

INTRODUCTION

Writing well, a basic requirement for most engineering jobs, is an important component of communicating well. Most students are surprised by the amount of writing that is required in an introductory engineering projects course as it is certainly beyond the demands of typical engineering courses. Surprise is realized again when new engineers find themselves assiduously writing at their jobs. Most engineers leave the university prepared to perform tests, simulations, analyses and calculations; they do not expect to write reports, documentation, memorandums and executive summaries. Thus, the heavy emphasis placed on writing in this course reflects the requirements of real-world engineering jobs.

Students also find that the style of writing in introductory engineering projects courses is quite different from that of other, non-technical classes. *Concise*, *factual* and *complete* are the desirable attributes of good technical writing for introductory engineering projects courses. To write clearly and factually requires practice and iteration. Implicit in this statement is that a great deal of effort is needed to produce useful engineering documentation. For most engineers, this effort is equivalent to time: time spent on gathering information or data, on writing, and on editing and re-editing the technical document.

WHO READS A TECHNICAL REPORT?

A technical document is a vehicle to convey facts to the reader. Thus, the engineer aims to share information, give knowledge, and tell others about things they need or want to know. In a typical engineering position, managers read written documents to learn the results of a study, the engineer's recommendations for work, or the cost of a proposed design or project. If the job is related to research, journal articles are published to document the findings and are read by technical peers. Similarly, the best target audience in an introductory engineering projects course is *not* the instructor, but other students who have a rudimentary knowledge of the topic or the course. Writing for a

peer audience means the writer must include all the important details of the topic. In contrast, when the writing assignments are targeted for the instructor, students often exclude important details because it is assumed that the instructor already “knows” specific facts. For course sections that are client-based, reports are written for the clients. Consequently, it is important to write effectively to communicate ideas to a specific audience.

THE WRITING PROCESS

Writing follows a specific, iterative process to organize, compose and edit written reports. These steps are shown in the following diagram.

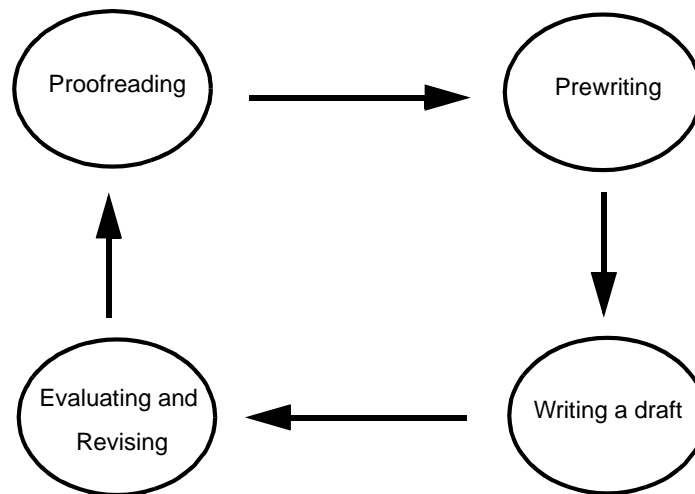


Figure 11.1. A schematic depiction of the iterative steps used in the writing process.

While not required, the writer follows these steps to review and edit each version of the document more than once. In developing the final version, the writer has the primary goal of producing a polished, comprehensive document that has no spelling or grammatical errors. In other words, the report is one in which pride and accomplishment are evident in the words, format and figures.

Prewriting

The goal of prewriting, or developing the initial versions of the document, is to make sure that all ideas, drawings, tables, references and results pertaining to the subject are brought forth for consideration. Several techniques may be used to elicit ideas and develop the main themes. The writer uses a notebook or computer software to collect the prewriting ideas.

Brainstorming, Free-Writing and Clustering

In the prewriting stage, all ideas are documented in an informal, unstructured manner. By *brainstorming*, the writer uses words or phrases to capture potential ideas. Nothing is eliminated at this time from consideration for inclusion in the document. When *free-writing*, the writer states or develops ideas further with full sentences. At this time, the writer notes if information or answers to ques-

tions require additional investigation. Sometimes *clustering* shows the development of ideas more efficiently than either brainstorming or free-writing. Less formalized than an outline, clustering is a technique that encourages the formulation of a logical sequence of ideas. For example, in Figure 11.2, clustering is used to collect the main topic ideas for a document discussing the development of a new heater. The writer notes the ideas associated with the purpose, the choice of material or shape, and the cost considerations. Some ideas are more fully developed in this example. The writer has extended the pathway of ideas for the shape of the heater to include the more detailed concepts of manufacturing and size. It is important to remember that ideas can be added to the clustering diagram whenever the writer needs to include additional details.

