

Chapter 15

Technical Writing

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*You will be judged in industry not on your work
but on how well you communicate your work.*

We dissect the five common instruments of technical communication: the formal report, the memo, the progress report, the executive summary, and the problem statement. This is followed by a list of *do's* and *don'ts* for overhead projector presentations. Also included are a short discussion on how to approach a writing task, several suggestions on style, and a writer's checklist.

§15.1 The Formal Technical Report

The formal report summarizes an analysis, experiment, or simulation whose results are intended to steer a group's future work toward a better product for the consumer. The elements of the formal technical report are:

- Title
- Abstract
- Table of Contents
- Nomenclature
- Introduction
- Analysis
- Experimental Equipment and Procedure

Results
 Discussion
 Conclusions
 References
 Appendices

Title. The title of the report should be as brief as possible without sacrificing clarity — seven to eight well-chosen words form a typical length. It must provide readers with a clear understanding of the content within.

Abstract (Summary). Although the abstract is placed first, it should not be written until all other parts of the report have been completed. Consisting of only one or two paragraphs (250-300 words), it should state in simple declarative sentences what was attempted, how it was accomplished (but only if special techniques were utilized), and what was achieved. That is, it should highlight the main points of the report.

Although this is the shortest and most difficult section to write, it is the most important. In technical publications, the abstract, and only the abstract, is what most people will read. Therefore it *must stand alone*, presenting all relevant ideas and results to those readers who will not go into the report for explanation. Often it is printed separately from the report.

Table of Contents. The table of contents lists each section heading along with the page where it can be found in the report. The table of contents itself is not listed, nor is the abstract. A list of illustrations and a list of tables will follow the table of contents if there are figures and tables in the report.

Nomenclature. The nomenclature list defines all symbols used in the report alphabetically: first Latin, then Greek. Readers need to have a place where they can easily find an explanation of the symbols used in the analysis section. When acronyms and abbreviations are used extensively, they should not be placed with the nomenclature, but rather should be placed in a separate listing. Acronyms and abbreviations should always be spelled out at their first appearance in the text, e.g., fast Fourier transform (FFT).

Introduction. The introduction should describe the motivation for

the project and provide any germane background information. Its essential purpose is to present the substance of the work and the context in which it was executed. Discuss here why you have chosen to perform this task — be certain that you refer to the product that is being investigated and the importance of your work to its successful development. At the end of the introduction, briefly describe the material contained in the report by noting what is presented in each of the sections to follow. The introduction provides the motivation to read on.

Analysis. The underlying mathematical basis of the project is presented in this section. The analysis should proceed from the general (and well-known) basic relationships to the specific formulas used in the interpretation of the data. The symbols must be clearly defined or should at least appear in the nomenclature list described earlier.

Analytical results that have been derived previously and are readily available (e.g., equations from a published text) can be quoted with suitable reference. Their derivation need not be repeated as long as that derivation is not central to an understanding of the work.

All relevant mathematical analysis should be presented. What is crucial to a good analysis are the supporting explanations and commentary on the mathematics. Do not require the reader to consult laboratory handouts or textbooks to understand the specific analysis required for the experiment.

Experimental Equipment and Procedure. A schematic representation of the experimental equipment, including detailed views of unusual or important components, is presented and discussed in this section. Other illustrations can be used to document pertinent dimensions of the apparatus and to further specify details of the experimental equipment used for the study. Tables, which are typically constructed to present information in numerical form (e.g., percentages, dimensions, and mechanical and electrical data), are also extremely helpful in this section.

If the procedure used for the experiments is not an established one, details of the techniques must be included. The criterion is that someone familiar with the general area of investigation should be able to reproduce your experiments from the information provided in this section.

Remember that the report's flow and overall feel can be destroyed

by an incomplete, or inaccurate discussion of the experimental procedure and equipment or by graphical or tabular matter that is misplaced, unexplained, incorrectly captioned, or inappropriately sized. Regarding the latter, some major points to remember are:

- When first referencing a figure or a table, place it on the same page or page after its explanation. It is distracting for the reader to have to leaf through the report to find a clarifying figure/table.
- Make figures at least one-third of a page in size with call-outs in 8- to 10-point bold type. Small figures and callouts are difficult to read.
- Include clear, complete, and sequentially numbered captions for each figure and table.
- Provide readers with a clear, precise explanation of each figure and table.
- Never include figures or tables that are not mentioned in the text!

