The Mayfield Handbook of Technical & Scientific Writing

Section 1

Planning and Producing Documents

Effective technical documents do not just happen; they are the result of a deliberate and comprehensive design and production process. Although writers may vary some of the steps they use to create a document, effective technical and scientific writing typically follows the same general procedures.

First, establish basic criteria. Five characteristics—accuracy, clarity, conciseness, coherence, and appropriateness—apply to all effective technical and scientific writing.

Identify the specific purpose of the document by clarifying both the reasons for its creation and its specific objectives. Often, technical and scientific documents are written as answers to a specific problem, which is articulated in a problem statement. Once you have identified the document's purpose, you should be able to determine the document's general type.

Technical documents are tools designed to be used by their readers. Accordingly, define your audience—the person or persons who will be reading the document. Then determine your audience's level of expertise and their purpose in using the document. It is also important to assess the attitude of the audience toward both you and the document's subject matter.

Once you have defined the purpose, the problem and the audience, collect, create, and assemble your information. Sketch out a preliminary outline to organize it. Keeping purpose and audience in mind, sketch out graphics and tables to display your important data.

Using your outline and preliminary graphics, write a first draft, a rough working version in which you get your ideas on paper. At this point in the process, do not be overly concerned about grammar, style, or usage.

If possible, put your first draft away for a day or two. Then revise your document in stages, saving stylistic changes for the last stage. Revise for organization; then revise the content for accuracy and appropriateness. Finally, edit your paragraphs and sentences to improve their clarity, conciseness, and coherence, and to fix any problems in grammar, spelling, punctuation, mechanics, or usage.

The last major step for most technical documents is one or more reviews. You may be too familiar with your document to see such things as gaps in information and inappropriate language. In addition, you may lack certain technical or managerial knowledge necessary for the document to achieve its purpose. For these reasons, writers of technical and scientific documents may ask peers to review their manuscripts for accuracy, clarity, coherence, and appropriateness. In many cases, a technical expert will review the document for technical content. A technical editor may review the document to ensure that it conforms to the organization's style and to correct any remaining problems. There may be legal reviews as well. Finally, a supervisor or a manager may review the document to ensure that it achieves the organization's purpose and is appropriate to the audience.

Just as most technical documents are reviewed by several persons, many documents are written collaboratively—that is, by several individuals. Collaborative writing often involves additional steps in document planning and management, drafting, and revision.

http://www.mhhe.com/mayfieldpub/tsw/doc-pxp.htm
Characteristics of Effective Technical Communication

Learn to recognize and cultivate the qualities of effective technical communication.

Good technical communication is accurate, clear, concise, coherent, and appropriate. In the prose of science and technology, these qualities are sometimes difficult to achieve. Not only do science and technology depend heavily on specialized concepts and terminologies, but they also make extensive use of numbers and graphics.

The following example shows how the different qualities of technical prose work together.

The flow of electrical current can induce the migration of impurities or other defects through the bulk of a solid. This process is called electromigration. In simple electromigration, the force on the defect is thought to have two components. The first component is the force created by direct interaction between the effective charge of the defect and the electric field that drives the current. The second component, called the "wind force," is the force caused by the scattering of electrons at the defect.

--J.A. Stroscio and D.M. Eigler, "Atomic and Molecular Manipulation with the Scanning Tunneling Microscope," Science

The preceding example is accurate in two ways. It is stylistically accurate in its precise use of language. It is technically accurate in its use of specialized terms technical terms such as electromigration, charge, electric field, and scattering, whose meanings are based in the context of a technical discipline. Both kinds of accuracy – accuracy of phrasing and accuracy of technical concept – are of first importance in science and technology writing.

The example is also clear because it is written in simple, direct sentences. Although the technical context is the highly specialized realm of theoretical and applied nanotechnology, the sentence syntax – word order – is restrained and structurally very simple. Part of this clarity is achieved by the rhetorical device of defining a term, electromigration.

The example is concise in its use of a minimum of words to express the basic idea of electromigration. It is not wordy, and it does not digress from the point being made.

The example is coherent because it develops its subject matter in an easy-to-follow line of thinking. The sentences are further linked by referents such as "this process," "the first component," and "the second component."

Finally, the example is appropriate to its purpose of presenting a general description of the process of electromigration, and to its audience, educated readers of Science, who are not necessarily experts in the field of nanotechnology.
Section 1.1.1

Accuracy
Cultivate accuracy in your writing. Accuracy, which is the careful conforming to truth or fact, has three main aspects:

1. **Document accuracy** refers to the proper coverage of your topics in appropriate detail. Often an accurate document needs to focus clearly on a problem. Document accuracy is generally cultivated by a clear problem statement and by a preliminary outline. These writing tools help you focus your writing effort by reducing your data in a way that solves a theoretical or practical problem.

2. **Stylistic accuracy** concerns the careful use of language to express meaning. Accurate language requires the careful use of paragraph and sentence structure and word choice to describe and analyze your topics effectively. As a writer, you gain command of accuracy by studying the elements of style and by learning to apply those elements to your drafting, revising, editing, and proofreading. Stylistic accuracy is also a matter of using words precisely.

3. **Technical accuracy** requires stylistic accuracy but is not based solely on it. The effective document in science and technology must be grounded in a technically accurate understanding and representation of the subject. Technical accuracy depends on the writer's conceptual mastery of the subject and its vocabulary, as well as on his or her ability to analyze and shape data with a minimum of distortion. In science and technology, enormous creative energy is given to mastering this technical aspect of subject development.

Section 1.1.2

Clarity
Strive for clarity in your writing. Clarity, which refers to ease of understanding, is a special problem in science and technology writing. Specialized languages, mathematically detailed analyses, and complex conceptual schemes can make technical subjects hard to grasp even when prepared by skilled writers and read by expert readers. You can increase the clarity of your material in several ways.

At the level of the whole document, you can promote structural clarity, making it easy for the reader to get the large picture. Use abstracts and other forecasting strategies such as introductions that state the purpose and scope of the document. Tables of contents, problem statements, and even strategic repetition also promote structural clarity. Graphs and tables, effectively designed and placed, help focus and clarify information. Descriptive titles and frequent subject headings guide readers and help keep the large picture in focus.

