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Engineering Writing for the General Public: A Classroom Approach

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Engineering Writing for the General Public:
A Classroom Approach

Abstract

The University of Southern California's Viterbi School of Engineering requires its undergraduates to take a semester-long course, Advanced Writing Communication for Engineers, to gain writing and public speaking skills. One specific goal of the course is to improve students' abilities to write for a variety of audiences, including the general public. To this end, all students in the course submit articles to the Engineering Writing Program's *Illumin* magazine, an online periodical whose purpose is to educate the public on the ways engineering affects our everyday lives. *Illumin* has a strong readership, providing students with a real audience to envision and invoke as they write.

This paper provides background on *Illumin* magazine and presents a classroom approach developed by the author for teaching about writing for the general public. The approach centers on research by Jeanne Fahnestock that argues that "transforming" technical information for the public often involves a shift in genre, from the *forensic*, in which facts are established, to the *epideictic*, in which the subject is praised or celebrated.

After a summary of Fahnestock's work and the ways the author introduces the research in the classroom, the paper provides suggestions for discussion topics that the research raises. Fahnestock's findings in the classroom usually spark debate on the persuasive and ethical nature of science writing that might seem "objective" to students or a general audience.

The aim of this classroom approach is to enable students to better understand the rhetorical and ethical implications of writing for the general public and apply them to their *Illumin* articles and their own professional writing. The paper concludes with a case study to illustrate one student's improvement from draft to final submission.

Introduction

Practicing engineers communicate often with constituencies who have varying purposes for reading and varying levels of technical expertise. These constituencies range from managers and colleagues to general audiences, who may have a significant stake in an engineering project or technology. Engineers need sophisticated rhetorical skills to accommodate the varying interests and levels of knowledge of these audiences. In recognition of the importance of these skills for engineering graduates, and in part to meet ABET requirements, most engineering schools across the country have incorporated some form of writing instruction in their engineering curricula.

At the University of Southern California's Viterbi School of Engineering, all undergraduates are required to complete a semester-long advanced writing course, Writing 340. This is a university-wide course offered in several specialties and housed in three schools, the Dornsife College of

Letters, Arts and Sciences, the Marshall School of Business, and the Viterbi School. One specific goal of WRIT 340 is to improve students' abilities to write for a variety of audiences, including the general public. To this end, all students in the engineering version of the course submit articles to the Engineering Writing Program's *Illumin* magazine, an online periodical whose purpose is to educate the public on the ways engineering affects our everyday lives. *Illumin* has a strong readership, providing students with a real audience to envision and invoke as they write. The assignment also allows for rich class discussions about the accountability of engineering to the public and the ethical and rhetorical complexities of communicating with a non-technical audience.

This paper first provides background on *Illumin* magazine and then describes a classroom approach for teaching about writing for the general public. The paper provides a summary of research by Jeanne Fahnestock on the rhetoric of science that argues that "transforming" technical information for the public involves more than simply "translating" technical language into non-technical language. Rather, Fahnestock argues, the transformation often involves a fundamental shift in genre, from the *forensic*, in which facts are established, to the *epideictic*, in which the subject is praised or celebrated.[4]

The paper then describes how the author introduces Fahnestock's findings to the class in a lecture and discussion, which usually spark lively debate on the following issues:

- The importance of communicating scientific findings to the public
- The persuasive nature of science writing that might seem "objective" to students or a general audience
- Ethical issues about reporting findings: strength of claim in scientific reports compared to strength of claim in writing aimed at the general public
- Ethical issues about promoting research to attract funding for it.

The aim of this classroom approach is to enable students to better understand the rhetorical and ethical implications of writing for the general public and apply them to their *Illumin* articles and their own professional writing. The paper concludes with a case study that illustrates one student's improvement from the draft stage to final submission to the periodical.

USC's *Illumin* magazine

Illumin magazine, an online publication begun in 1998, is "dedicated to exploring the science and technology behind the things we encounter every day"[4] and showcases the writing of USC engineering undergraduates, although submissions are open to students from universities across the nation. The articles "relate the far-reaching impact of the engineering profession, and provide a broader view of the socio-economic and political implications of rapid technological change."[5] The magazine features interactive multimedia features such as animations, graphics, and video and sound clips. All Engineering WRIT 340 students write an article for *Illumin*. At the end of the semester the articles are submitted either online by the students or as hard copy by

the instructors. Student editors give each paper three readings and select articles for publication based on their ability to capture the reader's interest, their success in fulfilling the purpose of *Illumin*, and their writing quality. Student graphic artists and animators create the visuals that accompany the articles. The magazine's faculty advisor gives a final edit. Issues are published two or three times a year, and the magazine is funded by the Dean's office.