The guidelines above apply to figures and tables used throughout the text.

Results. This is the section where the answers obtained from the analysis and experiments are presented. It should contain concise statements, referring often to the graphic or tabular data of the report. These statements inform the reader (without discussion) of the author's interpretation of the results, based upon the analysis and experimental data.

Never forget that your readers may have picked up your report in midstream — they may have read the abstract and then gone directly to the results. Always assume that the report will not be read from the first page to the last. With this in mind, make the results section count.

Discussion. The discussion begins with a very brief summary of the results and then proceeds to their interpretation by noting what is "as expected," what is unexpected, and what is of primary technical interest. This interpretation of the results, in terms of the motivation

for the experiment and its relevance to current projects where you work or study, should be the focus of this section.

The discussion could involve a comparison with other similar investigations or a comparison with expected results. Experimental results should be described precisely, to the accuracy of the measurements, and the estimated uncertainties and their effect on the calculated values should be noted. It is extremely important to provide exact statements and avoid vague modifiers such as *greater than*, *about*, *like*, and *sort of*. Any limitations of the work should be emphasized here along with the strong points — if you do not point out the limitations, someone else surely will later.

Be aware of how you are presenting information to readers. Readers have specific expectations — they expect to receive information in a pattern that presents what is known first and then what is new second. Begin with old or known information and then introduce new, related information. In other words, the discussion must follow a logical progression in order to soundly support the conclusions of the next section.

Conclusions. A useful beginning is to state that the following conclusions are supported by the results of this study. Then list these conclusions in one or more simple (declarative) sentences, with bullets or numbers to separate each one. Remember that readers are looking for concise statements of your results and discussion. They are not interested at that point in further explanation. They want the masses of data tidily synthesized into a brief set of conclusions. Never introduce new material in this section.

References. A list of cited references appears in this section, with great care taken to follow the specified format of the organization for whom the report is being written. A sample format might cite references by number sequentially in the text, e.g., [1], [2], ..., and then list them in the reference section at the end of the report in the order cited.

- [1] R. E. Walker, A. R. Stone, and M. Shandor, "Secondary gas injection in a conical rocket nozzle," *AIAA Journal*, vol. 1, no. 2, February 1963, pp. 334-338.
- [2] M. J. Turner, H. C. Martin, and R. C. Leible, "Further development and applications of stiffness method," *Matrix Methods*

of *Structural Analysis*, 2nd ed., vol. 1, Macmillan, New York, 1964, pp. 203-206.

[3] E. Segré, ed., *Experimental Nuclear Physics*, vol. 1, Wiley, New York, 1953, pp. 6-10.

[4] E. Book and H. Bratman, *Using Computers to Build Computers*, SP-176, Systems Development Corporation, Santa Monica, CA, August 1960.

[5] S. L. Soo, "Boundary layer motion of a gas-solid suspension," *Proceedings of the Symposium on Interaction Between Fluids and Particles*, Institute of Chemical Engineers, vol. 1, 1962, pp. 50-53.

Always provide page numbers for journal articles and a page or chapter number for books. Never list references that are not cited in the text.

Appendices. Lengthy calculations or side issues that would interrupt the main thrust of the report should be relegated to an appendix. A primary criterion for deciding whether or not to put something in the main body of the report is to ask if its inclusion is required for the logical evolution of the ideas? If not, the item should either be left out or placed in an appendix.

Bear in mind that these are only the briefest comments about a very important tool of engineering and science. It is likely that you will spend a great deal of your time in the preparation of technical reports. Your skill in this area will in large measure determine how far you advance in your profession.

EXERCISE 15.1. Using the format above, prepare a formal report on a topic of your choice or on one assigned by your instructor.