Stylistic clarity is promoted by simple, direct language. Simplicity in language is obtained with directly worded sentences. Using simple sentences and avoiding overloaded sentences and excessive nominalization also contribute to clarity. Word choice is a factor in stylistic clarity: use simple language wherever possible to counteract the abstract, highly specialized terms of science and technology.

Contextual clarity, in which the importance, authorization, and implications of your work are made
available, also contributes to ease of understanding. All work has a context, and your readers want
to understand what the context of your document is. What prompts you to write? What is your
purpose? Whose work precedes or has influenced yours? What is the organizational and intellectual
context of your problem? You answer those questions in introductions and problem statements and
in your citations and other references.

Section 1.1.3

Conciseness

Learn the strategies of conciseness. Conciseness has a special value in technical fields. Writers are
often tempted to include everything that could be relevant to their subject, rather than merely
everything that is relevant to the communication task at hand. The concise document is a piece of
writing that conveys only the needed material.

At the level of the whole document, conciseness is helped most by focus, then arrowing of
document scope to a manageable problem and response. Preparing a clear introduction and
developing a detailed outline are two strategies that give you control over document length and
scope. Identify and eliminate material that is not necessary to support your claims. Look for
sections, including appendices, that are not essential to your work. Graphics are powerful aids to
conciseness because they cut down on the amount of prose necessary to describe objects and
processes, summarize data, and demonstrate relationships.

Conciseness requires careful revising. Become familiar with the strategies for reducing wordiness.
Look for ways of cutting useless words, sentences, and sections from the document.

Section 1.1.4

Coherence

Look for ways to improve the coherence of your writing. Coherence is the quality of hanging
together, of providing the reader an easily followed path. Writers promote coherence by making
their material logically and stylistically consistent, and by organizing and expressing their ideas in
specific patterns. Efforts to emphasize the relationships among the elements of a document
strengthen its impact. Coherence can dramatically improve the reader's ability to understand your
material by promoting its flow or readability. Coherence is especially valued in science and
technology because of the inherent complexity of the subjects.

At the level of the whole document, coherence helps to provide the larger picture, in which the
connections among the parts of the document are made clear by the writer. Give readers a road map
to help them anticipate the content of your work. Abstracts, clear titles, introductions, and problem
statements all promote coherence by linking various parts of a piece of writing.

The paragraph is one of the most powerful instruments of coherence. By organizing material into a
topic sentence and supporting sentences, paragraphs pull together material and emphasize various
forms of conceptual development. Paragraph development is achieved partly through the specific
strategies of exemplification, analysis, comparison and contrast, definition, enumeration, and
description, all of which furnish distinct approaches to developing ideas. Transitional devices also
operate at the paragraph level to provide links between sentences and between paragraphs.
Appropriateness

Make your document appropriate to your goals in writing it, your audience's purpose in reading it, and the specific institutional contexts in which it is written and read.

Because a reader's knowledge or experience determines the level of comprehension of technical material, appropriateness is largely determined by your audience. For example, a fact expressed in a mathematical equation may not be effective in a report addressed to a managerial audience. See Document Density.

All technical writing should also be appropriate to the specific institutional context that motivated its creation. It should not only serve the writer's and the reader's purposes but also conform to the goals and conventions of the institution in which it exists. Institutional goals and conventions are sometimes clear and explicit. For example, in large companies, the specific goals of various documents, as well as the preferred form and style, are often described in company correspondence and style manuals.

Although the context is not always clearly delineated, it always can be worked out. Class work should be done within the context of the goals of the class as well as the specific assignment. Research reports should conform to the general goals and specific conventions of the scientific or technical community in which they are created.

Document Purpose

Documents should be created for explicit purposes or goals that both the writer and the reader would readily agree on. Although there are many explicit purposes for creating a scientific or technical document, there are four general categories: to provide information, to give instructions, to persuade the reader, and to enact (or prohibit) something.

Make the explicit purpose clear at the beginning of your document in an abstract, an executive summary, an introduction, or all of these. Sometimes a formal statement of objective is called for. You may also need to identify the person, the agency, or the contract requiring or authorizing the document or research.

In addition to explicit goals, however, writers almost always write with unstated but still extremely important implicit goals in mind. Among the most common of these goals are to establish a relationship, to create trust and credibility, and to document actions.
Section 1.2.1

Explicit Purposes

Most scientific documents have as their principal purpose one or more of the following actions:
- to provide information
- to give instructions
- to persuade the reader
- to enact (or prohibit something)

Whatever the general purpose of an overall document, certain sections of a document always have a specific purpose. The following table outlines the principal purpose usually associated with common document types and with sections in technical documents.

<table>
<thead>
<tr>
<th>Explicit Purpose</th>
<th>Document Types</th>
<th>Sections in Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>To provide information</td>
<td>Reports, literature reviews, specifications</td>
<td>Background, theory, materials, results, graphics and tables, résumé sections</td>
</tr>
<tr>
<td>To give instructions</td>
<td>Instructions</td>
<td>Procedures, work plan</td>
</tr>
<tr>
<td>To persuade the reader</td>
<td>Proposals, recommendation reports, job application letters, résumés</td>
<td>Discussion, conclusion, recommendation</td>
</tr>
<tr>
<td>To enact something</td>
<td>Acceptance letters, regulations, patents, authorization memoranda</td>
<td></td>
</tr>
</tbody>
</table>

Examples of Explicit Document Purposes

To provide information

This document will discuss the genetic basis of muscular differentiation of the Mediterranean fruit fly.

To give instructions

This document outlines a procedure for isolating the mechanisms of muscular differentiation in the Mediterranean fruit fly.

To persuade the reader

This document proposes a study of the mechanisms for blocking muscular differentiation in the Mediterranean fruit fly.

To enact (or prohibit) something

NOTICE: Mediterranean fruit fly quarantine area: no fruit allowed beyond this point.
Executive Summaries

Executive summaries may be written to summarize the key questions and findings of documents, mainly reports. They are directed to readers—generally managerial—who will not read further. An executive summary, unlike an abstract, is a document in miniature that may be read in place of the longer document. Executive summaries are placed immediately after the title page of a report. They typically range between 10 and 25 percent of the original document.

Structure and Content

The structure of executive summaries is similar to that of abstracts.

- Problem
- Method
- Results
- Recommendations

About 25 percent of the executive summary is devoted to the problem and method, and the remaining 75 percent is given to the results and recommendations.