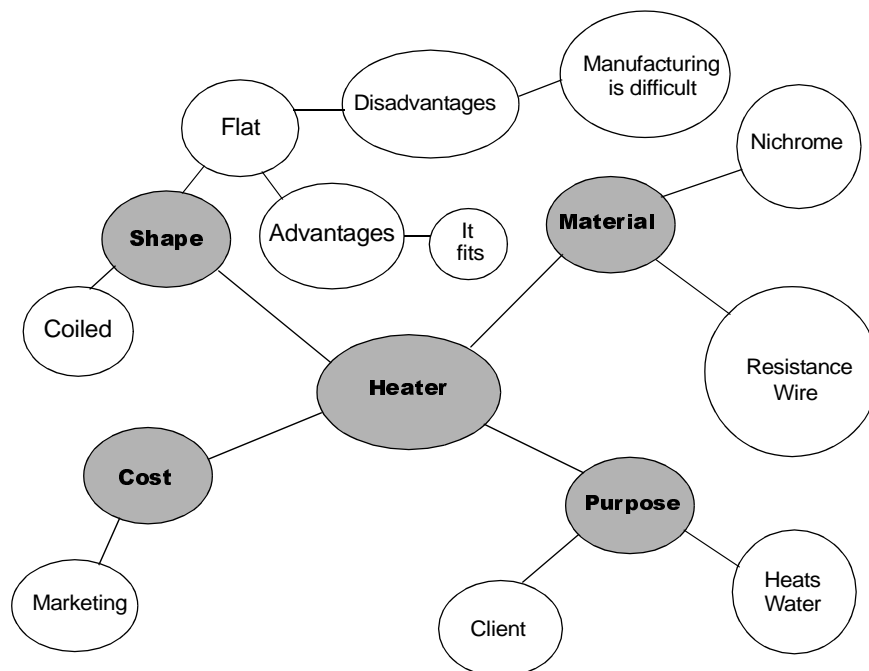


Figure 11.2. This diagram illustrates the “clustering” approach to prewriting. It shows the development of ideas considered for inclusion in a document describing the development of a heater.

Who — What....?

Almost all engineering projects are undertaken for a set of specific reasons. Use the answers to the common questions—who, what, where, when and how—to inform the readers of these basic ideas. The technical document addresses the client or target audience for the completed work. The document states what was accomplished (a product, a study, an analysis, a measurement, etc.). Include the purpose for the document and/or project. Describe how the work was completed, by using entries from design journals, data and results, and other documentation developed in the work. In the prewriting step, these ideas may be briefly noted instead of being fully developed into sentence or paragraph formats

Reading / Listening

Writing engineering documents requires an evaluation of previously developed information for the support of ideas or as reference information for the reader. Consequently, a significant amount of time is spent searching for and reading literature that may be pertinent to the engineering document being developed. Sufficient time should be allocated in the writing process to find information in journal articles, textbooks, the Internet, various library references, the new media and other sources. Team members or peers can listen as the writer reads important passages from these reference documents. By reading, listening, and discussing the ideas from outside sources with others, the writer develops important ideas more efficiently.

Arranging Ideas

In the prewriting step, ideas are noted and developed with little formalized structure. However, the writer can organize or arrange ideas in several additional ways. Chronological order is often used when writing documents that give instructions—a “how-to” manual, for instance. Spatial order is used to describe the relationship of objects to other things. A writer may wish to organize ideas in their order of importance. Here, the intent may be to develop an argument to persuade or justify. Logical order is used to define an idea, often when comparing and contrasting relevant topics.

Writing a Draft

After the ideas are assembled in the prewriting step, the writer is ready to write an outline that leads to writing a draft. A detailed outline often serves as the starting point for composing an engineering document. It is appropriate to use word processing software to create the detailed outline. The outline contains the major topics for discussion, useful notes and any outside references to support the writing. Begin by setting up the major writing topics. Expand the outline by selecting the appropriate subtopics based on the technical highlights of the work.

At this point, as much detail as possible should be filled in for each subtopic using the information developed in the prewriting step. Note whether any items require more thorough examination. At any time, it is appropriate to add subtopics that were previously forgotten.

It is not necessary to use correct grammar in creating the outline, as short phrases, notes and headings are usually sufficient to remind the writer what is meant. The resulting outline should be a brief, yet useful, document from which the written report is developed.

The first writing is a rough draft. If a word processor is used, the writer can expand the detailed outline into the first draft. For these initial writing sessions, the emphasis is placed on building sentences and paragraphs around the major subtopics from the outline. Include sufficient detail to fully describe each topic. Use a sufficient number of paragraphs and sub-sections to delineate all ideas effectively. It is not expected that the final form of the written report be completed in the first draft. It is important to note that several drafts of the document are expected to be developed in the writing process to obtain a polished final version.

Evaluating and Revising

Editing is critical to good writing. This step includes evaluating and revising the document for content, for grammar and for style. Editing for content requires a careful and thoughtful evaluation of what was said and what should be said. Determine if anything has been forgotten or whether new information is required. Assess whether new interpretations of the results or the research are required. Analyze areas that do not make sense and correct these sections. Also, determine if the document is comprehensive and discusses all the points as desired by all contributors.

Evaluating the Document

Once a written draft is completed, the writer should set aside the document for a brief period of time. This important step enables the writer to regain a fresh perspective of the written work. Often a few minutes is sufficient, but sometimes it helps to let several hours or days pass. The writer then reads and rereads the document, marking the paragraphs or sentences that require revising. Reading aloud also helps the writer evaluate and modify the draft.

