PART I

Getting Started: Writing the First Drafts

"Can Engineers Write?" Joan Knapp asks in the title of this section's opening article. The answer is, of course—provided engineers are given the training and practice anyone needs to do a complex task well. Thus the articles in this section will show you some of the best ways to start writing a technical document and some practical ways to proceed once you have started.

Preparing to write your report

In response to her own question, Knapp takes you through ten stages of writing an engineering report. She describes five kinds of people most likely to read your reports and shows how your writing must to a great extent be determined by who you are writing for. Her emphasis is on research reports, operation manuals, proposals, and feasibility studies, but what she says applies to many other kinds of technical writing as well.

The art of prewriting

While Knapp takes an overall view of the challenges faced in writing an engineering report, Ronal Nelson specifically focuses on preparing to write a document, an activity often known as "prewriting." He also expands on some of Knapp's most important points, breaking his topic down into five practical categories. Nelson's two-page worksheet will enable you to methodically approach several different aspects of preparing to write a report.

Gathering your thoughts

In their article on issue trees, Joann Dennett and Michael Hseih show how your report content can be efficiently organized before you begin writing by borrowing the idea of decision trees from some other scientific fields. This concept, when used by the engineering writer, becomes an "issue tree," a device that helps in the process of producing a well-organized and effective report. Rather than the linear approach to prewriting, writing, and revision, the issue tree calls for initially brainstorming your subject on paper, showing subtopics, logical relationships, analyses, important and less vital information, and possible conclusions. This approach will not only help you overcome writer's block but will also enable you to stay focused on your topic and have all your data lined up before writing your report.

Who is your reader?

In the fourth article Ruth Savakinas gives pointers on finding out who your audience really is. The pay-off for careful audience analysis prior to writing is a reduction in the need to rewrite. This article's title is a reflection on how we tend to rush into written work too quickly, without allowing time for thoughtful "pre-writing," and hence fall into the trap of writing first and afterwards doing a lot of re-aiming and re-writing.

Where should you start?

The Piersons take a look at the life of a report as it usually evolves, and advise you not to simply start at the beginning and work through to the end. The authors show the practical wisdom of writing a report "from the inside out," completing the body of the report first and then concentrating on the beginning and ending parts, including not only your introduction and conclusion but also the title and abstract.

Clarity counts

We all agree (I hope) that writing must be clear and that busy readers should easily understand our documents. As Ronald Dulek points out, we are aware of the need for clarity, but defining it and making sure our documents are clear is often a challenge. Dulek examines the numerous elements of clarity and concentrates on three of the most important ones: writing unambiguously, making information accessible to a variety of readers, and using language appropriate to the corporate situation. This article provides an insightful synopsis of what everyone needs to remember about writing clearly and is also a fresh look at some elements of clarity that are rarely considered.

Is my grammar correct?

Alan Manning raises the question of what constitutes correct grammar—a concern that has been the source of debate ever since the first grammarians set their opinions down on paper. With recent tendencies towards descriptive rather than prescriptive grammar, the "rules" have become even fuzzier. Nevertheless, violations of long-entrenched usage standards can jolt a lot of readers and cause them to have unflattering opinions of the writer. Manning takes a 1990 study of questionable usage and compares it a similar study made in 2001. He then develops an interesting "botheration scale," showing how certain errors cause more reader botheration than others. Turning this around, you will come to see that not all grammar and usage errors are equal, and that some can be taken more lightly than others.

Industrial and academic writing

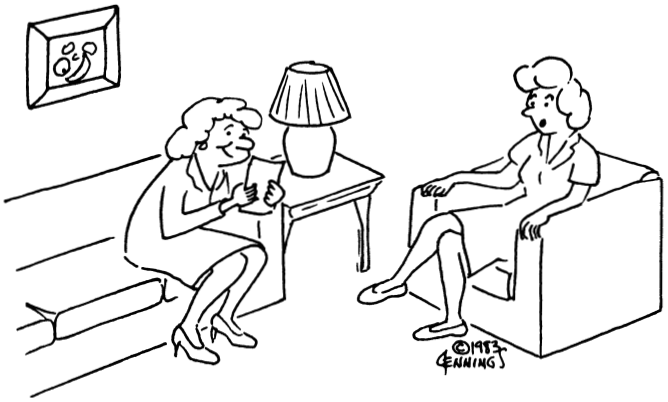
Whether we like it or not, much technical writing is taught in English departments by instructors with little knowledge of industry. This, as Don Bush shows, creates two cultures—academic writing and industrial writing. Both cultures have the same goal: to improve communication. However, they often approach this goal in different ways, and Bush makes some intriguing comparisons and contrasts on a number of levels. This article will be useful to any technical writers who received their initial training as writers in a liberal arts department, and who will surely find themselves agreeing with Bush that more "cross-fertilization" is needed between the two cultures.

