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Three Types of Scientific Writing

My first-year writing seminar, Writing about Engineering Problems, is centered around how engineers identify and solve problems, changing the world through technology. The goal of this course is to develop students' critical thinking and problem-solving skills while they learn academic writing. Nearly all of my students are engineers, who frequently do not think of writing as an important part of their studies.

For nearly the first half of the semester, I had my students work on a sequence of essays designed to introduce scientific writing. For the first essay, "How Things Work," each student selected an everyday object and described how it works, in detail, in the form of a popular science article. The second essay, "Climate Change," introduced students to the skill of data analysis: they had to build an argument on the basis of scientific data. For the final essay, "Engineering in Sports," students wrote a patent-like description of a technology designed to improve athletic performance.

I designed these writing exercises with two purposes in mind. The first was to convince my students that writing is an important skill for engineers to have. That's why I chose to have them study three types of scientific writing: they would see that engineers and scientists do have to write, and change their style to suit their audience. My second purpose was to make students conscious of the sentence-level choices they make when writing, and the effects those choices have.

To begin the sequence, I had the students look at excerpts written in each of the three styles and identify the main characteristics of each. The reading assignment, "Writing as Bridge-Building," describes writing as an engineering problem and helped convince the students that writing is an important skill for an engineer to have. I think this reading helped convince them that engineers are capable of writing well, motivating them to work on their essays.

As a part of each individual essay, we reviewed the main stylistic features in class. For example, during the climate change essay, I had the students look at several journal articles, then make an outline of a generic journal article. The three types of writing I chose (a popular science article, a scientific journal article, and a patent) have very different styles.

Popular science articles are written for the general public. As such, they are easy to understand, with short sentences and a limited vocabulary. Attracting the attention of a casual reader is an important facet of these articles, as they are generally read for enrichment rather than research purposes. They often skim over details that might confuse a reader. I had my students choose an item and explain how it works for this essay. Their essays were generally clear and interesting to read. My students agreed that this essay was the easiest and the most fun to write.

Scientific journal articles are intended for a much different audience. The scientists who read these articles are generally very skilled and knowledgeable in a particular area, making ease of

understanding unnecessary. Sentences tend to be longer and more complicated, with specialized vocabulary. These papers aim to convey as much information in as little space as possible. Citing sources is also very important for this type of writing, and I emphasized this skill by organizing an in-class activity and homework assignment around it.

The journal essay assignment was to select one graph from an online climate change report and explain what it showed, building an argument for or against climate change. For the most part, they were successful. However, my students said that this was the most difficult of the assignments because they felt their background was insufficient. I gave a lecture on climate physics which I thought would allow them to understand the background material they would find on their own (they were excited at getting to do math in their writing seminar). Were I to teach this again, I would spend more time on climate physics and offer more guidance on the selection of a topic and development of an argument. My students also complained that the topic was too restrictive.

The third and final essay of the sequence was a description of a sports technology suitable for a patent. Patents are not really meant to be read and understood, but to be used to protect the legal rights of an inventor. This makes them more difficult to understand, and full of details. This sort of writing helped my students use details (as one pointed out, it is in fact possible to write four pages about a baseball bat). Sentences in patents are often convoluted and devoid of personality, giving my students experience in both reading and writing such prose. After speaking with a patent attorney, I decided to have the students write the sort of document they would give to their lawyer to be turned into a patent rather than a patent itself. This seemed to be a more realistic assignment for future engineers (as opposed to future patent attorneys), and also allowed them to focus on content instead of having to learn difficult legal language.

This topic showed my students that engineering is changing sports technologies and got them to think about the role of engineering in athletics: often new technology leads to the appearance of increased human performance. My students thought this essay was interesting to write. I think that had more to do with the topic of sports than the style of a patent. On reading the essays, I thought the climate essays were more interesting and coherent than the sports essays. However, that is also characteristic of the styles involved. Patents are meant only to defend the patent-holder's rights, while journal articles are for disseminating information.

