive verbs in the professional engineering documents he analyzed were constructed in passive voice. Although some of these passive constructions were almost certainly inappropriate according to our own disciplinary stan-
dards (passive constructions, for example, appeared in an instructional document), this high number suggests that passive voice is a necessary and often appropriate construction in a discipline focused on material objects.

Although it may seem counterintuitive to those who are more people-focused in their writing, engineers’ reliance on passive voice is partly motivated by sensitivity to their audiences’ values and expectations. Ding (2001) suggested that engineers use passive voice to foster cooperation between writer and reader, both of whom presumably share a focus on objects. Couture (1992) and Sales (2006) both provided evidence that passive voice is often a deliberate rhetorical choice for engineers who strive to present an ethos of scientific objectivity rather than personal authority in writing. Walker (1999) noted that part of constructing an engineering persona involves knowing when to use the passive voice and that a failure to use passive voice may indicate an inappropriate focus on agents. These views were clearly shared by speakers at the Engineering Language/Grammar Skills Eng-Tips Forums (2007), who referred to active voice as “sloppy,” “unprofessional,” or less “technical” than passive voice. One engineer elaborated on his view:

This is technical writing, not a book report. Major pet peeve for me. I can’t take writing seriously if it says “and then we did this, and then we did this...” (Eng-Tips Forums, 2006)

Many engineers on this language skills forum volunteered that they often used active voice when writing client-focused messages but always used passive voice in more formal reports and other technical documents.

When textbooks imply that active voice is “better” than passive, they encourage students to ignore rhetorical context and audience in favor of what is presented as a near-universal principle of language. Such exhortations conflict with one of the central messages of our textbooks: Consider your audience. When writing instructors tell students to use active voice, they are telling them to privilege people over objects, to project a humanities ethos over an engineering one. Such advice ignores the needs of technical audiences who may want to see writers focusing on things rather than people. Rather than exhorting students to favor one voice over the other, textbooks should help students analyze their audience and rhetorical purpose and select a voice accordingly.

In any case, simply advising engineering students to avoid passive voice weakens a writing instructor’s ethos: first, by conflicting with advice that students have likely received in their engineering courses or workplace cooperatives and second, by sending the tacit message that, unlike them, we embrace humanities’ values by privileging people over things. Although it is almost certainly true that many engineers need to be more concerned with people, we will win few converts to this position by neglecting the values and interests that dominate our students’ primary coursework. If we wish to challenge certain aspects of engineering identity—for
instance, by encouraging engineers and others to see the limitations or impossibility of scientific objectivity—we need to make a more persuasive case: one that is more sensitive to our audience’s values. In place of prescriptive injunctions against particular styles, we need more thorough discussions of the rhetorical considerations that prompt specific language uses.

Problem 2: Bias Toward Humanities Citation Practices

Many engineering disciplines use a numbered citation-sequence documentation style, such as the Council of Biology Editors (CBE) style favored in many natural science disciplines. Disciplines favoring citation-sequence styles include mechanical engineering, electrical engineering, computer science, chemical engineering, mathematics, biology, medicine, and physics. The Institute of Electrical and Electronics Engineers (IEEE) has its own, well-known variant of the CBE style, and several other engineering disciplines have their own, discipline-specific variations of CBE.

Numbered citation-sequence styles project a particular ethos that privileges findings and disciplinary knowledge over the individuals who produced this knowledge. In this regard, engineers’ preference for numbered citation-sequence styles is similar to their preference for passive voice: Both de-emphasize people and shift attention to the phenomenon under study. In addition, numbered citation-sequence styles are more compact than name-year styles and thus help promote the engineering values of efficiency and economy.

Our textbooks, however, ignore these disciplinary values by privileging humanities’ citation styles over those practiced in our students’ home disciplines. Table 2 shows that of the 9 generalist textbooks containing a section on documentation, only 4 textbooks discussed a numbered, citation-sequence documentation style such as CBE.2 In contrast, all nine discuss APA and either MLA or Chicago (the two most common humanities styles). Of the two engineering-specific textbooks, Sorbey and Bulleit’s (2006) cover MLA, APA, and CBE, and Beer and McMurrey’s (2005) discuss IEEE. Beer and McMurrey’s is the only textbook to even mention this engineering-specific citation style.