Illumin has a worldwide readership and has won four Interactive Media Awards, among others. *Illumin* articles have been published in textbooks and university course readers and have been cited in newspapers and other media outlets, such as the *Orange County Register* and the Science Channel website. A screenshot of the *Illumin* homepage is given in Figure 1. As the figure shows, the website has a professional appearance and provides rich content for the reader.

Figure 1. Screenshot of *Illumin* homepage.

The *Illumin* assignment is designed to have several benefits for the students, including developing students as writers, editors and publishers, debunking the stereotype of engineers as bad communicators, and providing students with a deeper understanding of the applications of their discipline and the ways engineering intersects with the public. Perhaps one chief benefit of the assignment is that it provides a real audience for students to envision and invoke, and a motivation for them to write: publication. Too often, college writing assignments lack a clearly defined audience other than the instructor and purpose other than fulfilling the assignment.[6] While some instructors construct artificial audiences in the assignment prompt (as in, "Assume your supervisor at your engineering firm asks you to write a report…"), these audiences are often only vaguely addressed by the students, and for good reason: it is difficult to construct the institutional and political complexities of such an audience in a college assignment. The *Illumin* assignment mitigates these problems of defining an audience by providing an actual publication with actual readers from outside the university. Based on informal feedback from students, I have found the students often highly motivated to see their work published, in part because they know that publication provides evidence of their writing skills for prospective employers. The wide range of possible topics also gives students a fair amount of freedom to write about a topic that interests them, another motivating factor.

An approach to teaching the *Illumin* assignment and writing for the general public

To provide students with a theoretical framework for approaching the *Illumin* assignment and writing for the general public, I draw on the work of the rhetorician Jeanne Fahnestock, in particular her article "Accommodating Science: The Rhetorical Life of Scientific Facts."[4] The process I describe below has been successfully applied to the specific *Illumin* assignment, and can also be used to introduce concepts of popular science writing in general. To begin the course unit on writing for the general public, I summarize for the students Fahnestock's research and provide examples of her findings from the popular media, as I will do here as well.

Fahnestock argues that communicating complex scientific concepts in language that a lay audience can understand is more complex than modifying technical language and supplying fewer technical details. Rather, in science writing for the general public, not only does the language change, but also the genre—and hence, the purpose—of the rhetoric changes. She argues that the genre of expert science writing is *forensic*: that is, the purpose of science writing for an expert audience is to demonstrate fact—what exists, what occurred, and what caused it. The purpose of science writing for the general public, on the other hand, is often celebratory. This celebratory writing is the genre of *epideictic* rhetoric, or ceremonial rhetoric. The purpose of this type of writing is not to establish whether and why something occurred, but to celebrate the accomplishments of science (or in our case, engineering).

Writers usually celebrate science, Fahnestock argues, by appealing to a general audience in one or two (or both) ways: by appealing to the inherent wonder of the subject or to its application and the ways it will benefit society. To demonstrate the "wonder" appeal, I bring in an example

of a *Los Angeles Times* write-up about the *Pleocoma*, a California beetle described by the *Times* as "both strange and wondrous." The "mysterious" habits of the beetle, according to the Times, "might just tell us one day how California, this far-flung edge of the continent, formed and became home to such as wild diversity of flora and fauna."[3] Discoveries in astronomy or physics also work well as examples of the wonder appeal. This appeal can be used for *Illumin* topics that celebrate the ingenuity of engineers or the construction of marvelous structures, such as the Florence Duomo, the Roman aqueducts, the Troll A platform, or the Channel Tunnel.

The second appeal available to writers is the application of a scientific finding or a technology. Since application is the *raison d'etre* of engineering, this appeal works well for engineering students and the *Illumin* assignment. I pull articles from *Illumin* that use this appeal to demonstrate how it works. Often, the students' articles appeal to both wonder and application.

Making students aware of this shift in genre gives them a way to conceptualize the rhetorical purpose of their articles and the topics available to them. However, students also need to be aware that the rhetorical shift in genre from demonstrating fact to celebrating the facts often has consequences on the facts. Fahnestock demonstrates that when the "facts travel from one genre to another," a couple things happen. First, she argues that popular science writing tends to "increase the certainty of the claims made in the original."[4] She demonstrates this with a psychological study from the 1980s that suggested that boys' math skills are inherently superior to girls'. The writers of the original write-up of the study, published in the journal *Science*, carefully qualified their conclusions, hedging with words such as "may," "probably," and "seems likely," and they acknowledged that "our data are consistent with numerous alternative hypotheses." When the study was seized upon by the mainstream media, however, these qualifications were lost. Instead, *Newsweek* summarized the findings bluntly: "Sex differences in achievement in and attitude toward mathematics result from superior male mathematical ability."[4] The discrepancy between the two articles raises interesting ethical questions about strength of claim, which I will return to later.