Format

Presentation of executive summaries is especially important, since speed and the convenience of the reader are the main objects. The material should be organized into enumerated chunks, given descriptive headings, and highlighted. These special formatting characteristics are shown in the following example.

1. Preventive maintenance at the XYZ plant. The preventive maintenance program at the XYZ plant was rudimentary—still in the early stages of development. Neither its scope nor its procedures had been defined. Accordingly, several plant activities, including systems maintenance, testing, calibration, and operations were routinely carried out with inadequate or no procedures. The instrument calibration program was incomplete and inconsistent, with the exception of the equipment under the control of the Equipment Test and Inspection Group.

2. Maintenance backlog and funding. The maintenance backlog continued to increase, while there was a decrease . . .

Section 1.2.2

Implicit Purposes

Keep your implicit goals in mind when writing a document. In addition to explicit goals, writers almost always write with other unstated but still extremely important implicit goals. Common goals are to establish a relationship, to create trust and establish credibility, and to document actions.
To Establish a Relationship

Communication not only conveys information but also establishes a relationship between speaker and listener, or writer and reader. A well-written letter of inquiry, for example, can begin a professional connection that may last for years. Readers of research reports often initiate long and fruitful correspondences with the authors.

Even seemingly impersonal documentation and instructions can, if written carefully to addressing a user's need, establish a positive relationship between the user and the producer of the product.

To Create Trust and Establish Credibility

An underlying goal of all technical and scientific writing is to get the reader to trust the writer's credibility. Scientific and technical writing is based on precision. Accordingly, any technical or scientific document should justify the reader's confidence in the accuracy of its content, style, and organization.

Carefully qualify statements that need to be qualified. Do not make claims that are merely suppositions. If your reader begins to doubt your ability or intent to analyze and shape data with a minimum of distortion, the document will no longer be effective.

To Document Actions

Scientists, engineers, and managers often use writing to create permanent records of their thoughts and actions. One of the primary differences between most forms of written and spoken communication is that writing can be fairly permanent, whereas speech vanishes as soon as it is produced. Consequently, technical communication is often more effective when it is written down. Make important observations, suggestions, or objections in writing. Similarly, communicate important tasks and deadlines in documents such as project plans. Keeping precise records of experiments and procedures in notebooks is crucial to a project's overall accuracy and to establishing intellectual–property rights.

Section 1.2.3

Statement of Objective

If appropriate, state your document's objective at the beginning. Readers of technical writing are often busy people; such a statement will alert them that it is important to read further.

The following opening sentence from a memorandum by an engineer at Morton Thiokol warning his superiors of the problem that later caused the explosion of the space shuttle Challenger provides an example of a good statement of objective.

This letter is written to ensure that management is fully aware of the seriousness of the current O-Ring erosion problem in the SRM joints from an engineering standpoint.

--R. M. Boisjoly
Section 1.3

Problem Statement

If you are focusing on a problem, be sure to define and state it specifically enough that you can write about it. Avoid trying to investigate or write about multiple problems or about broad or overly ambitious problems. Vague problem definition leads to unsuccessful proposals and vague, unmanageable documents. Naming a topic is not the same as defining a problem.

Weak
Coda file system. [This definition is too vague; it suggests a broad topic but not an approach to the topic.]

Improved
Protecting against temporary link failures in mobile computing: A design for the coda file system.

Weak
Engine starting and warm-up behavior.

Improved
Effects of fuel enrichment on engine starting and warm-up behavior.

Problem statements often have three elements:

1. the problem itself, stated clearly and with enough contextual detail to establish why it is important;
2. the method of solving the problem, often stated as a claim or a working thesis;
3. the purpose, statement of objective and scope of the document the writer is preparing.

These elements should be brief so that the reader does not get lost.

[problem and its context] A recent trend in the design of new aircraft is the addition of winglets, which are small fins attached to the ends of the main wing. After an aircraft has taken off and is cruising, winglets improve its performance by reducing the drag caused by the main wing. However, during the critical stages of aircraft takeoff and landing, the winglets cause two problems. First, they cause vibrations in the main wing, commonly called buffeting. Second, they cause the aircraft to lose some control of yaw, the motion of the nose right and left. In a study funded by NASA [Ref. 2], the main wing of a DC-10 transport aircraft was outfitted with winglets, and it experienced significant buffeting
during takeoff and landing.

[approach of the current research] In our current project, we examine winglet-induced buffeting in three wing designs. We record buffeting and yaw under experimental wind-tunnel takeoff and landing conditions for (1) a wing without winglets, (2) another wing with conventional winglets, and (3) a wing with spheroid winglets. Our objective is to determine the degree to which differences between load lifts on the wings and their winglets during takeoff and landing are causing the performance problems we have described.

[purpose and scope of current document] In this study, we develop theoretical models of winglet load lifts and compare these to the lifts of wings and winglets actually recorded during testing conditions.

--Tan T. Trinh, "Winglets at Takeoffs and Landings"

Section 1.4

Audience

Write to your audience. People read technical documents for different reasons, and readers have varying levels of technical expertise. To be effective, technical writing must target its audience or audiences.

Target your audience by identifying your audience type and level of expertise, your audience's purpose in using the document, and your audience's attitude toward both you and the content of your document. These considerations will influence specific features of the document, including organization, introductions, equations and mathematical models, graphics, technical terms, and level of detail.

These features, especially the level of detail, contribute to the density of the document, the rate at which information is presented to the reader.

See Document Density for an explanation of how these features vary for different audience types to identify the expertise and purpose of different types of readers.

Section 1.4.1

Audience Types and Level of Expertise

Determine your audience's needs by assessing their expertise and their purpose in reading the document. Effective technical writing recognizes several types of readers, reflecting different levels of expertise:

- experts
- technicians
- managers
- laypersons
as well as mixed audiences, composed of one or more of the listed groups. Vary your organization, density of information, and emphasis to meet the purpose in reading the document and their level of expertise. See DocumentDensity.

**Section 1.4.1.1**

**Writing for Experts**

Distinguish between two types of experts: general experts and specific experts. Both kinds are readers with extensive technical knowledge of the document's subject matter.

**Levels of Knowledge**

*General experts* possess extensive knowledge about a field in general, but they might be unfamiliar with particular technical terms, specific equipment, or recent advances in your document's subject matter. *Specific experts*, on the other hand, share or surpass your knowledge about a document's subject matter.