§15.2 The Memo

Memos are written by all "knowledge workers." They are most often designed to be used within the writer's own company or organization. They may note the existence of a problem, propose some course of action, describe a procedure, or report the results of a test or an investigation. They are sometimes referred to as informal writing, which is not the same as sloppy, casual, or careless writing. A

memo must be carefully prepared, thoughtfully written, and thoroughly proofread for errors. It begins with headings:

To: Name, Job Title
Department
Name of Organization

From: Name, Job Title
Department
Name of Organization

Subj: Issues addressed in the memo

Date: Date
with optional headings:

Dist: Distribution list of other people receiving the memo

Encl: Other documents included with the memo

Ref: List of important background documents

The format of the memo is simple and contains the following parts:

- Foreword --- presents the statement of the problem or important issue.
- Summary --- may include an approach to resolving the problem or issue, the details of a procedure or investigation, or any other information that a reader needs to know.
- Discussion or Details --- provides the specialized information needed by technically involved readers and support for any claims in the summary.

EXERCISE 15.2. Prepare a memo to your instructor explaining a current project or assignment that you are working on, a problem for which you have a solution, or an idea that you would like to propose.

§15.3 The Progress Report

As you move from task to task you will be required to keep your managers and co-workers informed of your activities. The progress report is used to clearly and concisely summarize your efforts on a particular project. Much like any other report prepared for an interested party, it will consist of sections:

Beginning. This gives an indication of what the report is about and where it is going to lead. Expose the readers to the scope and objective of the task at hand, the overall progress to date, and any changes to the initial goals.

Middle. Here the reader is acquainted with the specific time span of the project and exactly what progress has been achieved so far. Describe in detail the work that has been done, the tasks that need to be completed, and the schedule that has been set for their timely accomplishment.

End. In this section you pull all the information in your report into a logical, coherent whole. Summarize the main points and reiterate where you are along the road to completion.

Remember that this report may be used to stop the effort in midstream or to assign help for its realization. For the sake of the project, then, make certain that the report is attractive and easy to understand.

EXERCISE 15.3. If you are involved in a project for one of your courses, prepare a progress report to inform your colleagues of its status.

§15.4 The Executive Summary

Often you may be required to submit an executive summary rather than a full report. The executive summary condenses all the work done on a project into the briefest of documents. It will contain information that a nontechnically oriented person will need to make a clear decision on the work that you have done. Pare the content to only what has been accomplished, how it has been accomplished, and at what cost. Describe the key elements of your work concisely in language that will be understood by a reader who may only vaguely understand the technical basis of the project. The executive sum-

§15.5 The Problem Statement

mary focuses on the managerial side of business, not on the technical side. It should contain the following information:

- The background of the situation or the problem
- How the work has been accomplished
- Implications of cost
- Conclusions
- Recommendations

Observe the similarities between an executive summary and an abstract. Both communications are short in length. Each relies upon concise, clear language to focus the reader's attention on what is being investigated, what tasks have been accomplished, what conclusions have been drawn, and what course of action should be taken. In many cases, this will be the only text that is read by management before a decision to proceed is made. With that understanding, you will need to expend much careful effort in preparing both of these communications.

EXERCISE 15.4. From a report that you have already prepared, write an executive summary to be presented to upper management.

§15.5 The Problem Statement

During the course of your work on engineering and science projects, you may be asked to present a problem statement concerning the work that you assume is to be done and the course that you will take to complete it. It is important that the initial statement of the problem be as clearly communicated as the solution itself. Here are some basic guidelines to follow before you begin to write:

- Working with data that you have collected, pursue all avenues that might lead to a solution.
- Use personal contacts with colleagues and others who can share their knowledge of the problem with you.
- Actively investigate the problem firsthand.
- Make sure that all your information is accurate and complete.

Once the data are collected, you can begin to prepare the problem statement. It will contain a direct statement of what you perceive the particular problem to be. Do not address peripheral issues. A clear focus on the true problem will assist you immeasurably in logically presenting the approach to its solution. The document should fully describe each step that you will take to bring a successful conclusion to the work.

EXERCISE 15.5. Select a problem of interest to you. Evaluate what you believe to be the true basis of the problem and how you will go about achieving a solution.