It is not clear that technical communication textbooks need to cover MLA citation style at all because no technical discipline I know of uses it; an engineering professor I spoke to was surprised to hear of its existence. By emphasizing authors’ names, titles, and direct quotes, MLA style focuses readers’ attention on authors and their specific words. This information is important to those in humanities disciplines but does not reflect the preferences of technical disciplines in which individual ownership is de-emphasized (Dowdey, 1992). By contrast, numbered citation styles work to blur distinctions among individual authors and texts by frequently using a

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2Burnett (2005) failed to discuss citations altogether.
range of numbers, such as “[5–8],” to refer to texts and discouraging direct quotations (Dowdey).

The failure of half of our textbooks to even discuss numbered citation styles is troubling. Anderson (2003), after covering MLA and APA documentation practices, even went so far as to state that “most other documentation styles resemble one of these two” (p. 604). Such careless statements undermine our ethos as teachers. Although I am certainly not advocating that we try to cover every citation style that our students might use (and there are a number of discipline-specific styles within engineering itself), our textbooks should at least cover the basic mechanics of a popular numbered citation style and point students to places where they could find out more about styles used in specific sub-disciplines. In fact, students might even be encouraged to research and analyze the specific style used in their field and discuss what these practices suggest about their field’s values. Approached in this manner, the wide variety of citation practices in scientific and technical fields could become an opportunity to discuss the rhetoric of citation practices rather than an injunction to use the styles an instructor knows.

Problem 3: Important Research in Data Visualization Ignored

Perhaps one of the biggest distinctions between technical communication and more general composition instruction is the amount of attention that technical communication pays to visual design. Each of the textbooks reviewed in this study devote an entire chapter to designing visual elements such as graphs, tables, technical illustrations, and other figures; most include a separate chapter on document design, and many include a chapter on Web design. Anderson (2003) noted that visual representations “often convey part of a message more clearly, usefully, and persuasively than words” (p. 266), a message repeated almost verbatim in Sims (2003), Burnett (2005), and others. Burnett wrote that “your professional success
will be greatly influenced by your ability to understand and use visuals” (p. 412). The message of these textbooks is clear: Selecting, arranging, and presenting visuals is essential to effective technical communication.

Given this emphasis on visuals, it is surprising to see how often technical communication textbooks ignore or flout the research and advice of scholars in visual design. Perhaps the best known leader in visual design is Edward Tufte, and several of the books reviewed specifically cite his work. It is therefore surprising to see how often even the most basic maxims of Tufte’s work are violated in these books. For instance, Tufte (1983) famously argued that using three-dimensional graphs to display two-dimensional data confuses, distorts, and misrepresents. Such confusion is illustrated in Figure 1, in which it is difficult for readers to determine whether profits are at, above, or below particular values. Yet Lannon (2003), after a brief warning not to sacrifice clarity for the sake of a visual effect, seemed to advocate the aesthetics of three-dimensional bar graphs by noting that “a third axis creates the appearance of depth” (p. 308). Gerson & Gerson (2003) appeared completely seduced by three-dimensional graphs, including examples of three-dimensional bar charts, pie charts, and even a three-dimensional line chart—all of which could be more accurately represented by more conventional visualization in two dimensions. Several other textbooks remain silent on the subject, failing to warn students that displaying two-dimensional data in three dimensions adds clutter that, at best, obscures and, at worst, distorts the message.

Pie charts are one of the most controversial methods for representing data, yet most of our textbooks fail to even mention this controversy, let alone provide students with the background they need to make informed choices about this visualization. Although pie charts are beloved in business documents and in popular me-
dia, data visualization experts generally agree that they are greatly overused. Few (2007), for instance, wrote, “Of all the graphs that play major roles in the lexicon of quantitative information . . . the pie chart is by far the least effective” (p. 1). Cleveland (1994) similarly dismissed pie charts as “pop charts” (p. 262), and Tufte (1983) described them as “dumb” (p. 178).