**Purposes in Using Document**

Experts read technical and scientific documents for a variety of purposes:

- to maintain and expand their own general expertise
- to obtain specific answers to their own research and writing
- to evaluate a document's technical or scientific content

**Strategies for Writing to Experts**

- If your audience consists solely of specific experts, you may not need to give extensive background or define key technical terms or acronyms.
- If your audience includes general experts, provide sufficient background information and define any terms that they might be unfamiliar with.
- Do not just present a concept to an expert. Also explain its parts and processes in detail.

See Document Density.

**Section 1.4.1.2**

**Writing for Technicians**

Technicians are the people who construct, operate, and fix things. An office worker expert in desktop publishing is a technician, as is the person who repairs your telephone or washing machine.

**Levels of Knowledge**

Technicians are often more expert than anyone else in how a particular thing works or why it doesn't
work. They are also usually familiar with the common technical terms associated with the devices they use and the processes they perform. They may not be familiar, however, with general or abstract concepts about a device or a process.

**Purposes in Using Document**
Technicians read technical and scientific documents for a variety of purposes:

- to learn how to perform particular tasks
- to learn how to solve specific problems
- to learn about new devices and procedures relevant to their particular tasks
- to acquire and expand background knowledge helpful to the performance of their tasks

**Strategies for Writing to Technicians**

- Keep introductions and background information brief.
- Make information accessible:
  - When appropriate, reduce information to instructions on how to perform a procedure or diagnose and fix a problem.
  - Use graphs and tables.
  - Keep sections and overall instructions as short as possible;
  - Index and cross-reference material.
- Provide short definitions or explanations of any unfamiliar terms, tools, devices, or procedures.

**Section 1.4.1.3**

**Writing for Managers**
Assume that managers are busy people who need to use documents primarily as tools in making decisions. Because managers read and review many documents, be brief and to the point.

**Levels of Knowledge**
Managers vary in their technical knowledge. Many managers, especially in technical organizations, are general experts in a document's subject matter. Rarely, however, are managers specific experts in the content of a document. Managers usually supervise a number of projects, so they may not be familiar with every recent technological advance. And often managers are specialists in fields such as marketing or management and have little detailed technical knowledge.

**Purposes in Using Document**
Managers read technical and scientific documents for a variety of purposes:

- to aid in making decisions
to assess current situations
  to maintain their general level of expertise
  to evaluate projects and employees

In general, managers read for the *bottom line*, a concise summary of the present situation and specific recommendations for action.

**Strategies for Writing to Managers**

- Distill key information into an *executive summary*.
- In general, present information in order of importance.
- Emphasize information that will aid in making decisions.
- Present sufficient *background* information in your *introduction*.
- Summarize all *recommendations* for action in your *conclusion*.
- Segment information to allow easy reading of parts of the document.
- If necessary, put long, technical explanations into *appendixes*.
- Use *graphs* to summarize information.
- Explain any unfamiliar *terms*.

See also *Document Density*.

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**Section 1.4.1.4**

**Writing for Laypersons**

A layperson is one who does not possess the technical knowledge of an expert or a *technician*. Thus, all of us read some documents as laypersons; no one is an expert in all fields.

**Levels of Knowledge**

Do not assume a layperson has a technical background. Unless you know that all members of your audience will understand a technical term or concept, explain it carefully, using examples and analogies with which the reader is familiar.

Some lay audiences can be classified as novices, persons who do not yet possess technical expertise in a field but are in the process of acquiring it. Technical textbooks at different levels, for example, are written to audiences that are starting out as laypersons but may become experts.

**Purposes in Using Document**

Laypersons read technical and scientific documents for a variety of purposes:

- to expand their general knowledge
- to help make decisions as citizens, consumers, and investors
- to learn how to use a device or perform a procedure
to become an expert

Strategies for Writing to Laypersons

- Present extensive background information in your introduction.
- Organize information from the familiar to the unfamiliar.
- Simplify information to the level sufficient for the audience's purpose in using the document.
- Explain all technical terms.
- Illustrate and explain technical terms and concepts with analogies (e.g., "Your hard disk is like an attic; if it is too full, you may have trouble retrieving a specific item," ) and anecdotes.

See Document Density.

Section 1.4.1.5

Writing for a Mixed Audience

Often a document will be read by readers with different levels of expertise. Computer documentation, for instance, may be written for experts who are familiar with all the hardware and software processes involved, technicians who will install and support the application, a manager who may be deciding whether or not to purchase the software, and laypersons who may occasionally use it.

Strategies for Writing to Mixed Audiences

- If appropriate, create separate documents for each audience type.
- Use an executive summary to present the gist of your document in understandable language.
- If many of your readers will not be experts or technicians, place all lengthy technical discussion in appendixes and refer to them in the main body.
- Segment the document into sections so that different audiences can read different parts.
- Include in the front matter or introduction a short discussion of what sections are appropriate to each type of reader and for what purposes.
- Explain all technical terms thoroughly in any section that may be read by a lay reader.
- Include an exhaustive glossary section explaining all technical terms in either the front matter or the end matter.

See Document Density.
Section 1.4.2

Audience Use of Document

Readers of technical and scientific writing, whatever their level of expertise, read a document for three general purposes:

- to acquire information
- to help make decisions
- to learn how to do something

To Acquire Information

Readers at all levels of expertise read technical documents to acquire information. Experts read current documents in their own fields to maintain their level of expertise and read documents in related fields to increase the breadth of their knowledge. Furthermore, experts or technicians in one field are often novices in another field and read documents to acquire a basic understanding. Sometimes technicians read documents to acquire a basic understanding of general concepts and processes that will help them perform their tasks and diagnose and solve problems they may encounter. Managers read to acquire both the general and the specific information necessary for them to supervise their staffs effectively and to function well in their organizations. Laypersons read scientific and technical documents to acquire general knowledge about a subject or as novices attempting to become experts.

To Help Make Decisions

Readers at all levels of expertise read documents to make decisions. An expert may read a technical study to decide whether or not to conduct a specific experiment or to use a new design element. A manager may need to make or approve a decision. Technicians use documents to decide on the selection of specific hardware and software and to determine the best procedure for performing a task. Laypersons may read documents to help select a particular product or investment.