§15.6 Overhead Projector Presentations

Many researchers say that your skill in oral presentation is more crucial for success than your writing. Let us sketch the *do's* and *don'ts* of that fond institution of the technical world, the overhead projector talk. In preparing your slides:

- Do not "slap and snatch" — plan at least 1 minute per slide.
- Do not dwell more than 3 minutes on one slide.
- Never use more than seven bullets per slide.
- Lead the listener logically down your chosen path.
- Do not present detail — distill each idea into one short phrase.¹
- Provide "hooks" to bring distracted listeners back into the flow.
- Use overlays.
- Be cautious with color.
- Use readable type.

Some believe that the title slide must be followed by a talk outline slide and a problem definition slide. But all agree with the following rule:

¹But not a cryptic phrase. As a rule of thumb, a listener should be able to reconstruct an overview of your presentation given copies of your slides.

§15.7 Approaching a Writing Task

Tell them what you are about to tell them, tell them, then tell them what you have told them.

With the technology available today, there is no excuse for stodgy handwritten slides. Slides should be prepared via computer software and then laser printed in at least 24-point type. Be cautious with colored backgrounds which may wash out text. Test color combinations on the projector before giving the talk.

§15.7 Approaching a Writing Task

As you approach a writing task, study your audience to determine how they will receive your communication. For instance, by knowing your audience, you may be able to defuse conflict about a controversial topic and bring your readers into a positive frame of mind. Think about the way that your audience perceive the world around them and tailor your communication accordingly.

Once the nature of your audience has been determined, the next step is to construct a basic outline to ensure the orderly flow of your material. Then, thanks to electronic word processing, the initial writing process becomes a brainstorming session:

- Write without hesitation or concern for quality.
- Put ideas on paper as quickly as possible.
- Do not revise as you go.

This first burst of writing further clarifies the problem — it reveals what is known and what is not, provides a basis upon which to seek new information, clearly indicates gaps in information, and gives a foundation upon which to build. After this initial frenzy, the hard work of revision begins.

§15.8 Style

Use appropriate language. Because you want your reader to understand your message, it is important to fit the language to the audience. Since most of your text will be directed at audiences comprised of scientists and engineers, you should learn to avoid language that does not suit a technical writer. Technical writing is direct, concise, and clear. If you write to impress, you will fail many more times than you succeed.

It is a careless writer who uses slang, cliché's, ornate words, and meaningless jargon. In other words, if you wish to keep your reader's attention, do not dress up ideas in tasteless, trite, stilted, or official-sounding expressions. Rather, use simple, natural language that will clearly express what you mean.

It is extremely important in a world where jobs are performed by both males and females to avoid sexist language. Words that designate gender distinctions must be removed. For example, a pronoun such as *he* used to describe a mixed group creates a biased view. One of the easiest ways to eliminate gender focus is to make the words plural, thereby removing the male or female focus. Another way is to replace words that unnecessarily distinguish between male and female, e.g., *workman* and *chairperson* for *chairman*.

Stay away from odd-looking and sounding mutations that do not help the text to flow, such as *s/he*, *he/she*, or *his/or/her*. Use plurals, change words, or simply say *he and she*, *his or her*, or *him and her*.

Enhance flow. In a text that is fluid, the reader will sense that the ideas are moving smoothly toward some conclusion. How is this achieved?

One way of enhancing flow is to resurrect the *pronoun*. It is very appropriate to use pronouns to draw needed connections between text. "The lab was a mixture of difficult equations and painstaking work. It was not meant to be an easy exercise." The reader is drawn into the second sentence and sees the connection through the use of *it*, which refers back to the lab experiment. These pronouns serve as a link between sentences currently being read and those already finished.

Repetition of keywords (for emphasis) can also help your readers. However, remember that although repetition helps to reinforce your ideas, needless overuse of a word will only make for tedious reading. Always carefully evaluate each word that you use to provide the reader with effective continuity of thought.