What is wrong with the pie chart? In short, as Cleveland (1994), Few (2007), and Tufte (1983) all noted, pie charts sacrifice precision for visual appeal. It is difficult for readers to determine precise values or compare individual parts by looking at the slices of the pie. Thus, although pie charts may be appropriate in contexts where precision is not important, they are rarely the best choice when the reader is interested in exact values or differences or when the writer wants to project an ethos of technical competence.

To illustrate this problem, take a look at Figure 2 and quickly answer: Which slice is the biggest? The smallest? By how much?

If my goal is simply to get a rough estimate of the disciplinary makeup of a student population, Figure 2 may be an adequate visualization. However, by obscuring exact values, Figure 2 suggests that reader and writer share a common disregard for precision, a tacit message that technical experts may want to avoid. To be sure, the questions I have asked about Figure 2 would be easier to answer if the chart labels specified the exact percentages of each slice, but then, as Few (2007) noted, this solution essentially creates an awkwardly arranged table. If the visual representation does not help us answer questions about the data, why bother to include it at all?

The problems inherent in pie charts are compounded when readers are asked to make comparisons across multiple pie charts, which are particularly ill suited for showing change. As Tufte (1983) noted, “The only worse design than a pie chart is several of them, for then the viewer is asked to compare quantities located in spa-
tial disarray both within and between pies” (p. 178). To illustrate this problem, try to use Figure 3, which is derived from Houp, Pearsall, Tabeaux, and Dragga (2002), to answer the following questions: By how much did Medline searches change between 1996 and 1997? Which search topic area exhibited the most change between 1996 and 1997? Note the number of times your eyes need to shift back and forth between the various sections of the charts as you search for the answer. If the purpose of this visualization is to show how topic searches changed from August 1996 to January 1997, the authors would be much better off presenting this data as a line chart, bar chart, or even a table.

The pie chart does have its uses. When the goal is to quickly estimate the relationship between part and whole or to estimate combinations of proportions (such as A + B or C + D), the pie chart has a slight advantage over other visualizations (see Spence, 2005, for a review of this research). The pie chart may also be an appropriate choice for simple data presented in business settings, where pie charts seem to be ubiquitous. However, if the task requires readers to make multiple comparisons across individual components, or slices of the pie, the pie chart is usually an inferior visualization.

It is true that rhetoricians such as Kostelnick (2007) have critiqued Tufte and some of the maxims I cited above as appealing to a Platonic-like universal sense of clarity when clarity actually depends on complex relationships among audience, purpose, and context. But for writers working in disciplines in which clarity and

![Figure 3](image_url)

**a. Topics searched, August 13–19 1996**

**b. Topics searched, January 12–17, 1997**

**Total number of searches:** 6,203

**Total number of searches:** 6,154

FIGURE 3  This figure illustrates the problems with making comparisons across multiple pie charts. Derived from Houp, Pearsall, Tabeaux, and Dragga (p. 307). Original source: Miller (1997) for the National Library of Medicine.
precision are central values, popular and frequently maligned data visualizations such as pie charts can work against a writer’s intended ethos. Thus, we would expect pie charts to be used rarely in engineering, a discipline that places a strong value on precision. This hypothesis is confirmed by my analysis of engineering documents: I found only one use of a pie chart among a total of 269 tables, figures, and other graphics (see Table 3). Interestingly, this one instance of a pie chart appeared in the introductory section of a long government report, a section that seemed geared toward a nontechnical audience of automobile manufacturers and government decision makers. An engineering colleague I interviewed confirmed that pie charts are rare in documents written for engineers, claiming that engineering students “could live without that one.” Instead, he noted the importance of scatterplots, line graphs, and other data representations that require plotting on an x- and y-axis.