To Learn How to Do Something

All readers, whatever their level of expertise, sometimes read instructions to help them perform various tasks. A manager may read a document to learn how to use new budgeting software. An expert may read a document to learn how to use a new device. Instructions are an essential part of a technician's role in performing tasks and making things work. Finally, as laypersons, all of us use instructions to perform everyday tasks, from using an Automated Teller Machine to filling out our income tax forms.

Section 1.4.3

Audience Attitudes Toward Writer and Subject

As you think about your document's content and organization, consider your audience's attitudes toward both you and the subject matter.
Attitude Toward You and Your Organization

If your audience views you as an expert, in some situations you may not need to offer lengthy explanations for your conclusions and recommendations. When we go to a doctor, for example, we do not always ask for a detailed explanation of a diagnosis or procedure. Similarly, a reader of a technical manual written by the manufacturer is likely to accept a statement of the possible causes of a certain type of error without further explanation. Because the reader trusts the accuracy of the manufacturer, no explanation is necessary.

On the other hand, if the audience does not know you or does not consider you an expert, or if the reader has had past negative experience with you or your organization, the document should include extensive explanations of your conclusions and recommendations to create trust and establish credibility.

Audience Interest in Subject

Your audience's interest in your document's content will affect its organization. If your audience is already interested in your subject, you may be able to shorten your introduction. If your audience is not interested in your subject or if you do not know the level of their interest, explain why the material in the document is important to the reader.

Audience Attitude Toward Subject

If your audience initially may be hostile to your major conclusions, you may want to present the problem first, then your analysis, then your conclusions or recommendations. On the other hand, if you believe your audience to be receptive to your conclusions (especially if your audience is a manager), begin with conclusions and recommendations.

Section 1.4.4

Document Density

Document density refers to the amount, type, detail, complexity, and rate of information presented to the reader. The density appropriate to any document is determined by its audience and the ways in which the audience will use it. Matching the density of information to your audience is crucial for the success of any technical document. The following table presents some general guidelines.

Guidelines for Document Density

<table>
<thead>
<tr>
<th>Feature of Document</th>
<th>Expert</th>
<th>Managerial</th>
<th>Layperson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductions</td>
<td>Technical</td>
<td>Problem/solution</td>
<td>Relevance</td>
</tr>
<tr>
<td>Math models</td>
<td>OK</td>
<td>Avoid</td>
<td>Avoid</td>
</tr>
<tr>
<td>Equations</td>
<td>OK</td>
<td>Keep simple or avoid</td>
<td>Avoid</td>
</tr>
<tr>
<td>Graphics</td>
<td>Detailed, analytical</td>
<td>Simple, presentational</td>
<td>General illustrative</td>
</tr>
<tr>
<td>Detail level</td>
<td>Accurate, numerical</td>
<td>General, accurate</td>
<td>Simple, narrative</td>
</tr>
<tr>
<td>Technical terms</td>
<td>Expert, technical</td>
<td>Administrative</td>
<td>General, illustrative</td>
</tr>
<tr>
<td>Emphasis</td>
<td>Analysis</td>
<td>Operations, costs</td>
<td>Informational, interest</td>
</tr>
</tbody>
</table>

See Examples of Document Density.
Section 1.4.4.1

Examples of Document Density

The following two passages illustrate differences in the amount, type, detail, complexity, and rate of information appropriate to the two different audiences, one expert and one general. Both passages describe possible adverse side effects of the commonly prescribed allergy drug terfenadine (brand name Seldane).

The first passage is excerpted from the Physicians' Desk Reference, the standard guide to prescription drugs used by medical doctors in the United States. To ensure their patients' health, doctors have a professional, ethical, and legal obligation to know the specific information contained in this work about any drug they prescribe. The second passage is taken from The PillBook, a popular consumer guide for prescription drugs. This document is designed for laypersons with little technical medical knowledge. The laypersons' purpose in using the book is to become more knowledgeable about the specific drugs they may take and to become aware of any potential dangers.

---

Warnings

Terfenadine undergoes extensive metabolism in the liver by a specific cytochrome P-450 isoenzyme. This metabolic pathway may be impaired in patients with hepatic dysfunction (alcoholic cirrhosis, hepatitis) or who are taking drugs such as ketoconazole, itraconazole, or clarithromycin, erythromycin, or troleandomycin (macrolide antibiotics), or other potent inhibitors of this isoenzyme. Interference with this metabolism can lead to elevated terfenadine plasma levels associated with QT-prolongation and increased risk of ventricular tachyarrhythmias (such as torsades de pointes, ventricular tachycardia, and ventricular fibrillation) at the recommended dose. Seldane™ is contraindicated for patients with these conditions (see WARNINGBOX, CONTRAINDICATIONS, and PRECAUTIONS: Drug Interactions).

- Physicians' Desk Reference

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Because the foregoing document is written for experts who will be using the information for what may be life-or-death decisions, the information provided is extensive. The document describes in detail the biological processes that make the drug dangerous to patients with liver problems and lists the two specific liver diseases that should deter doctors from prescribing the drug. Similarly, the passage gives an exhaustive list of all drugs that might cause specific heart problems. Because the document is intended for experts familiar with medical jargon, technical terms such as isoenzyme and ventricular tachycardia are used without any explanation.

---

Cautions and Warnings

In rare cases, terfenadine may cause serious adverse heart rhythms.
or other cardiac events. It should be taken with care by people with serious liver disease and by those taking erythromycin, ketoconazole, or itraconazole. . . . Dizziness or fainting may be the first sign of a cardiac problem with terfenadine.

--Harold S. Herman, ed. The Pill Book

The technical terms of the first passage, such as ventricular tachyarrhythmias, are replaced by more accessible but less precise terminology such as serious adverse heart rhythms. This passage reduces the list of drugs that may interact dangerously with terfenadine to the few drugs that would most likely be taken by readers of the book. Finally, because a principal use of the book is to allow consumers to identify possible dangerous drug reactions, the passage lists for the reader the most common symptoms of ventricular tachyarrhythmias: dizziness or fainting.

Section 2

Document Types

After identifying a document's purpose, determine the appropriate document type. An easily recognizable document type and format increases a document's overall coherence and the audience's ability to use it efficiently. Consequently, most technical documents conform to fairly standard document types that present information in standard formats.

Almost all technical documents conform to one of the following standard document types:

- Memoranda
- Agendas
- Meeting documents
- Literature reviews
- Reports
- Letters
- Proposals
- Press releases
- Specifications
- Documentation
- Instructions and procedures
- Style guides
- Theses
- Oral Presentations
- Résumés
- Notebooks

Or to electronic document types such as: Electronic mail, Web sites, Hypertext.