Can Engineers Write?

JOAN KNAPP

Abstract—**Writing skill is an important element in engineering success. To supplement engineering curricula that provide little help in developing writing ability, this article describes ten steps in report writing that apply to research reports, operation manuals, proposals, and feasibility studies. The steps are (1) analyze your audience; (2) classify the report; (3) design the report; (4) do the research; (5) write a rough draft of the body of the report; (6) write a conclusions section; (7) write an introduction; (8) write an executive summary or abstract; (9) revise the report; and (10) add missing elements.**

CONGRATULATIONS, graduates! Engineering school has taught you all you need to know to guarantee a successful career, right? Maybe not. You haven't learned how to write a report. However, the fact that you got through engineering school means that you can surely handle such trivialities as writing assignments, doesn't it? Perhaps. But recent studies, such as the major study of graduate adequacy conducted by Colorado School of Mines in 1978, suggest that many graduating engineers are deficient in communication skills, particularly writing. The studies also conclude that those skills are necessary for a successful career.



"My son never writes home—he's an engineer."

The experience of practicing engineers bears out the correlation between writing skills and successful careers. Engineers who write well advance in rank, eventually reaching management levels. Those who cannot write tend to be passed over for promotions and remain in routine jobs. Junior engineers may find writing requirements minimal during the first year or two of practice, but as they gain expertise, they are increasingly required to communicate that expertise. Those who can do so are promoted to more challenging, better paying positions.

Unfortunately, the usual engineering curriculum offers little or no help in developing students' writing abilities. Since grades depend on tests involving calculations only, students have no incentive to improve their writing. Further, constant emphasis on mathematical rather than verbal material may actually decrease ability to communicate verbally over a four- or five-year period. And, finally, many students adopt a defeatist attitude toward writing; because they don't write, they assume they can't.

Yet most engineers have the potential to write well. Indeed, because they have been trained to think logically, engineering students often have the capability of becoming better writers than humanities students. What they need is instruction and practice.

Although this article cannot substitute for the supervised practice and detailed instruction offered in a writing class, it is addressed to senior students with the intent of providing a method and some guidelines for report writing. To simplify the process of planning and writing a report, I have divided that process into ten steps and I discuss each step as it commonly applies to engineering reports.

1. Analyze your audience. Nobody gets up in the morning, looks out the window, and says, "What a nice day! I think I'll write a report." Poems may be written on such occasions; reports are not. Whether it be a handwritten memorandum or a handsomely bound proposal, a report is a communication needed and directed by an audience.

Thus, when you are asked to write a report, your first step should be to ask three questions: Who will read the report? For what purpose are they reading it? Are they engineers? Based on the answers to those questions, readers usually fall into one of five audience categories:

a. Expert	Other engineers, preferably in the same field, who read the report for information relating to their own projects
b. Executive	Managers, usually lacking an engineering background, who read the report to make executive decisions
c. Technician	People usually lacking an engineering background, who read the report for direction in using products and systems designed by engineers

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The author is an Information Developer with the Field Engineering Division, IBM Corporation, 3131 28th Street, Boulder, CO 80301; (303) 441-2367.

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d. Lay	People lacking an engineering background, such as special-interest groups, who read the report for non-engineering reasons
e. Combined	A group such as a government agency, comprising engineers and non-engineers, who read the report to make decisions

Placing your reader in one of these categories helps you structure the report to fulfill readers' information needs and also helps you select the level of language that will communicate best. For instance, if you're reporting to the Sierra Club on the cost/benefit ratio of a water project, you should avoid highly technical language where possible and insert simple definitions for the terms you have to use. If, on the other hand, you're reporting to an engineering firm on thermodynamic analysis of an engine, nontechnical language would be both inefficient and insulting.

2. Classify the report. The foregoing examples suggest the second step you should take in writing a report. Not only must you analyze the audience and their purposes, but you also must classify the report and its purposes to decide what format you will use. The more common reports engineers write are physical research reports, operation manuals, proposals, and feasibility studies. Although in-depth directions for writing these reports cannot be given here, a brief description of the purpose and format for each type follows.

• *Physical research reports* are written to describe research projects, such as stress tests on metals. They follow a rigid format: introduction, problem statement; materials; methods; results; discussion; summary; and conclusions.

Students who have written lab reports are familiar with this format, but a report written in a work situation differs from that in the academic situation in four ways. First, the practicing engineer is not writing for a professor who knows the answers but for people who don't know the answers and are primarily interested in answers. Second, if new testing methods are used or if a physical system is modeled via equations, those features must not only be described but also justified. Third, as in all professional reports, a title page, table of contents, lists of illustrations and symbols, and other reader aids are required. And fourth, different language levels are needed in different sections of the report. These distinctions are illustrated in the discussion of feasibility reports.