In order to encourage the students to revise their drafts, I utilized peer review processes designed to mimic the actual processes associated with each of these types of writing. For the popular science essay, students simply passed their essays around in class and read and commented on one another's informally. Journal articles are read by a journal's reviewers and recommended for acceptance or rejection. I had the students form committees, each of which read several essays and decided whether or not to accept them for a class journal. Since each student received a written response from the reading committee instead of getting to discuss the essay, I had the students write back to the committee. For the most part, students

agreed with their committees' recommendations. However, some students chose to revise in ways other than their committees suggested. As a document intended to assist a patent attorney in preparing a patent, having the students meet in attorney-client seemed a natural way to do peer review. The students found their peers' comments quite helpful in preparing their final essays.

The final assignment of this sequence, the beginning of an essay on the Internet, allowed students to include stylistic elements in their essay plan. I wrote this assignment in order to reinforce the stylistic part of the essay sequence. By writing this proposal, students had to review the main stylistic points of the three genres they had written in, and decide which of the three suited their new topics the best. At the end of this sequence, students agreed that writing for a particular audience was an important skill which this sequence helped them to develop.

How things work

Rationale: Engineering is often about making new things, both everyday objects and exciting new technologies. In this unit, you will learn how something (of your choice: an everyday object, an algorithm, or anything else that is not too complicated) works, and how to explain it in writing. This essay introduces clarity of thought and the principles of engineering. By explaining how something works, you will have to examine the process carefully and see how well you really understand your chosen object.

This is the first of a sequence of essays designed to give you the opportunity to try out different styles of scientific writing (journal articles, popular science articles, and patents) and understand the different effects they achieve. The first is written as a popular science article, because it assumes no specialization and you are likely to have very different topics and backgrounds. This is probably the style of writing closest to what you are used to doing for classes.

Preliminary writing 1: due Tuesday, 30 January

Read the excerpts (on the course website) from a scientific journal article, a popular science essay, and a patent. Also read lesson 1 in *Lessons in Clarity and Grace* (pages 3--10). Be prepared to discuss your answers to the following questions. Think about specifics such as sentence length, vocabulary, and the use of active or passive voice as you prepare your responses.

How do the styles of the three samples differ? How are they similar?

What is the audience for each type of writing?

Which is easiest to understand? What makes this writing easy to understand?

Would you use different strategies to read these different types

of writings? What techniques would help you understand each one?

Why do you think an author would choose one style over another?

Are there reasons beyond the standards for each type of publication?

In class: Tuesday, 30 January

First we'll discuss the reading assignments and assigned questions, in small groups, with each group giving a summary of results to the class. Discuss your essay 1 (due today) with your group members. How does your writing style compare to the styles of these samples? We'll make a class list of the characteristics of each type of scientific writing, based on your observations of the sample texts.

Then I'll give a brief presentation introducing the essay topic. After the presentation, you will break into small groups and discuss other items, their uses, and design. By the end of the class period, you should have chosen something you would like to understand in detail. This could be an everyday object, an algorithm, a biological process, or whatever you like.

Preliminary writing 2: Due Thursday, 1 February

Read ``Writing as Bridge-Building'' by Henry Petroski (on reserve).

Write a paragraph about what your item is and does, in each of the three styles we discussed today (you will finish with three versions of the same paragraph). Write a second paragraph about how you had to think differently to write the same content in a different style. It might help to keep in mind some of the following questions: How did you vary your sentence length? Did your vocabulary choices change? What kind of background is necessary to understand each of the three paragraphs?

In class: Thursday, 1 February

In small groups, discuss the three different writing styles (with emphasis on the popular science format) and Petroski's essay. Use the last few minutes of class to write down what stylistic points you'll need to remember when writing your essay.

Then expand your paragraph, in the popular science style. Think about what engineering problem your item solves, and why it is necessary. Today, I want you to figure out how well they understand your item, and how much research you will need to do. Trying to explain the item to your peers should help you figure out what you need to put in your next essay, and how to organize it. Annotate the outline of your answer with research ideas. By the end of class, you should have an idea of what to do for the research assignment due Tuesday.

Preliminary writing 3: Due Friday, 2 February and Tuesday, 6 February

Please email me a plan of your research (based on the ideas you developed in class) by Friday evening.

For Tuesday, do your research. This research, like all scientific research, could take several forms: experimental, theoretical, numerical, or library. Taking the item apart and other such strategies are also encouraged. Most scientific research involves more than one of these approaches. I expect this research, and the resulting paper, to be easily understood by your classmates.

Turn in a summary of your methods and results, and be ready to give a brief presentation in class on Tuesday. Don't forget to cite your sources.