Section 2.1

Memoranda

Memoranda are brief, informal reports used to establish a record. They generalize the communication process by transmitting the message from one or more authors to one or more recipients. E-mail messages typically take the form of memoranda.

The memorandum is among the most versatile of organizational documents. From brief research reports and progress reports to trip reports and thumbnail proposals, the memo form is widely used to communicate technical and administrative information. Memoranda are written for numerous internal purposes—forexample, to request information, to make announcements, to outline policies, and to transmitted minutes. Thus, in most organizations, memos play a crucial role in establishing a record of decisions, requests, responsibilities, results, and concerns.
The distinctive element of the memorandum is its heading, which is used to frame the message in a very accessible and transparent manner.

Section 2.2

Meeting Documents

Use meeting documents as tools to encourage productive and efficient meetings.

The two principal meeting documents are the agenda, which tells participants what topics will be discussed at the meeting, and minutes, which record what actually occurred.

Section 2.11

Meetings

Meetings are the lifeblood of every organization, big and small. Ideas are exchanged freely during meetings, items to be acted upon are identified, policies are agreed upon or changed, and individuals, irrespective of status, are able to have their voices heard. Meetings may be formal or informal, depending upon the number of individuals attending, the purpose, and the context of a meeting.

Meetings rarely happen spontaneously, however, and are usually planned well in advance, with published agendas circulated beforehand for individuals to consider. Meetings, whether formal or informal, usually also are recorded in a set of minutes, which are circulated sometime after the meeting. You should also be comfortable with using display media such as flipcharts, whiteboards, and chalkboards to run a meeting.

Pacing a Meeting

Effective leaders of meetings know that discussion of items can get bogged down in minutiae and
that sometimes an agenda must be dispensed with because a seemingly minor item has been shown to be enormously important. Pacing a meeting effectively means being able to discern when a topic has been discussed enough and when discussion needs to be pressed further.

Pacing a meeting effectively also means making sure that everyone in attendance has had an opportunity to speak, even if this means inviting an especially quiet individual to talk. Good meetings encourage a free exchange of ideas among all participants.

Effective leaders of discussions use flipcharts, white boards, or chalkboards to focus discussion.

Section 2.2.1

Agenda

An agenda is a simple list of topics to be discussed (in order of listing), along with the names of individuals who have agreed to lead discussion of those topics. An agenda helps focus a meeting on a core of topics and allows you to control the pace and flow of a meeting and identify important items to be acted upon. Meetings without published agendas generally seem unfocused and unproductive.

Prepare and circulate an agenda of items to be discussed for each meeting. Circulation of an agenda before a meeting will allow your audience to consider their responses to items listed and will help stimulate discussion. Agendas may be circulated by e-mail or hard copy. The advantage of hard-copy agendas is that they may be brought to a meeting to facilitate the taking of notes during discussion. Experienced meeting leaders recognize that both hard-copies and electronic copies of agenda are usually misplaced, so they bring enough copies for everyone present at the meeting.

Here is an example of an agenda.

Development Team Agenda

1. Report by B. Perez on investigation of possible security software
2. Report by S. Chan and P. Stanley on development of database prototypes
3. Discussion of possible hardware platforms
4. Review of deadlines for project
5. Agenda for next meeting

Section 2.2.2

Minutes

Keep accurate minutes of meetings, both formal and informal. Minutes are an essential part of organization life. They maintain an institutional memory of all actions taken or proposed and the key points of discussion. They also inform appropriate individuals who were not present at the meeting of the key action and discussion items.
Minutes can be formal or informal. Formal minutes are often required by federal, state, or local law, by – laws, charters, or regulations. They are usually distributed to the members of the group before the next meeting, and then approved (sometimes after being amended).

Some minutes are legally parts of the public record and available to anyone. Often, however, organizational minutes are private and confidential documents, which should be distributed only to appropriate individuals. If the minutes are confidential, each page should be stamped with a message such as "CONFIDENTIAL--DO NOT DISTRIBUTE."

The following information, adapted from Robert's Rules of Order, is usually included in formal minutes:

- The name of the group that is meeting and what kind of meeting it is (for example, a general meeting, an emergency meeting, or a meeting devoted to a single issue)
- Precisely where and when the meeting is being held
- Names of the group members in attendance and members absent; names of all other individuals present, except for public meetings with an audience
- The name of the person who called the meeting to order and at what time
- A report of whether or not the previous meeting's minutes were read and, if they were read, whether or not they were approved (or approved with modifications)
- Summaries of any reports presented to the group and any action taken on them (acceptance, approval, endorsement, referral)
- A summary of the discussion of each item on the agenda and any other important issues discussed at the meeting
- A record of all formal motions, including the name of the individual making the motion
- A record of the vote on all motions, including the number of votes for and against, and the number of abstentions
- The time that the meeting was formally concluded

Informal minutes also include the date of the meeting and the names of all members attending or absent, but they focus more on summarizing key points of discussion and listing all action items to be performed by individuals or the group.

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MEMORANDUM

TO: Copyright Issues Group
FROM: Paula Stanley
DATE: July 9, 1996
SUBJECT: Copyright Committee, Greenhill College

Minutes of Regular Meeting, July 9, 1996

Members Present: Ms. Appelbaum, Dr. Blackburn, Dean Chan, Professor Garcia, Professor Greenberg, Professor Kozowski, Mr. Smith, Professor Snow, Ms. Stanley, Dr. Washington

Members Absent: Professor Keynes

Guest: Professor Arnold Alexander, Chair of the Faculty Senate
Dr. Blackburn called the meeting to order in the Library Conference Room at 1:15 p.m.

The minutes of the 14 June 1996 meeting were approved unanimously without comment or amendment.

Professor Greenberg and Ms. Stanley summarized the report of the legal review subcommittee (included with the meeting agenda) that Greenhill College owns any intellectual property developed by a faculty member in his or her major field except for textbooks, which are specifically excluded in the College's *Policies and Procedures*. The subcommittee report recommended that Greenhill College should also waive ownership interest in 1) artistic works that are not accomplished under a program of research and do not use Greenhill College facilities, and 2) intellectual property developed pursuant to a preexisting consulting agreement where there are no sponsored research obligations and there is little or no use of Greenhill College facilities.