Transitional devices allow the reader to see connections between varying ideas and statements. The lack of transition is a primary cause for reader disinterest and frustration. Transitions in all their forms allow the reader to move easily through a text — without these simple signposts, a document can become lifeless and difficult to read. One example of this device is the *transitional word*. Such words help a reader navigate through text by connecting one idea

to the next, one sentence to another, and one paragraph to another, e.g., *first*, *then*, *on the other hand*, *besides*, *furthermore*, *therefore*, *similarly*, *in lieu of this*, *likewise*, *finally*, *as a result*, *however*, and *moreover*.

Another approach for enhancing the flow of ideas involves *varying sentence and paragraph length*. This technique allows the reader to enjoy the "experience of reading" what is often highly complex, monotonous technical text. Making a group of colorless sentences more fluid and readable involves creating structures that vary in length from the simplest of sentences (subject/verb) to those that are extremely complex (two or more main clauses and one or more subordinate clauses). In terms of paragraph length, very short paragraphs should be avoided because they do not allow the reader to see groupings of sentences that are related. On the other hand, overly lengthy paragraphs obliterate subdivisions in thought — there is nothing more disruptive to the reader than a series of paragraphs that consistently run to more than one page.

When we read or listen, we like to sense *continuity*. We enjoy being able to follow the train of ideas, i.e., how one idea leads to another. It is disconcerting to be given one piece of information only to be jolted by another unrelated piece, with no hint as to its connection. It is vitally important that you be aware of how each sentence combines with its neighbors to create a flowing, coherent whole.

Within the paragraph, the main focus usually rests in the *topic sentence*. The topic sentence can appear at any point in the paragraph. It also can appear in the form of a pervading idea in which the reader is clearly able to see the focus of the paragraph. It is your job to make certain that all the ideas contained within a paragraph relate to one central theme. New ideas require new paragraphs.

Be consistent. If you capitalize Figure and Table in the beginning of the text, continue throughout the text. If you capitalize something on one page, do not lower its case on the next page. Make certain that it is used appropriately the first time and then continue to use it correctly as you progress through the text. Your readers may not be aware of the first instance of your indecisiveness, but eventually they will notice the vacillation.

Proofread your text. There is nothing more horrifying than

reading a document that is full of spelling and grammatical mistakes. A spell checker cannot think; it does not know the word you wanted to use, e.g., it cannot decide that you meant to use *form* (not *from*) or *trial* (not *trials*). This cannot be emphasized enough — carefully proofread your text!

Read what you have written out loud. Where you stumble, there is a problem. Mark those places that cause you difficulty and make an effort to improve their flow. Sometimes it is easier to write a new paragraph or even a subsection rather than doctor a faulty one.

EXERCISE 15.8A. Evaluate the number of transitional words that are present in a piece of text. Look carefully at how these words make the sentences flow together. If the text does not contain any visible transitional words, insert your own to improve the reader's understanding.

EXERCISE 15.8B. Read two pages of technical text. Carefully analyze the sentence structure. Is there variety of structure, and does it help you to read the text?

EXERCISE 15.8C. Select four different pieces of text: a children's book, a newspaper, a legal document, and a technical article. Use the points of style above to evaluate each piece of text.

Yearly reread W. Strunk and E. B. White's *The Elements of Style*, 3rd ed. (Macmillan, New York, 1979).

§15.9 Writer's Checklist

- Is the purpose of the document clear?
- Are each of the headings in the outline covered?
- Does the text flow logically?
 - Do the sections and paragraphs have a central focus?
 - Are stylistic techniques such as the use of transitional words and repetition employed?
- Are there contradictions in the document?

§15.9 Writer's Checklist

- Are there indefinite or vague statements?
- Does the information in the document prepare the reader for the conclusions?
- Do the data support the conclusions?
- Are the conclusions clear and logical?
- Will readers draw the same conclusions as the author does? Or are there portions of the text that could be interpreted in a variety of ways?
- Are the recommendations appropriate?
- Has the text been proofread?
- Is the document written so that the nontechnical reader can understand it?
- Is the writing clear enough and persuasive enough to be accepted by the most skeptical readers?

In the end, remember that technical writing is truthful, is disinterested, is logically developed, contains no emotion, contains no unsupported opinions, is sincere, is not argumentative, and does not exaggerate.