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Introduction to the Approach

The kinds of writing that engineers, scientists, and technical experts create can be very different than most other kinds of prose. In its need to be highly technical, descriptive, complete, and explicit, writing can quickly become convoluted. This book seeks to identify the most common writing mistakes made by scientists and engineers and to present a "scientific" approach to avoiding these mistakes. The idea is for scientists and engineers to approach writing in the same way they approach the problems they work on: methodically, with an understanding of underlying principles and the reasons behind these principles. In this introductory chapter, I attempt to describe this approach and provide some suggestions for using this book.

1.1 An Objective Approach to Writing

When I think back to when I was younger, back to when I was in elementary school, it appeared as if my fellow students were divided into two groups: (1) those that were good at math and (2) those that were good at English. I was in the former group. I liked the logic and precision that accompanied arithmetic and then mathematics. By following a systematic approach to a problem, one could arrive at the correct answer. These answers were right or wrong, without any in-between.

A Scientific Approach to Writing for Engineers and Scientists, First Edition. Robert E. Berger.

On the other hand, English always struck me as a bit fuzzy, especially when we got to English grammar in junior high school (now called middle school). While there were plenty of definitions and rules, it seemed to me as if there was no way to systematically apply the rules. I would write a paper, and the teacher would return it with "corrections" to the sentences I had written, without any explanation as to why those corrections were preferred. I now see that the teacher was behaving as the typical editor I described in the Preface—rewriting my material in a way that made sense to her. Another teacher might agree with the way the sentences were written in the first place or might write a different version entirely. It appeared to my middle-school self that no systematic or common approach to the writing of sentences existed.

Many of us in the good-at-math group went on to become scientists and engineers. In these professions, we could focus on posing seemingly more tangible problems and pursuing a systematic approach to solving them. However, we did not have to spend much time in science and engineering before discovering that an ability to communicate effectively in writing was essential to a number of critical functions:

1. When applying for funding, the lifeblood of research and business, the scientist or engineer must effectively communicate a number of important concepts—including the problem to be addressed, the proposed advancement in the state of the art, the qualifications of the investigator, and the benefits of achieving success—in order to convince reviewers to endorse the application and recommend it for funding.
2. When submitting a paper to a technical journal, the scientist or engineer must convince peer reviewers that a significant scientific problem has been addressed, that the technical approach represents an improvement over approaches attempted in the past, and that the solution advances the state of the art in a particular field.
3. When seeking resources to commercialize technology, the technical champion must prepare a business plan to convince a potential investor that the new technology has market potential, that the intellectual property is protected, that customers will want to buy the product, that the management team has the wherewithal to commercialize the technology, and that significant profits can be made.

The three critical functions listed above will be used as examples in Part IV of this book. However, these functions are not the only instances that require clear written communication. The everyday activities of scientific and engineering work require written communication to professionals (both inside and outside your organization), to clients, and to the public.

So we engineers and scientists often find ourselves in an awkward situation: we must navigate the subjective waters that constitute "good writing," in order to forward our ability to advance in the more objective discipline of our choosing—science or engineering. But is the process of writing, especially the process of writing sentences, as

truly subjective as it seems? Is it possible that a set of fundamental principles existed all along and had not been shown to us in a manner that made sense to our training? Is it possible that the sensibilities of those of us in the good-at-math group were such that we were not able to recognize those principles? If so, what would it take to communicate those principles to scientists and engineers?

Perhaps what it would take is an approach presented by another scientist or engineer, an approach in which (1) the fundamental principles are clearly stated, (2) the distinct categories to which these principles apply are clearly defined and represented using technical terminology, and (3) the principles are illustrated by many examples of technical writing. The presentation of such an approach is the purpose of this book.

1.2 Reasons and Principles for Good Writing

I don't know about you, but I like to have a good reason for the things I do professionally. Scientists and engineers are always expected to justify their work in very specific (almost formulaic) ways:

- Are you planning an investigation? Consider some typical headings one might use in describing the investigation: (1) Rationale, (2) Experimental Design and Methods, (3) Analysis, (4) Potential Pitfalls/Alternative Approaches, (5) Expected Outcomes. Typically, the rationale comes first because it explains the ***reason*** why the proposed approach is likely to answer the question that drives the investigation.
- Are you conducting an experiment? What will be the independent and dependent variables? For what ***reasons*** are the independent variables retained in the experiment more important than the ones left out?
- Are you selecting a material for a particular application? For what ***reason*** did you select one material over another?