Professor Snow moved to accept and endorse the subcommittee's report. With no discussion, the motion was passed with seven members voting yes, two members voting no, and one member abstaining.

The Committee then reviewed the "close-to-final" draft of the new Intellectual Policy Guidelines. Dean Chan moved to amend the Guidelines to add a statement that Greenhill College will retain a "shop right" in all intellectual property developed at Greenhill College, including journal articles and textbooks.

Dr. Washington expressed concern that such shop rights might encourage circulation of pirated copies of copyrighted works. There was then considerable discussion on possible protections that might be placed on journal articles and textbooks to ensure that copies made pursuant to Greenhill College's retained shop right do not proliferate outside Greenhill College.

Ms. Stanley suggested including notices or markers on both the electronic and printed forms of the articles and placing electronically distributed copies on a protected server. Dean Chan suggested that the acknowledgment that Greenhill College has a responsibility to make such efforts at protecting the material should be placed in a statement accompanying the Greenhill College reservation of shop rights.

With such protection built in, the Committee agreed that Greenhill College's shop rights should apply to the published version of a work. Julio Garcia felt that publishers might want to negotiate this. He volunteered to revise the motion to reflect the Committee's discussion and then to send it to the Copyright Committee of the AAP for their comments.

Professor Alexander felt that the "shop right" wouldn't be much of a problem for faculty but the change in the ownership policy might be, especially if it were perceived as a "give-back" by the faculty. He suggested we poll other colleges and universities to find out what their policies are. Alexander also suggested that the Faculty Policy Committee should also review the revised "shopright" provision before the Committee votes on the final guidelines at its next meeting on 5 August 1996.

The meeting adjourned at 3:30 p.m.

Next Meeting: August 5, 1996
Section 1.5

Organization

Organize your planning and writing. Organization is the arrangement of elements into a structure, a whole.

- Organization is a work strategy for setting priorities that helps the writer make the best use of his or her time. The process of getting organized requires that you, as a writer, work out a schedule for your research and writing. Work plans and other document-planning aids can be valuable tools for helping you produce work on a reasonable schedule.

- Organization is a specific approach to document planning. The key instrument of document organization is the outline. Outlines help you work out both the general structure of your document and specific sections and topics.

- Organization is essential in making your document coherent to your audience. A predictable and logical structure helps readers understand the information presented in your document. Almost all documents, from short memoranda to lengthy reports, consist of some type of introductory material, the body, and concluding material.

Section 1.5.1

Developing a Detailed Outline

Outlines effectively reduce and order your source materials. An outline will force you to

- partition material
- develop a point of view
- establish the scope of your document
- sequence your topics
- develop a writing strategy

The same outline can be used to generate feedback, serve as a writing aid, and provide the subject headings of your paper.

Work out a general plan first, and then make the outline more specific.

The following is an outline of a research article.

Title: "Chemical Changes in Ground Water Preceding the Kobe Earthquake"

<table>
<thead>
<tr>
<th>General</th>
<th>Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>Description of quake</td>
</tr>
<tr>
<td>Background</td>
<td>Prediction model</td>
</tr>
<tr>
<td>Method</td>
<td>Ground water variables, flow rate, radon</td>
</tr>
<tr>
<td>Results</td>
<td>Flow rate</td>
</tr>
</tbody>
</table>
Before quake

After quake

Radon content

Before quake

After quake

Analysis

Comparison with other recent quakes

Possible mechanisms of change

Fissure widening from regional
tectonic stress

Permeability from increased
micro cracking

--H. Wakita and U. Tsunogai, "Precursory Chemical Changes in Ground Water, KobeEarthquake," Science

Section 1.5.1.1

Informal Outline

In an informal outline, sometimes called a scratch outline, the writer brainstorms to develop a list of
topics, which are then put into some order. The following informal outline might serve as the basis
of a short theoretical report for a review of the current state of photoelectric conversion chemistry.
Section 1.5.1.2

Formal Outline

In the formal outline, you develop a numbering system to accompany the topics. The process of creating and sequencing the topics is a critical stage in developing your document, because the resulting plan determines the document's internal logic and order. In the following outline, the writer has designed a writing strategy. When the document is reviewed, the outline will help the reviewer understand the writer's goals.

Outline: Tools and Materials for High-Speed Machining: A Survey

1 Progress in tool technology is largely speed-based
   1.1 Materials
1.2 Automation
2 Tool failure mechanisms
   2.1 Fracture
   2.2 Deformation
2.3 Wear
3 Strategies for developing tooling systems for high-speed machining
   3.1 Chemically stable materials
   3.2 Diffusion-limited wear regimes
   3.3 Isolation of the tool from the workplace
4 Conclusions
   4.1 Aluminum alloys
   4.2 Hard steels
   4.3 Titanium alloys

Section 1.5.2

Subject Headings

See also Forecasting and Outlining.

Use headings to help guide the reader through the document. Headings help the reader grasp the organization of your document. Be sure your headings are identical with your table of contents. Many word processors can automatically generate a table of contents from your subjectheadings.

Weak

This paper reports the results and interpretation of a detailed experimental investigation of the physical and biological factors affecting gasoline vapor transport from contaminated soils into a building.

The study was conducted at the site of a former gasoline station located at the Alameda Naval Air Station (ANAS), California (see Figure 1). In 1980, one of three 45-m³ underground storage tanks was damaged. The tank was drained and repaired between 1980 and 1987. Subsequent tests revealed that subsurface leakage continued to be a problem, and in 1990 fuel was removed and . . .

Improved

This paper reports the results and interpretation of a detailed experimental investigation of the physical and biological factors
affecting gasoline vapor transport from contaminated soils into a building.

**Site Description**

The study was conducted at the site of a former gasoline station located at the Alameda Naval Air Station (ANAS), California (see Figure 1). In 1980, one of three 45-m$^3$ underground storage tanks was damaged. The tank was drained and repaired between 1980 and 1987. Subsequent tests revealed that subsurface leakage continued to be a problem, and in 1990 fuel was removed and . . .

--M. L. Fischer et al., "Factors Affecting Indoor Air Concentrations of Volatile Organic Compounds at a Site of Subsurface Gasoline Contamination," *Environmental Science and Technology*

**Section 1.6**

**Forecasting**

See also *Coherence*.