The second thing that happens in the shift from forensic to epideictic rhetoric, according to Fahnestock, is that that popular science writing tends to "leap to results," or jump from reporting the data to speculating on the broad possible implications of the data—again, arguably without sufficient qualification. This finding is further reflected in a more recent study on medical news reporting that demonstrates the "tendency for press releases and the associated media coverage of RCTs [randomized controlled trials] to place emphasis on the beneficial effects of experimental treatments."[12] The "spin" found in the press releases, the authors show, is subsequently reflected in the popular media reporting of the original study. I demonstrate this "leap to results" in class with a discussion of the finding of the fossil *Darwinius masillae*, nicknamed "Ida." Ida was discovered in 1983 by amateur fossil hunters but was divided into two collections, with the significance and reunification of the two parts not being realized until 2009. Ida is considered by the scientific community as "the most completely preserved fossil primate that has ever been found,"[9] and therefore a significant discovery. However, the fossil was quickly billed by the popular media as the "missing link" between primates and humans, the

fossil record that would conclusively prove Darwin's theory of evolution. In celebration of the finding, the American Museum of Natural History in New York staged a "Hollywood premiere-like news conference"; the History Channel aired a documentary called *The Link*; a book was published with the same title; and a website was established, revealingthelink.com. To quote from the website, "Ida is one of the transitional species that Darwin wrote about 150 years ago, even though they were missing in the fossil record at that time."[7]

However, the original research published in the journal *PLoS One* made no such "leap to results." In fact, the authors refute this idea: "Note that *Darwinius masillae*, and adapoids contemporary with early tarsioids, could represent a stem group from which later anthropoid primates evolved, but we are not advocating this here, nor do we consider either *Darwinius* or adapoids to be anthropods." Other paleontologists weighed in, with Chris Beard of the Carnegie Museum of Natural History at Johns Hopkins commenting that Ida is "part of the primate family tree that is about as far away from humans as you can get and still be a primate."[8] Nonetheless, the authors did not distance themselves from the hype. And in fact, when asked about the hype, one of the lead authors of the scientific article, John Hurum, was unapologetic: "That's part of getting science out to the public, to get attention….I don't think that is so wrong."[9]

Fahnestock's research opens up a number of issues about the interaction between technical experts and the public and about the ethics of communication between the two groups. After I summarize and demonstrate Fahnestock's research, I begin a class discussion in which we try to answer the "so what?" question about Fahnestock's findings. The points we usually discuss are briefly sketched below.

Why it is important for the public to be informed about developments in science and engineering
Although we discuss throughout the course the ways engineering and technology affect the public, Fahnestock's research vividly illustrates the ways public policy can be shaped by media reporting on technology. Fahnestock's example of the study on the math abilities of girls and boys provides a perfect example of the kinds of public policies that are affected by scientific research: what kinds of classes should boys and girls be taking? If girls are not biologically mathematically inclined, as the research suggested, perhaps they should not be steered toward careers in the STEM fields, and low numbers of women in STEM college majors might be justified. Similar problems may arise with genetic research that suggests differences between racial groups: one study concludes that "linking race, genes, and health produce increases in racist attitudes in some audiences."[2] Any number of examples illustrating the central role of technology in public policy debates can be drawn from engineering fields, such as oil and gas "fracking" technologies and and unmanned drones being developed for use in the US. The public must be able to make informed decisions about the use of these and other technologies.

The persuasive nature of science writing that might seem "objective" to students or a general audience
Undergraduate engineering students tend to think of forensic science writing as unbiased, "informative" writing; they often believe that the data speak for themselves and have to be taught

that the data is always interpreted, shaped, and presented by the authors to support a particular conclusion. It is tempting for students to think of the *Illumin* articles also as strictly informative rather than persuasive, since the articles do not usually argue an ethical position or make recommendations. But our discussion of Fahnestock's article helps them to see that both forensic and epideictic rhetoric are actually suasive. The *Illumin* articles seek to persuade their audience that engineering is a profession worthy of praise. In this view, *Illumin* is an encomium to engineering, promoting the profession in ways similar to other outreach programs such as professional society websites, student recruitment initiatives, and the NAE's Grand Challenges. We might discuss the need for the engineering profession to promote itself, and whether engineering is or has been seen as a force for good in the world. If students understand the rhetorical purposes and conventions of various genres of science writing, they can write more persuasively.