Of the 12 technical communication textbooks reviewed, only 3 even briefly mentioned that pie charts sacrifice precision for visual appeal. None of the textbooks specifically warned students against requiring readers to make visual comparisons across multiple pie charts. In fact, Houp, Pearsall, Tebeaux, and Dragga (2002) seemed to implicitly advocate (or at least sanction) the practice, praising the charts in Figure 3 for the way they emphasize the amount of change in Visible Human (which appears as yellow in their text), which nearly doubles from 5% to 9%. Perhaps worst of all, given our discipline’s emphasis on audience, is that only two of the textbooks (Burnett, 2005; Sorbey & Bulleit, 2006) noted that pie charts are rare in scientific and technical literature and therefore might hurt a writer’s ethos with technical audiences. Although it would be foolish to recommend banishing the pie chart, our textbooks should help students weigh the pros and cons of this visualization: Pie charts are an appropriate choice when the data are easy to understand, precision is not essential, and the audience prefers to see nontechnical

<table>
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<th>Representation Type</th>
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<th>Academic (90 pp)</th>
<th>Total</th>
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<td>22</td>
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<tr>
<td>Technical Illustrations &amp; Diagrams</td>
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<td>25</td>
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<tr>
<td>Other(^a)</td>
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\(^a\)Includes complex graphics or representations that are not easily recognizable as a standard data representation.
material; they are inappropriate for making comparisons, when exact values matter, or when the author is trying to project a technical ethos.

In discussing data visualization, I have focused on problems with three-dimensional visualizations (which many graphics programs seem to implicitly encourage) and pie charts. In addition to discussing the pros and cons of these visualizations, our textbooks might also cover some more advanced graphics, such as scatterplots and boxplots (also known as box-and-whisker plots), as well as techniques for including more information on more common visualizations, such as including error bars on bar charts to indicate statistical significance. Such visualizations have the advantage of displaying large amounts of quantitative information in a small amount of space but the disadvantage of confusing or intimidating non-technical readers. In addition, we should also seek to teach students some basic principles of data design, such as Tufte’s (1983) well-known maxims to “erase non-data ink” (p. 105), use “small multiples” (p. 170), or convey “simplicity of design and complexity of data” (p. 177). Although we do not want to teach our students blind adherence to these maxims, students can nonetheless benefit from learning that such principles carry strong currency among certain audiences.

Although it is not necessarily connected to data visualization, it is also worth noting that our textbooks would benefit from referencing recent research on presentation slide design. Such research has suggested that using a succinct sentence rather than a word or phrase in a slide heading increases audience retention of material (Alley, Schreiber, & Muffo, 2005; Alley, Schreiber, Ramsdell, & Muffo, 2006). These researchers also argued compellingly in favor of using images rather than text (and especially bulleted lists) in the body of slides to avoid presentations where speakers simply read off the screen. As our writing textbooks are updated, they should begin to reference and allow themselves to be influenced by such work.

Problem 4: The Absence of Data, Results, and Numbers

Our textbooks’ lack of attention to relevant research in data visualization may be symptomatic of these books’ general disregard for numbers and data. Numbers are key elements in engineering discourse, but our textbooks do little to teach students how to construct arguments that rely on numbers as evidence.

In preparing this manuscript, I spoke with an associate dean in my school’s engineering college who had told me years earlier that what he would most like to see technical communication instructors teach was the technical report, which he initially defined as “anything containing technical material.” As I pressed him for a less amorphous definition, our conversation kept returning to words such as “data,” “results,” and “tables.” When I showed him six different technical documents and asked him to identify the one that most matched what he had in mind, he selected an experimental report written in the IMRAD format (introduction, meth-
ods, results, and discussion) common in scientific and technical disciplines. The stress my colleague placed on data and results is echoed by other engineering instructors concerned with student writing: Walker (1999) and Herrington (1985) both found that engineering faculty stress the importance of students’ ability to accurately report, interpret, draw conclusions from, and explain possible errors in data they had collected. Kryder (1999) similarly found that the engineering faculty she surveyed wanted students to learn to write up test results.