A useful way to obtain a critical examination of the document is to use a peer evaluation. A peer evaluation directly benefits the writer, since the written document is aimed for that target audience. An informal evaluation is often sufficient to gain constructive comments. However, a more formal evaluation method can produce detailed, useful comments and ideas. The writer first prepares a list of questions about uncertain parts of the document. The peer evaluator reads the document with the objectives of stating what is effective and good, providing polite and constructive suggestions and criticisms, and providing specific suggestions for improvement. It is important for the writer to not feel personally criticized. Instead, the focal point of an effective peer evaluation is to highlight those sections of the document that require additional work.

Revising the Document

The writer revises the document based on the comments obtained from all the evaluations. Several revision techniques are suggested in Table 11.1 to help the writer develop effective ways to improve the content, format and objectives of the engineering document.

Table 11.1. Revision Techniques to Improve Content.

Writing Objective	Revision Technique
Make the writing more interesting.	Add examples or details.
Eliminate vagueness.	Expand on the facts or details. Use examples.
Focus all sentences on the topic.	Remove those sentences that are unrelated.
Clarify the presentation of ideas in each section, paragraph or sentence.	Reorder as needed.
Display a clear connection between ideas and sentences.	Add transition words such as “because” or “for example.”
Use language that is appropriate for the reader and technical forum.	Replace slang words and contractions with more formal word choices

Proofreading

It is important to use correct grammar in any writing. If a report contains numerous misspelled words, incomplete or run-on sentences, or other grammatical errors, the reader will be distracted from the focus of the report. Furthermore, a poor grasp of writing fundamentals could be a detriment to advancement in *any* career. Take advantage of the spell-checking and grammar-checking features available in word processing software. Be aware, however, that these spell-checkers cannot distinguish between homonyms, synonyms or other inappropriate word choices. A word-by-word reading of the text is required to ensure that proper word choices are used. Table 11.2 provides examples of some common grammatical errors seen in technical writing, with a suggestion on how to correct each error.

Table 11.2. Suggestions to Improve Grammar.

Type of Error	Instead Of	Use
Plural-singular verb mismatch	"The data <i>supports</i> our hypothesis."	"The data <i>support</i> our hypothesis"
Incorrect word choice	" <i>It's</i> color is red." " <i>Their</i> going to meet at noon."	" <i>Its</i> color is red." " <i>They're</i> going to meet at noon."
Vagueness	"This means that the code is satisfactory."	"This <i>result</i> means that the code is satisfactory."
Incomplete sentence	"Which is the intent of the project."	"To enable movement is the intent of the project."

Use a technical style reference [1] to help develop proficient writing mechanics and style. Table 11.3 provides examples and suggestions to convey meanings clearly and completely and to improve technical style.

Table 11.3. Suggestions to Improve Technical Style.

Objective	Instead Of	Use
Use simple, clear language	"consider using" "due to the fact that" "in order to" "at the level of your eyes"	"use" or "employ" "because" "to" "at eye level"
Be concise and avoid wordiness	"The longer section was used in the second joint. This configuration is used because the shorter piece restricted the angle of the second joint so in order to obtain a larger angle a longer piece was required." "The need for testing will confront teams with the challenge of inventing new methods."	"To compensate for the smaller angle in the second joint, a longer section is used." "The need for testing will challenge teams to invent new methods."

Table 11.3. Suggestions to Improve Technical Style.

Objective	Instead Of	Use
Focus on the concept	“We decided that option A was better than option B. We found information that supported our findings.”	“The literature supports the use of option A over option B.”
Use active voice	“to be,” “can be” or “may be” “There has been an effort made to make the code more efficient.”	“is” “The code was made more efficient.”
Omit unnecessary phrases	“The main reason for these opposing results from the theory is due to the lack of accuracy in the experimental data.” “One final thing that should be noted is that...”	“Inaccuracy in the experimental data led to these opposing results from the theory.” “Finally, note that...”

Most writers find that a fresh outlook is required for efficient editing to occur. Enlist another team member or an outside editor to critique the document. Also, discussing the work or contents of the report with someone other than team members may result in new insight that can enhance the final document.

Iterating the Writing Process

The writing process is an iterative cycle, as shown in Figure 11.1. Occasionally, one pass through all steps in the writing process results in a polished final document. Usually, the writer uses several complete iterations to ensure that the document is complete. One proofreading pass primarily addresses content. Another pass ensures that all figures and tables are complete and included. Another proofread makes sure that grammatical errors are eliminated. The final pass through the process verifies that the document is polished, error-free and ready for its official submission.

REFERENCES

Following are a few of the many grammar and writing style guides available at most bookstores:

1. Hacker, Diana, *A Writer's Reference*, 3rd edition, 1998.
2. Shelton, James H., *Handbook for Technical Writing*, NTC Publishing Group, Lincolnwood, IL, 1996.
3. Steinmann, Martin and Michael Keller, *NTC's Handbook for Writers*, NTC Publishing Group, Lincolnwood, IL, 1995.