• *Operation manuals* for water and sewer systems, for power plants and other industrial complexes, and for specialized tools and instruments are written to tell the user how to operate and maintain these systems and products. A manual must include a brief introduction, stating its purpose; a set of performance directions; and a set of debugging procedures. Theoretical sections presenting principles of design and descriptions of mechanisms may be included, but they should be firmly separated from sets of instructions.

When writing a manual, use clear, simple language; keep sentences short; supplement the text with plenty of drawings; and separate individual instructions by using numbers and white space. Current research at American Bell suggests that effective use of white space can increase speed of comprehension by as much as 50 percent.

• *Proposals* are written to propose that a project be undertaken. Projects may range from practical (better parking facilities) through R&D (research and development of a space shuttle) to pure research (a method of soils testing). Because of this diversity of projects, no firm directives for format or language levels can be given. But since proposals are the most audience-oriented of all reports, great care should be taken to analyze the audience and to present a report as persuasive and attractive as possible for that audience.

The proposal begins with a statement of the problem (good parking facilities, a space shuttle, or adequate methods of soils testing do not exist) and then presents the immediate background to the problem, the benefits that will come from solving it, and the feasibility of the solution. It describes the methods to be used, the facilities available, the tasks to be done, and a schedule for doing them. The competence of the persons or organizations doing the work must also be demonstrated: What are their qualifications? How much previous experience have they had? What references can they supply? Finally, costs and method of payment must be specified.

More than any other type of report, a proposal must be visually attractive and inviting to the reader. Use headings and white space generously. Supply helpful, attractive graphics. Indicate different sections of the report clearly (index tabs at the outside edge are often helpful). And, finally, select a binding that is both durable and convenient for distributing sections of the report to various audiences.

As a junior engineer, you will probably not be asked to write a proposal. But you may be asked to write a section of a proposal, and you will benefit from knowing how a proposal works. The kind of report you will most commonly be asked to write is a feasibility study.

• *Feasibility studies* are written to answer three questions: Is a given project physically practical? Is it economically practical? Is it suitable from the viewpoint of those who will be affected by it? These questions require definite answers supported by factual evidence. This requirement, in turn, demands that the writer reverse the research process, beginning with conclusions and organizing facts to support them.

To illustrate, suppose you are asked to report to the Boulder City Council on the feasibility of a walkway over the intersection of Broadway and College Avenue. You would have to research the rationale for the walkway and various walkway designs to decide on a practical solution; your report

would then present that decision supported by data. The most common error made by beginning writers of feasibility reports arises from confusion with physical research reports: Writers report what they have done rather than what they have discovered.

Because the ability to write a feasbility report is important to your career, this hypothetical example is used to illustrate the remaining steps in writing a report. You have defined your audience: the Boulder City Council. Although they aren't engineers, they will give the report to the city engineer or an outside expert. You are therefore writing for a combined audience. You have classified the report as a feasibility study. What is your next step?

3. Design the report. Most report-writing textbooks suggest that you begin research at this point. But much research and writing can be avoided if you first brainstorm the subject, examining possible approaches and arriving at the most practical, and then discuss these approaches with your clients to find out what they want to know and in what detail. Perhaps the city council already has a design in mind and is partly committed to it. If it's a good design, your report can support it with the modifications you suggest; if not, your report must show why another design is superior. You should also find out what dollar figure they have in mind: If they're thinking $200,000 and you're thinking $500,000, your report will not be useful. Third, you should find out what kinds of information they're most interested in. If they're not much interested in environmental impact, you can limit your research accordingly. And, finally, you should find out how massive a report they are expecting.

On the basis of this information, design the report. If the council is expecting a 25-page report, decide what proportion should be given to structures, what proportion to materials, and what proportion to environmental impact. Within the structures section, decide how many designs should be presented, what graphics are needed, what major and minor factors should be considered, and in what detail they should be described. You now have a format that prevents you from gathering facts willy-nilly and trying to fit them together to produce a report.

4. Do the research. Since research is a separate activity, only two suggestions for doing it are presented here.

First, begin with the obvious. Measure traffic flow to see whether the project is justified. Measure street width, maximum vehicle heights, and walkway grades to determine whether users of the walkway would feel as though they were climbing Mt. Everest; if so, the street may have to be lowered. Draw up preliminary specifications (final specifications will be made in the final report) and calculate costs. Determine who will be affected by the structure and how their views can be sampled.