The reporting of test and experiment results is fundamental to every engineering discipline. Test reports are produced by professional engineers working for research and development companies (Barabas, 1990; Winsor, 1996) as well as design engineers working on government or military contracts (Ornatowski, 1998; Sales, 2006). A civil engineer with 30 years of experience working for government transportation agencies told me that about 30% of his time on the job was dedicated to working on and reporting small transportation studies. My own analysis of engineering documents found that data from tests and experiments played a central role, with an average of nearly 10 tables and 10 graphs per report (see Table 3). Much of the rhetorical activity in these documents consisted of explaining and interpreting this nontextual data for readers.

Our own field’s research in engineering settings has shown how much rhetorical activity can be involved in such data reporting. In fact, the central messages of Winsor’s (1996) often-cited *Writing like an engineer: A rhetorical education* are that numbers are not self-evident and that “when the data is not easy to interpret, direct conclusions can only be achieved through persuasive writing” (p. 103). Similarly, Ornatowski (1998) strikingly showed how a group of engineers used their rhetorical skills to positively reinterpret test results originally presented as a failure. One of these engineers acknowledged the rhetorical nature of test results by reporting, “The data is what the data is: sacrosanct,” but “what I can do is highlight data, withhold data, present it in a different fashion. . . . so, yes, there are ways you can change how a report is perceived or a test event is perceived” (p. 337). Winsor (1998) similarly showed that such rhetorical interpretations of data are central to engineers’ everyday interactions: Even when everyone agrees on the facts of the data, engineers must use rhetoric to come to an agreement about what the data mean.

As the writer’s audience becomes less technically skilled, the rhetorical work of interpreting results becomes more important. Barabas (1990) went so far as to conclude that data interpretation is the primary rhetorical skill that separates “good” from “poor” engineering writers. She found that engineers identified by their supervisors as good writers included more conclusions and audience-focused interpretations than those identified as poor writers, who drew fewer conclusions and overloaded their writing with unnecessary detail about their methods. Some supervisors suggested that poor writers’ tendencies toward excessive and inscrutable detail were a carryover from school writing in which teachers seemed to evaluate
papers by how long and belabored they were, a hypothesis supported by Gwiasda (1984), who likewise found that school-based engineering assignments encourage writers to ignore audience.

In short, then, my research suggests that results and data interpretation are central to engineering work, that engineering faculty want writing instructors to help students master these skills, and that data interpretation is often a complex and highly rhetorical act that students do not master in their classroom-based engineering coursework. Given the centrality of data to engineers’ technical communication and its highly rhetorical nature, we would expect discussions of data and results sections of reports to take a prominent place in technical communication textbooks.

So how do our textbooks fare on this point? I use Markel’s (2004) Technical Communication as a case study because its publisher claims it is the most popular textbook on the market and many of the book’s examples suggest that engineering students are included in its target audience. In contrast to the engineering documents I analyzed, which included nearly one table of data for every five pages of text, Markel’s textbook included only three sample documents (two of which presented the same content in different formats), and these documents contained a total of only four different data tables to illustrate how writers persuade readers to accept particular conclusions. Moreover, one of these tables (presented twice) reflects poor data reporting: The table is unnumbered; it lacks a caption; it uses a nonstandard, distracting color scheme; it does not order the data in a logical way; and it is not referred to explicitly in the text (pp. 472, 517). In fact, other than the chapter on graphics, this textbook included only 14 additional passages that used numbers as evidence for an argument. Of these 14 passages, more than half were arguments about costs or budgets (such as, “last year we overproduced by seven percent, for a loss of $273,000,” p. 278) that are indistinguishable from what one would expect to see in a business communication course.

We see this same disregard for technical data and results in other texts. Thus, Pfeiffer’s (2006) chapter on “formal reports” jumped from detailed guidance in preparing the letter of transmittal, table of contents, and introduction, directly to the discussion section, offering no advice on how to write results. Riordan and Pauley’s (2002) one-page section on “the body of the formal report” contained little more than advice on pagination (p. 371). Beer and McMurrey (2005), although dedicating some space to discussion of the data and other material in the body of various engineering reports, focused more on formatting than on the rhetorical invention and arrangement that researchers such as Barabas (1990), Ornatowski (1998), and Winsor (1996; 1998) showed are central to data interpretation.