In class: Tuesday, 6 February

Presentations: tell your classmates about what research you did and what the results were. Each presentation will be strictly limited to 4 minutes, so that everybody gets a chance. You should use either a demonstration or a poster as the basis for your presentation. Make comments on your classmates' presentations. I'll bring note cards so that you can write a few comments on each presentation and give them to the presenter. By the end of today, you should know whether or not your results help you explain your item.

Essay: Draft due Wednesday the 7th; revised version due Tuesday the 13th

Write an essay, in the form of a popular science article, about how your item works. This essay should be clear enough that one of your classmates, after reading it, will understand exactly how your item does what it does. Use the introductory work you completed and the research you did to explain exactly what happens when your item is used. What makes your item different from (or better than) other items that do similar things? How might you improve your item? Email the draft of your essay to your group members by 3 pm on Wednesday afternoon, so that they have time to read it before class on Thursday.

In class: Thursday, 8 February

Writing workshop: exchange essays with your classmates and make comments. When reading another's essay, think about how easy it is for you to understand the item described. Is enough background information included? Would (additional) diagrams or equations clarify anything? Is the essay's organization sensible? Make a plan for revising your essay, based on the comments of your group members.

Climate change

Rationale: This assignment is designed to introduce you to climate change, a topic of current popularity. You'll learn about the physics of climate, as well as how to interpret scientific data. By writing this essay in the style of a journal article, you'll become conscious of the stylistic choices characteristic of this genre, and the way you can make them in your own writing.

In class: Tuesday, 13 February

Introduction to climate dynamics. References:

Neil Wells, *The Atmosphere and Ocean: A Physical Introduction*. Philadelphia: Taylor & Francis Inc., 1984.

Dennis L. Hartmann, *Global Physical Climatology*. San Diego: Academic Press, 1994.

Preliminary writing 1 (in three parts): due Thursday, 15 February

Part one: Skim several journal articles and be prepared to discuss their format and language. Pay particular attention to the parts of a typical journal article. Some journals will be linked on the website, but you may use others, including those available in paper copies in the library. Bring to class:

A list of three articles you skimmed, in proper bibliographic format.
A printout or photocopy of one article that you think is stylistically typical.

Part two: Read lesson 3, ``Actions'', in *Style: Lessons in Clarity and Grace*.

Part three: Start looking through the IPCC (Intergovernmental Panel on Climate Change) report, online at <http://www.ipcc.ch/>. We will focus on the ``Scientific Basis'' part of the 2001 assessment, http://www.grida.no/climate/ipcc_tar/wg1/index.htm. You will have to use data from this report for the next sequence of assignments. It is best to start becoming familiar with it now.

In class: Thursday, 15 February

Today we'll review the format of a journal article, and the stylistic conventions behind it. We will also develop standards for this essay assignment.

Preliminary writing 2 (in two parts): due Tuesday, 20 February

Part one: Read lesson 7, ``Concision'', in *Style: Lessons in Clarity and Grace*.

Part two: Choose a graph of data from the IPCC report. You need not read the entire report (which is probably over 1000 pages); just pick a graph from a section that interests you, and read a selection. Write a summary of what your graph shows and how the data was collected, as if you were writing the abstract of a journal article. Keep in mind that journal article abstracts can be no more than 250 words! Since you only have 250 words, you will have to be very careful about how you choose them. Bring a copy of your graph and abstract to class to share with your group and turn in.

In class: Tuesday, 20 February

In small groups, discuss your answers to the stylistic questions and compare your graph to the graphs of your group members. Do all the graphs show the same trends? What do the graphs say about causality? What are some possible explanations for the trends shown in the graphs?

Next, exchange abstracts with your group members. How could the other abstracts be improved? Make comments on your partners' abstracts and

how a paper might come out of the information in the abstract and your discussion today. By the end of class, you should have a plan for your essay.

Preliminary writing 3: due Thursday, 22 February

Write a few paragraphs about how your data was obtained. What methods did the people who found this data use? What are the limitations of these methods? What does this say about the reliability of the data? What assumptions lie behind each method? Are these assumptions reasonable?

In class: Thursday, 22 February

Today we'll discuss the methods behind gathering scientific data, and what such data means. An important part of every journal article is an analysis of the strengths and weaknesses of the methods used. Citing sources is another important part of scientific integrity that we will discuss today.