Second, if library research is involved, take notes on cards that can be arranged according to topics and then rearranged within topics to provide supporting information for conclusions. You may find a note-card system convenient for recording and storing all information obtained through research. It provides a place to file bits of information and also helps you draw up an outline for each topic.

5. Write a rough draft of the body of the report. Since you have already designed the report, you can write any section when it has been researched. If you find the original report design inadequate, modify it, but don't let research alter the basic structure you designed to respond to your audience's needs.

Guide your reader through each section of the report. Suppose you've finished researching a section on design and have identified the most practical one. Do you describe the unsatisfactory possibilities and then, with great flourish, present your solution? Quite the opposite. Begin with the solution and support it through comparison and contrast with other possibilities. If it has disadvantages, admit them, but remember that you are the authority and that your audience is interested in answers.

At the beginning of each section, tell the reader what points you discuss. Listing these points displays them clearly and guides your writing so that each point can be the subject of a separate paragraph.

Paragraphs are the basic building blocks of writing. Each must be restricted to a single topic summarized in a topic sentence, usually the first sentence in the paragraph. The remainder of the paragraph develops the topic through factual evidence, explanation, or examples. Logical ordering of this material and transitions between ideas are necessary so that the reader experiences each paragraph as a structured body of information.

The sentences that compose paragraphs are also structured entities. Sentences usually contain a single thought or two related thoughts; in the latter case, the writer supplies the connection through punctuation and connecting words. Engineers tend to use too many short, unconnected sentences. Combining them improves the reader's logical grasp of the material and also improves the flow of the paragraph.

Two final suggestions are offered for writing rough drafts: First, don't be afraid of including too much detail. Extraneous material can always be edited out, but if your original draft doesn't contain the logical connections needed by your reader, you may find it difficult to supply them in later drafts. And, second, double-space your writing, use only one side of the page, and leave generous margins. These practices allow you to cut and paste to move subsections and to insert additional material and transitions without rewriting when you revise the report.

6. Write a conclusions section. Although individual

sections of your report present conclusions for that section, you need to gather those conclusions into a cohesive whole. Doing so requires formulating general statements from particular conclusions and arranging these in a hierarchy, with the most important (or logically prior) conclusions first. For example, state that the walkway is structurally feasible and why before stating that design A is the most practical design.

Since the conclusions section may be read by people who do not read the entire report, it must be self-sufficient and fairly detailed. It may be placed at either the beginning or the end of the report.

7. Write an introduction. Now that you have finished the report, you can write an introduction stating subject, purpose, scope, and plan of development. An introduction is not an overview of the subject of the report; rather, it is an overview of the report itself. Thus, conclusions, historical background, and literature reviews do not belong here.

Introductions frequently begin with a problem statement: "Two people, four students, and six dogs were injured at the intersection of Broadway and College Avenue in 1982." The remainder of the introduction explains how the report addresses the problem.

Beginning writers sometimes attempt to write the introduction before they have written the report—a virtually impossible task. Once the report is complete, however, writing the introduction should present no problem.

8. Write an executive summary or abstract. An executive summary presents the substance of the report in abbreviated form to an executive audience; an abstract presents this information to an expert audience. Abstracts and summaries are usually limited to a page or slightly more, but no rules about length or amount of detail apply to all reports. The best plan is to read well-received reports on similar topics and structure the abstract or summary accordingly.

Like the conclusions section, the summary or abstract must be self-sufficient and must be written at the language level appropriate for the targeted audience. Although you may have been writing for an engineer throughout the body of the walkway report, an executive summary for the city council demands a shift to language appropriate for a lay audience. But beware that a shift in level isn't accompanied by a shift in tone. Don't "talk down" to this audience; just use different terms.

9. Revise the report. Revision is such a complex process that specific directions for it cannot be given. A practicing engineer I consulted in writing this article offered this suggestion: "Put the report down for a couple of days and then come back and analyze it for clarity and concentration of ideas. Among other activities, this analysis may result in adding, deleting, and moving material; adding concluding statements and transitions between sections and subsections; checking topic sentences of paragraphs to see that they present a logical line of reasoning; adding transitions within paragraphs; checking sentences for subject-verb agreement, noun-pronoun agreement, and parallel structure; correcting punctuation and spelling; and substituting active for passive voice where appropriate.

10. Add missing elements. To add missing elements, consult a report-writing textbook and past reports in the company files. The elements to be added include letter of transmittal, title page, table of contents, list of illustrations, glossary, list of symbols, appendixes, list of references cited, and bibliography. Rules for documentation of sources depend on the firm or agency you are working for. All these additions take time but they are minor considerations compared with the conceptually demanding task of writing the report.

Finally, select an attractive binding, sign your name, and prepare to bask in the satisfaction of a job well done.