Of the five books devoting more than a paragraph to discussing results sections, at least two offered questionable advice by suggesting that the results section consists of an uninterpreted “data-dump” of findings. For instance, Sims (2003) wrote, “In the results section, you simply report the results—the data that
you gathered. You interpret the results in the conclusions section of the report” (p. 434). Sorbey and Bulleit (2006) similarly implied that the data-dump results section is standard practice by including a model paper that includes a single sentence in the results section that introduces, but does not interpret, a table of experimental data.

Although it is true that conjectures, projections, and recommendations are generally reserved for a discussion section, this does not mean that the results section is free of interpretation. Theoretically, such a practice makes little sense because separating data from analysis places a cognitive strain on readers, forcing them to shift back and forth among physically separated sections of text. Moreover, none of the reports I examined reflected the advice that the textbooks offer. The results sections in all of these industry and academic reports contained analytic language that showed the authors to be actively shaping, interpreting, and arguing for their data. A sample of some of these analytic words and phrases is shown in Table 4. As the words in Table 4 suggest, writers are actively engaged in shaping and arguing for their data. In all 10 reports, these analytic and persuasive words appeared alongside the data they described, thereby integrating interpretation with presentation.

Overall, our generalist technical communication textbooks show a troubling lack of regard for the data, results, and numbers that are central to engineering writing. This omission is even more disconcerting given that many other disciplines served by the technical communication class—including statistics, mathematics, medicine, chemistry, physics, psychology—similarly place a high degree of emphasis on writing about results. Many students in these disciplines will enter jobs where they are expected to solve problems about data and demonstrate numerical reasoning. Yet our textbooks do little to prepare students for this type of writing. Of the 12 textbooks reviewed, only 1, Lannon (2003), gave more than cursory attention to the rhetoric of data and results, and even then the discussion was too brief.

<table>
<thead>
<tr>
<th>Rhetorical Function</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conclusion, Summation</td>
<td>Therefore, thus</td>
</tr>
<tr>
<td>Causation, Explanation</td>
<td>Since, because of, the reason for, the reason was, which means, attributable to</td>
</tr>
<tr>
<td>Relationships</td>
<td>Compared to, by contrast, similarly, interaction between</td>
</tr>
<tr>
<td>Change</td>
<td>Improved, became higher, increased, reduced</td>
</tr>
<tr>
<td>Emphasis</td>
<td>Importantly, as expected, dominant, significant, in spite of</td>
</tr>
<tr>
<td>Conjecture</td>
<td>Indicating that</td>
</tr>
<tr>
<td>Concession or Contradiction</td>
<td>However, to explain, it should be noted that</td>
</tr>
</tbody>
</table>
What types of information and rhetorical principles should our textbooks attempt to communicate about writing results? I propose that we should at least strive to teach students how to do each of the following.

**Interpret data and draw conclusions.** Students need to learn that the meaning of data is not self-evident and that in the workplace, supervisors, clients, and others will expect them to explain what the data mean. Our rhetorical training in stasis theory and topoi can help us work with students to identify common patterns and arguments for talking about data. For instance, many arguments about results take the form of evaluation arguments ("Table X demonstrates that Equipment A produces more accurate readings than Equipment B") or cause/effect arguments ("Figure Y indicates that Equipment C will no longer operate at peak efficiency after 10 years.") Walsh (2007) has reported success in using a set of common scientific topoi to teach students to model common patterns found in experimental articles. Thus, our rhetorical training offers us many approaches to teach students how to write about their results.

Students need to learn to organize their writing so that their bottom-line conclusions are emphasized and can be easily located and understood by busy readers. I recently reviewed a set of experimental papers produced in a senior-level industrial engineering class and found that students often buried their most important findings in lengthy paragraphs about complex statistical analyses. In many papers, the bottom-line message from the report first appeared on page 11 of 12 or page 19 of 20. Some papers even neglected this bottom-line message entirely. When I spoke to the course instructor about these problems, she acknowledged that this was a common problem in engineering students’ writing because these students are afraid of being wrong. Yet research on professional engineering communication suggests that clearly presenting conclusions is essential to engineering writing (Barabas, 1990; Ornatowski, 1998; Winsor, 1996; 1998).