Ethical issues about promoting research in order to attract funding for it

Once students understand that science writing is persuasive, and that public policy is directly affected by developments in the STEM fields, I ask the students whether the lead author of the Ida fossil study, Hurum, acted ethically when he commented that the media's distortion of the Ida discovery was "not so wrong" as long as it was "getting science out to the public."[8] As Yavitch et al.[12] and Caulfield[1] point out, the research community itself contributes to perhaps overly optimistic or sensationalized results, for reasons including "commercial enthusiasm and pressure from public funding agencies."[1] How do researchers ethically promote their research without misleading their readers, whether technical or non-technical? On the one hand, students might point out, research is not free, and good researchers understand that they must convince their readers that their research is worthwhile if they are to attract funding for it. On the other hand, the scientific process demands that researchers report their findings honestly. Students are often divided about this issue, with some of them agreeing with Hurum and others arguing that he crossed an ethical line.

We also discuss whose responsibility it is to ensure that scientific findings are reported accurately. Do the researchers have a responsibility to ensure their conclusions are not distorted or exaggerated by the media? Or is their responsibility solely to the scientific community? Is the responsibility the media's alone? We talk about the public interest in science and engineering, and what can result if the public feels it has been misled. With politically controversial topics in the US such as evolution and climate change (I bring up the media storm over the climate scientists' emails that purportedly suggested they exclude data that did not support climate change theory), if the public feels it is being deliberately misled to serve an ideological end, the credibility of the scientific community is diminished.

Ethical issues about reporting findings: strength of claim in scientific reports compared to strength of claim in writing aimed at the general public

Qualifiers that "hedge" a claim, such as "suggests," "may," "probably," and "could," are an essential characteristic of science writing for expert audiences[3,8] and should be for lay audiences as well. It can be difficult for students to strike the appropriate balance between appearing

authoritative and not overreaching with their claims; students must "learn to be confidently uncertain."[10] The mainstream reporting on the psychological study discussed by Fahnestock provides a vivid example of the importance of qualifiers and the ethical problems that arise when they are omitted. To introduce the topic for discussion, the instructor might compare the qualifiers used in the original research article published in *Science* with the the reports in the mainstream media. One possible rhetorical exercise is for the students to rewrite the mainstream media's sentences to include appropriate qualifiers.

To summarize, Fahnestock's article gives the students a way to conceptualize their *Illumin* articles as epideictic rhetoric; it also gives them two concrete ways to appeal to their audience, through the wonder and application appeals. The article also opens up several discussion topics on the interaction between the scientific community and the public, and the ethical implications of communicating technical information to a lay audience. The list provided here of discussion topics is by no means exhaustive, but I believe it touches on important issues—both on a concrete, sentence level (such as the importance of hedges) and on a rhetorical and ethical level —in engineering communication.

Results: A student paper case study

The Engineering Writing Program does not currently have quantitative results measuring the success of the *Illumin* assignment in developing students' abilities to communicate with the general public. However, the publication's wide readership and use in other educational settings attests to the success of the student articles in reaching a general audience, the chief aim of the publication.

In addition, I offer here a brief case study of one student's writing process on this assignment as an example of the ways our discussion provided a foundation for her revision. Given below is the introductory paragraph of the initial version of her article "Biology's Approach to Construction: The Development and Use of Scaffolds in Tissue Engineering" (the parenthetical citation in the paragraph is from the student's paper and does not refer to the references listed at the end of this paper):

> In the mid 1980s, the field of tissue engineering was established as the next major biological breakthrough. As these technologies developed, it became plausible that these engineered tissues could replace organs and other living cells that had been damaged or lost. Successful regeneration showed exceptional promise with the use of biocompatible materials that function as connectors across an injured area. (Li 65) These "biological bridges" allow for cell proliferation and thus reattachment and organ growth. With this goal in mind, increased funds and research have been invested to develop instruments for cell growth. The most effective and useful medium created is the scaffold.

This paragraph presents a number of problems for a general audience. First, some of the technical terms may be unfamiliar to the audience, such as "tissue engineering,"

"biocompatible," "cell proliferation," and "instruments for cell growth." Second, there is a disorienting lack of context. The first sentence seems to pick up in the middle of a thought: what is a "biological breakthrough"? And what have been past breakthroughs? Third, the use of passive voice ("living cells that had been damaged or lost," "increased funds...have been invested," and the entire last sentence) further distances the audience from the topic and obfuscates what exactly is going on. Even when the student uses active voice, the subjects of the sentences are abstract: "successful regeneration," "technologies." This student, as is typical with many of her peers, seems to be trying—unsuccessfully—to imitate an "academic" style, especially inappropriate for the audience she is actually addressing.