It may not be as obvious to scientists and engineers, but good reasons also can be used to guide the mechanics of writing. Is there a good reason for inserting a particular idea at one position in a sentence instead of another? Is there a good reason for using commas to separate this idea from the rest of the sentence? Is there a good reason for presenting the items in a list as bullets, rather than leaving them in a paragraph? All of these questions can be answered in the affirmative. Moreover, ***I believe good reasons can be found to guide every writing decision***. We do not need to write by instinct alone.

Essentially, clear written communication can be approached as a set of principles, each of which is substantiated by sound underlying reasons. Some of these principles can be stated as follows:

- Distinguish between the core idea of a sentence and any auxiliary ideas, which we will call *qualifiers*.
- Use commas to separate nonrestrictive qualifiers (do not use commas for restrictive qualifiers).

- Do not put more than two qualifiers in a sentence (with a few exceptions).
- Ensure that lists satisfy the *principle of equivalence*—all items in a list should be treated the same way.
- Clearly distinguish among the distinct items in a list.
- Ensure that each paragraph makes a single point and is sized for ease of understanding on the part of the reader.
- Write so that sentences in a paragraph flow from one to the next.
- Arrange paragraphs to enhance an argument.

In this book, my intention is to (1) unveil these principles and others, (2) explain the reasoning behind them, and (3) demonstrate their validity through numerous examples gleaned from technical writing. As with any practice, the more you apply these principles in your writing, the more likely they will become habitual, and the more likely your communication will be understood by your readers.

1.3 The Upside-Down Approach

Technical Communication is an ongoing field of research with a long history [1–4], supported by a dedicated set of academic journals (including, for example, *Technical Communication*, *Technical Communication Quarterly*, and the *Journal of Business and Technical Communication*). Topics covered in these journals and others encompass a wide variety of subjects, including the teaching of technical writing [5, 6], the teaching of technical writing to non-native English speakers [7, 8], and the teaching of technical advances to support technical communication [9, 10]. Many universities offer degree programs or academic certificates in this field [11, 12].

Academicians in Technical Communication teach courses in writing to science and engineering students, using a number of textbooks (e.g., [13–17]). The approach presented in these books teaches writers to focus on the big picture—namely, higher order concerns of purpose and structure—before narrowing down to the fine-tuning of writing sentences. Typically, these treatises (1) begin with an overview of the technical communication environment; (2) discuss the planning, researching, and organizing of documents, with attention to the intended audience, collaborations, and ethical issues; and (3) end with a set of chapters devoted to the preparation of particular types of documents (memos, reports, proposals, correspondence, instructions, etc.). Well into the discourse, some of these textbooks include a chapter on writing style—in rare cases, a short presentation of writing mechanics is included—but this subject represents only a tiny fraction of the full textbook.

Other books on writing are targeted toward practicing scientists and engineers [18–22]. Although shorter, the approach taken in most of these books is similar to that taken by the textbooks discussed above. (However, one of them is focused primarily on the writing of research reports [21], and another is essentially an English grammar book with subject matter arranged alphabetically [19].)

In contrast, scientists and engineers have been trained to use a narrow-to-broad approach. They understand that in science and engineering, one first needs to master fundamental tools before applying these tools to more complicated problems. Thus, in mathematics, one first learns algebra and calculus before taking on partial differential equations; in mechanics, the motion of simple bodies must be understood before attempting to predict the motion of a fluid continuum; in physics, the concepts of electrons, waves, and interference are prerequisites to the study of quantum mechanics.

So in this book, I will follow the narrow-to-broad (inductive) approach that is more familiar to scientists and engineers. In this approach to technical writing, the scientist or engineer, whether a practitioner or student, would first develop an ability to write clear sentences before combining sentences to form paragraphs and combing paragraphs to make an argument (see box). Thus, the presentation in this book is the reverse of that used in many technical-writing textbooks or guidebooks. As summarized in the box, the material flows from the more narrow units of communication (sentences) to the broad (a thesis), with some miscellaneous (but important) concepts in between:

- In Part I (Chapters 2–8), we begin with the most fundamental unit of communication, the sentence, especially complex sentences in which a core idea must be qualified by one or more auxiliary ideas. I show that such auxiliary ideas can be grouped within a relatively small set of categories and that simple rules can be applied to guide their use.
- Then, in Parts II and III, we cover a number of other items that tend to be misused in technical writing: (1) lists—how to insert them within a sentence without distracting the reader (Chapters 9 through 11); (2) adjectives and adverbs, especially when used in long strings (Chapter 12); and (3) other little irritants—articles, reference words, unnecessary words, and redundant words—that may erect barriers between the author's intent and the reader's understanding (Chapter 13).
- Beyond the sentence, we will move on to paragraphs, where we describe how to string sentences together to make a single point and provide a flow that enables a smooth transition from one sentence to another (Part IV, Chapter 14).
- Finally, we will get to the big picture. I will show you how to organize a more in-depth, multi-paragraph argument, taking advantage of word-processing tools, so that the reader can easily follow the argument (Part IV, Chapters 15 and 16).

It is not intended that this upside-down approach should replace traditional technical-writing pedagogy. It is understood that the field of Technical Communication is much broader than writing mechanics alone. Moreover, when we get to the big picture near the end of this book, the types of documents I use to illustrate an argument—proposals, research reports (including journal articles), and business plans—are but a subset of the total spectrum of technical communication. Given this narrow focus, if this book were used as a textbook, it may be appropriate to consider it as a complement to other

Hierarchy of the Units of a Written Composition

- **Sentence**: a complete thought.
- **Paragraph**: a coherent series of sentences that are combined to make a single point.
- **Premise**: a coherent series of paragraphs intended to support a particular proposition (e.g., whether a particular problem is worth solving, whether a particular technical approach will lead to solving a problem, and whether a market exists for a product).
- **Thesis**: a proffered position or theme (e.g., whether funding should be provided to carry out a research project or whether investment should be provided to commercialize a particular technology) that is maintained by arguing for a series of premises.

In paragraphs, premises, and theses, arguments are used to convince the reader of the essential soundness of that unit's topic. In a paragraph, one argues through a number of sentences; in a premise, one argues through a number of paragraphs; in a thesis, one argues through a number of premises.

approaches, one that offers a systematic approach to writing mechanics and is targeted to the sensibilities of scientists and engineers.

1.4 How This Book Can Be Used

In addition to its potential use as a textbook, this book can be used by individual scientists and engineers to improve their written communication. In this usage, the book can be regarded as either (1) a systematic approach for minimizing the probability that your writing will be misunderstood or (2) a reference for implementing particular writing strategies as you prepare a document. The two uses are not mutually exclusive: employing the first should increase the efficiency of employing the second.

The first way of using the book would entail reading it from start to finish. However, it is acknowledged that the time constraints facing many scientists and engineers may prevent them from taking on a new subject until a need arises. When that happens, an initial attempt to understand the principles of the book (see the partial list of principles in Section 1.2) should be undertaken, in order to establish a foundation on which specific writing needs can be fulfilled. Below, a few examples are presented to illustrate the point that an initial attempt to understand the principles of writing would speed the use of this book as a reference for specific writing needs:

- As you build a sentence, it is important to distinguish between the main idea and the *qualifiers* (auxiliary ideas that help explain the main idea). Get to know the six

types of qualifiers (Chapter 2). It is likely that you use them all the time. Then, once you know what type of qualifier you are using in a specific writing situation, Chapters 3 through 5 can be used as a reference to properly position and punctuate the qualifier, thereby rendering the sentence more intelligible to the reader.

- As another example, the use of lists is ubiquitous in technical writing. You should understand the principle of equivalence for the items in any list. You should be able to distinguish between balanced and unbalanced two-item lists. Chapters 9 through 11 can serve as a reference for punctuating and clarifying a list.
- As a final example, it is important to understand that a paragraph should have a singular purpose, have a flow between its sentences, and be sized for the reader's convenience. If these principles were understood, your ability to analyze the suitability of any paragraph under construction would be enhanced. Then, Chapter 14 can be used as a reference for fine-tuning that paragraph.

In using this book as a reference, take advantage of the more than 300 writing examples used to illustrate all of the principles and the reasoning behind these principles. These examples are drawn from actual documents prepared by scientists and engineers. It is likely that you will find an example that is analogous to any specific writing situation that you are seeking to address.

Please note that the example sentences have a citation next to them in [square brackets]. It is important to provide attribution to original sources, and I do so throughout this book. Also note that to easily distinguish the examples, they are written in a different font. Finally, note that the numbering of the examples begins anew within each subsection.