**Present data in a way that leads readers to this conclusion.** Once the author has decided what the bottom-line message is about the data, care should be taken to design tables and figures that effectively present the message that the author wishes to convey. Thus, current textbooks’ chapters on graphics should be more tightly integrated with sections that help students interpret and present results. Students should receive more practice and advice on identifying what argument or message they want to communicate about their data and choosing the visual representation that will best emphasize this message to a particular audience. Few’s (2004) *Show Me the Numbers* is an excellent primer on how to produce rhetorically effective figures and tables (one that is much more accessible than Tufte, 1983, to whom Few owes considerable debt). Our technical students would benefit from more exercises that require them to take a data dump of numbers in a spread-
sheet and craft this data to make a clear and compelling argument in mutually reinforcing data visualizations and textual prose.

**Acknowledge errors, flaws, and unexpected or unfortunate results.** As Ornatowski (1998) has demonstrated, one of the most challenging rhetorical problems facing engineers and other technical writers occurs when tests do not go according to plan. Herrington (1985) also emphasized that acknowledging errors is a higher level rhetorical skill expected of advanced engineering students. We can use our training in Toulminian analysis and conditions of rebuttal to teach students strategies for conceding mistakes and flaws in the arguments they want to make about data without confusing readers about their purpose.

**Follow the conventions of the IMRAD data reporting genre.** Most engineering technical reports, like experimental reports in the sciences, follow some variation of the IMRAD format of a scientific article. However, the conventions of this genre are not always clear to practicing engineers: Both Barabas (1990) and McKenna (1997) noted that engineers often have trouble organizing ideas into proper report sections. McKenna, for instance, found a report that presented the summary in the second report section. McKenna also faulted engineers for using a chronological narrative organization that focuses on the writer's actions because this can cause writers to conflate methods and findings and contribute to confusing and poorly organized reports.

Students need to learn how to participate in the larger scientific and technical discourse community by understanding the conventions of its most well-known genre. They need to understand the social actions that the IMRAD genre achieves: It allows for multiple types of reading by including similar information differently described and elaborated in specific, predictable sections. Many workplace documents implicitly follow an abbreviated or modified IMRAD format even if they are not explicitly structured as IMRAD documents. For instance, many trip reports introduce the problem (introduction), describe what was done (methods), analyze the problem (results), and make recommendations (discussion). Students thus need practice identifying the various permutations of the IMRAD genre and analyzing the rhetorical goals that these permutations may be attempting to achieve.

**CONCLUSION**

As Miller (1992) neared the conclusion of her review of technical communication textbooks, she made a puzzling claim that “here are no distinctive features of technical writing that set it clearly apart as a species from business writing” (p. 117). If Miller was talking here about technical communication as a profession, then her claim may be valid. But if we think about technical writing from the perspective of
someone trained in a technical or scientific discipline such as engineering, mathematics, or chemistry, then it is indeed different from business writing, with unique stylistic preferences, documentation standards, genres, and standards for what counts as evidence. Certainly, for example, there are major differences between the writing produced by an engineer and that produced by a marketing representative.

When our textbooks focus on the types of writing commonly produced by professional technical writers, they are at their strongest. Thus, sections on producing instructions tend to be strong, and they reflect the considerable research that has been conducted on this topic. Similarly, sections on proposal writing tend to tackle this difficult, complex, and varied genre effectively. Our books are also to be applauded for their growing reliance on new developments in usability research. But when the topic turns to the types of writing that technical professionals, such as engineers, produce for their peers, our textbooks have much less to say. This is particularly true for writing that relies on numbers and technical data for its claims. This trend is not surprising, but it is one that we should rectify.