But an even greater flaw than the stylistic missteps is that the paragraph fails to achieve its rhetorical purpose: to introduce the subject and establish the significance of her topic for a general audience. The student has made clear use of neither the wonder nor the application appeal; she has neither suggested that biological scaffolding is inherently interesting, nor has she demonstrated how the general public will benefit from it. While this paragraph would not not likely be successful for an academic audience, it would probably bore a general reader, who would find little reason to continue reading.

I commented on the paper and met with the student to discuss how she might revise the paper to better accommodate the needs of her audience. In particular, we talked about ways she could appeal to her audience's interests through the application appeal and accommodate their level of knowledge about her subject. She later submitted the following revised introduction. While this revision is not without flaws, it makes a greater effort to engage its readers and use language they would understand. (The parenthetical citations in the paragraphs are, again, from the student's paper.)

> Last year, over 1 million knee-replacement surgeries were performed worldwide, with over half of those surgeries done in the United States. (Number of Knee Replacements) This procedure, often done because of cartilage deterioration, requires the removal of existing bone, the insertion of a metal joint, and the re-attachment of ligaments to the artificial knee. Besides the risks of anesthesia and other surgical complications, the patient can experience serious immune responses as the body attempts to reject the foreign metal material. Then consider that the average artificial knee must be replaced within the first 10 years of insertion. (Knee Replacement) Thus, this invasive and potentially dangerous surgery is also likely to fail, making the next procedure even more dangerous.
>
> With millions requiring such procedures, it has become even more important for scientists to find a safer and more acceptable alternative. Fortunately, tissue engineers have revolutionized this field, developing technologies to replace living cells that had been damaged or lost. By using biocompatible materials that function as connectors across injured areas, these "biological bridges" allow cells to grow, divide, and reattach. (Li 65) This process results in tissue growth and repair. The most effective of these

> "bridge" mediums is the scaffold. With its microscopic, porous form, the scaffold is suited as a structured device through and on which cells can grow. Further, scaffolds are biocompatible to prevent rejection, and they even degrade over time as the tissue is replaced. These characteristics make scaffolds ideal for any tissue, even nerve. With this versatility, tissue scaffold can be used in applications from knee replacements to spinal cord regeneration.

Here, the student gives a general reader a reason to read by using the application appeal. She immediately introduces a problem that the reader would find familiar, the risks and possible complications of knee-replacement surgery. Then, she introduces bioscaffolding as a solution to the problem. The implications and advantages of the bioscaffolding technology for a general audience are much clearer here, and the student's prose is much clearer as well, with short, non-technical sentences such as "This process results in tissue growth and repair." There is less passive voice; instead, in this version, "tissue engineers" are responsible for the developments in the field. There is even some use of the imperative to directly address the reader ("Then consider that the average artificial knee must be replaced…"). The final sentence of the introduction reiterates the application of bioscaffolding. Because the writer has made the practical implications of the bioscaffolding clear here, the reader is much more likely to be interested in continuing with the article.

Our previous in-class discussion of the "wonder" and "application" appeals provided a vocabulary with which this student and I could discuss the problems of the first draft and gave her a way to think about not simply informing her readers about bioscaffolding, but rather persuading them that the technology and the tissue engineers should be celebrated. The revisions were successful: the article was published in the Fall 2012 edition of *Illumin.*[9]

Conclusion

It is important to note that the transformation of forensic rhetoric for experts to epideictic rhetoric for the public, as Fahnestock describes, is not necessarily a bad thing. The public's desire for a clear reason to read is not wrong, and as Fahnestock notes, "Even if the scientific report were translated from insiders' to outsiders' language with the minimum amount of distortion and no attempt to provide an epideictic exigence for the report, the public as readers would … ask 'Why is this happening? Is this good news or bad news? What should we do about it?'"[4] Rather, the classroom approach presented here attempts to serve two purposes. First, it provides the students with strategies to appeal to their audiences through the "wonder" and "application" appeals. Second, it introduces or reiterates the rhetorical and ethical complexities of communication with the public with the aim of encouraging students to make ethical decisions in their own communication. This involves making claims of appropriate strength, limiting conclusions to what the data support, and understanding that even "objective" science writing is better understood as persuasive writing.

While we do not currently have quantitative assessment data on this approach or the *Illumin* assignment in general, this classroom approach hopefully gives engineering students a deeper understanding of the purposes and conventions of engineering writing for the general public. For a more complete picture of the effectiveness of the assignment, future work should include obtaining some type of assessment data, such as student feedback or reflection on their learning process, or employer feedback on graduates' writing skills.

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