Essay: Draft due Tuesday, 26 February

Imagine you are the scientist who made the graph you have chosen. Write an essay of around four pages, in the style of a journal article that meets our class standards, based around your figure. Make sure you include a copy of the figure with your draft and final essay! Bring three copies of your draft to class on Tuesday.

In class: Tuesday, 26 February

Peer review: Each group of three students will receive three essays to review. Write a response to each essay. Does it meet the standards we developed in class? What should be changed to make it meet the standards?

Essay: Revised version due Thursday, 1 March

Revise your essay, taking into account the peer review feedback you received. Turn in:

The final version of your essay, including your graph.
All three marked-up copies of your draft.
The written response from your peer reviewers.
A response to their response: state whether or not you chose to follow your reviewers' recommendations and why.
If you chose to make other revisions, describe what you did and why.

Engineering in Sports

Rationale: This is an introduction to the patent process, something every engineer should be aware of. A basic understanding of how patents work will help you understand current debates concerning intellectual property law. This assignment will also show you how engineering revolutionizes modern sports.

Reading assignment: due Thursday, 1 March

Read ``Gear Heads'', <http://www.technologyreview.com/article/14165/>.

In class: Thursday, 1 March

Today's class will be an introduction to patents, intellectual property, and engineering in sports. You will pick a topic for your essay. Your topic should be a particular innovation in your favorite sport. Some examples are an improvement on a required piece of equipment, a new technological system for scoring, or a new training aid.

Preliminary writing 1 (in three parts): due Tuesday, 6 March

Part one: Schedule a conference with me.

Part two: Decide what you want to do for your independent reading project. I'll ask you about your plans during our conference.

Part three: Read ``Crash course on patents'', <http://www.iusmentis.com/patents/crashcourse/>

Make sure you read all the sections listed in the table of contents. Additional information on patents (including many real patents) is available at the Patent and Trademark Office, <http://www.uspto.gov/>.

In class: Tuesday, 6 March

Field trip to the library! We'll meet in the Blue Room of the Engineering Library. You should have time to get started researching your topic during class.

Preliminary writing 2: due Thursday, 8 March

Do whatever additional research you need, and write a summary, including a section on how your chosen invention has changed your sport and a bibliography. Be prepared to give a brief overview of your topic (1--2 minutes).

In class: Thursday, 8 March

Today we'll discuss engineering innovation in sports. Each of you will give a brief, informal presentation (1--2 minutes). We will also talk about what you should put in your essay. By the end of class, you should have a plan for writing.

Essay: draft due Tuesday, 13 March; final version due Thursday, 15 March

Pretend you are an inventor, who has just developed a new technology to improve human performance in your favorite sport. Write a detailed description of your invention (about four pages). This is what a patent attorney would translate into the legal language of a patent. Your essay should contain all the information necessary for a patent and be written in a style and with language approximating a patent. However, you do not need to concern yourself with the legal language or claims; that is your patent attorney's job. Your job is to write the descriptive part of the patent, including all the necessary details and diagrams, which will allow your attorney to understand your invention and produce the final

patent. This essay should convince your reader that your invention is patentable.

Bring your three latest essays (How things work, Climate change, Engineering in sports) to class on Thursday! Turn in your sports essay with your marked-up draft and revision plan.

In class: Tuesday, 13 March

Peer review: in pairs, read your essays aloud and discuss them. What other details do you need? Does it convince your reader that your invention deserves a patent? If you were a patent attorney, how would you turn this essay into a real patent? With your partner, write a (very detailed!) plan for revising your essay.

In class: Thursday, 15 March

Today we will discuss the three different styles of writing you've used in your last three essays. We will also start talking about the Internet essay, which you will begin work on during spring break.

The Internet

Preliminary writing 1 (in two parts): due Tuesday, 27 March

Part one: Write a proposal for your essay. You should describe your topic and outline the argument you'd like to make. What questions do you plan to answer in your essay? Include a preliminary bibliography to show that you've done enough research to convince yourself that your topic is feasible. Write a paragraph on stylistic elements you want to think about while writing this essay. Is one of the three styles we've discussed more appropriate for your topic? Why or why not? What stylistic features will you use for this assignment?