It may be argued that in calling for more emphasis on writing about data and results and on the IMRAD genre, I am privileging academic over workplace genres. Such arguments might point out that, although many technical communication scholars have found prominent examples of IMRAD writing in the workplace (Barabas, 1990; Ornatowski, 1998; Sales, 2006; Winsor, 1996), these scholars have tended to favor design and research laboratories that are likely different from other engineering workplaces. But even if experimental report writing is not as common as some of our research might suggest, students may still benefit from writing instruction that they see as immediately beneficial to their disciplinary coursework. Moreover, students who master the IMRAD genre, thereby learning to distinguish methods from results and conclusions, will be better prepared to write many workplace genres. Anyone writing a trip report, progress report, or even meeting minutes will benefit from practice in distinguishing a chronological account of what was done (methods) from bottom line recommendations and conclusions (results and discussion). Perhaps more importantly, nuanced attention to the rhetorical demands of all sections of an IMRAD report should give students practice in thinking about numbers rhetorically, a skill that for those in numbers-based disciplines, should certainly translate into other workplace writing.

I should add that in arguing for more emphasis on IMRAD and on discussing quantitative information, I am of course not suggesting that we eliminate other important types of writing such as proposals, instructions, memos, and feasibility reports. However, I do feel that in place of the large sections that many of our textbooks include on writing for the general public (the type of writing that a professional technical writer rather than a professional engineer is likely to produce), we should dedicate more space to discussing how to present quantitative information and technical data to peers (other engineers) as well as managers and cli-
ents with less technical background. Technical communication instructors will be at their most effective when they are able to give engineering students specific strategies for “translating” highly complex technical information between technical and nontechnical audiences. Such strategies include but of course are not limited to the following:

- choosing between active and passive voice to focus sentences on either people or things and to meet a given audience’s needs and values
- choosing appropriate citation styles where necessary
- selecting data visualizations that balance the engineer’s need to present an ethos of accuracy and precision against the audience’s need to grasp a clear message
- organizing technical reports so that managers can easily find recommendations, conclusions, and other bottom-line messages while still satisfying fellow engineers’ needs for detailed reporting of precise numbers, calculations, and methods.

In other words, this study suggests that our already hefty textbooks should do more than just expand to include more information. They need to become more sensitive to the complex rhetorical task of balancing precision, accuracy, and technical detail with managerial or client audiences’ needs to see the big picture. Students need many more examples of writing that illustrates that complex technical information need not be unintelligible. In addition, they need much more analysis and discussion of the specific rhetorical strategies that effective engineering communicators use to adapt complex technical information (including quantitative information) for the various audiences in their workplaces. As a model for how such strategies might be communicated, we might look to Penrose and Katz’s (1998) Writing in the Sciences. Although I do not recommend this text for the general technical communication class (it is written at an advanced level and focuses on academic journal writing), it nonetheless serves as a model for how to analyze and discuss some of the specific strategies that advanced writers use to make complex technical information intelligible. Along these lines, I also recommend Gopen and Swan’s (1990) classic article, “The Science of Scientific Writing.” Both of these texts are remarkable for their focus on how specific linguistic strategies can be used to achieve particular rhetorical ends. We might also look to the work of our colleagues in English for specific purposes and other linguistic fields who have reported success using corpus analysis techniques to immerse students in the unique linguistic features and preferences of disciplinary genres (see Murdraya, 2006; Swales, 2004).

Changing the technical communication curriculum to be more sensitive to the rhetorical needs, values, and conventions of students’ core disciplines may help address some of the problems with the stand-alone technical communication class.
Rhetorical knowledge transfer appears to be much stronger when students can see the connection between the curriculum and the discourse genres in their community (see Ford, 2004, for a review of this literature). Surely we can do more to help students make these connections.

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REFERENCES


Joanna Wolfe is Associate Professor of English at the University of Louisville. She is currently working on instructional materials to teach students the rhetoric of data reporting. Drafts of these materials can be accessed at http://louisville.edu/faculty/jlwolf02/writing-about-data.

**APPENDIX A:**

**THE 5 INDUSTRY AND GOVERNMENT TECHNICAL REPORTS ANALYZED**


**APPENDIX B:**

THE 5 ACADEMIC ENGINEERING JOURNAL ARTICLES ANALYZED