Present the whole before the parts. One of the common problems in reading science and engineering materials is that of trying to understand the context of the discussion. Give your reader a general view of where you are going before you plunge into the details. This principle applies to the introductions of documents, as well as to the openings of document sections.

---

**Weak**

**3.2 Results**

Friction between specimens first induces a moment about the loading hole that can lead to a different stress state at the crack tip. It also delays the Hertzi an indentation energy flow from the loading point to the crack tip. The extent of the delay may depend on the contact surface conditions between the specimen and back-up plate, which would contribute to $K_{Ia}$ scatter. [In this example, the section opening is not linked to what has been said, and it also moves into an account of the results that gives no context.]

**Improved**

**3.2 Results of the BLM Program on Crack Arrest Testing**

The results of the BLM Crack Arrest Testing Program show a significant scatter in the $K_{Ia}$ values. Friction effects described in the last section may play an important role in producing this larger scatter. The friction between specimens influences two aspects of their behavior. First, it induces a moment about the loading hole that can lead to a different stress state at the
crack tip. Second, it delays the Hertzian indentation energy flow from the loading point to the crack tip. The extent of the delay may depend on the contact surface conditions between the specimen and back-up plate, which would contribute to $K_{Ia}$ scatter. [The forecasting in the improved example is developed in several ways, including descriptive headings, a clear topic sentence, introductory sentences giving context and background, and transitional words.]


Section 1.7

Drafting a Technical Document

After you have collected your information, identified your document's purposes, objective, and audience, developed an appropriate outline, and, if appropriate, sketched out key graphics and tables, you are ready to begin writing the first draft of your document.

Many writers find the following suggestions helpful in writing a first draft.

- Writing can generate new ideas. If you discover potentially relevant new ideas or approaches, include them even if they are not in your outline. You can revise your outline when you edit for organization.

- The main purpose of a first draft is to sketch out ideas in writing. Consequently, fixing specific problems in sentences, words, grammar, spelling, usage, or mechanics when writing a first draft can be distracting and can hinder the development of important and interesting ideas. Many writers just mark these problems when writing a first draft and then address them when they edit for grammar, style, and usage.

- You may find yourself needing to locate or develop additional data or to confirm already existing data. Marginal notes or comments in the text (e.g., "add median response time," "need figures," or "check maximum values") allow you to keep your ideas flowing.

- You do not need to write the document in the order of your outline. Many writers, for example, find it useful to write the introduction and the conclusion of a document last.

Section 1.8

Revising Organization

Revise your document to produce a predictable and logical structure between and within sections. A predictable and logical structure produces overall document coherence, which allows your audience to read the document efficiently and to use its information effectively. Consequently, the first review of any technical document should focus on ensuring a logical and accessible structure.

Reviewing Organization

1. If you have not already done so, divide your document into sections and subsections by inserting headings and subheadings into your document.

2. Read over the headings and subheadings of your document. (If your document has a table of...
contents, review it.)

3. Are all the elements of your document type present and in the appropriate order? If not, are there good reasons for omitting or rearranging some sections?

4. Does each section and subsection follow logically from the preceding one?

5. Early in the text, is there a clear road map of the entire document? (See Forecasting.) Does the document follow that road map?

6. Review the graphics in the order presented in your document. Do they present the key information to the reader in a logical order?

7. Read aloud the topic sentence of each paragraph of your document. Do ideas flow smoothly from paragraph to paragraph? Will the relationship between one idea and the next be clear to your audience?

Strategies for Revising Organization

1. If appropriate, add sections, subsections, and section headings, and subheadings to make your document conform to its standard type.

2. If appropriate, add sections and subsections to improve the logical structure and coherence of your document.

3. If necessary, revise the forecasting statements to provide the reader with an accurate road map of the ideas that will follow.

4. If appropriate, add new graphics and revise and rearrange old ones to provide the reader with a visual summary of the document's central ideas.

Section 1.9

Revising Content

When you are satisfied with the organization of your document, review your document to ensure that all information is accurate, complete, and comprehensible. Check to see that the information is relevant to your document's purpose and to your audience's use. The efficient exchange of information from writer to reader is one of the main objectives of all technical writing.

Because revising content may significantly alter parts of a document, experienced writers review and revise the content thoroughly before they begin to edit for style, usage, grammar, punctuation, and spelling.

Questions About Content

Read through your draft slowly, stopping at the end of each section, and ask yourself the following questions:

1. Is the information accurate?
   a. Are there any incorrect data entries?
   b. Are all outside sources documented? Is all information from outside sources either paraphrased or quoted exactly and enclosed in quotation marks?
Strategies for Revising Content

1. Correct any inaccurate quantitative data or other information.
2. Add further information, explanations of concepts and processes, and instructions necessary for your document's aim and audience.
3. Delete from the body of the document any information that is unessential and unimportant to most of your readers. If the information will be important to some of your readers, include it in one or more appendixes.
4. Clarify technical terms.
   a. Replace any term that is used incorrectly.
   b. Replace any vague terms.
   c. If a single term is used to refer to two or more separate items, replace the term with separate terms for each item.
   d. If two or more terms are used to refer to a single item, choose the best term and replace all occurrences of the other terms with the one you have selected.
   e. The first time you use an acronym or an abbreviation that may not be familiar to all your readers, write out the complete term followed by the acronym or abbreviation in parentheses.
   f. Consider adding a glossary if you use many terms with which some readers may not be familiar.
5. Separate important technical terms and concepts so that your audience may easily digest the material.

Section 1.10

Editing for Grammar and Style

When you have dealt with the more basic matters included in the revision stage, it is time to review the document carefully for correctness. As you edit your document, however, continue to do whatever you can to improve accuracy, clarity, conciseness, coherence, and appropriateness. For example, could any sentences be made more effective by restructuring?

No matter how sound your document may be technically, your credibility will be undermined by errors in sentence construction or grammar, word choice, usage, punctuation, mechanics, or spelling. If you need more information about grammatical elements, refer to parts of sentences and parts of speech. If English is not your native language, check the list of common ESL writing problems.

Finally, have you used the language of your sources appropriately and give them proper credit? If your document is supposed to follow an established style for citing sources and creating a reference list, have you followed the right style correctly and consistently?

When you come to sentences that are hard to follow, locate the main agent (thing doing something) and the action (thing being done):

1. Circle the main subject or agent of the sentence. This noun will identify the who or what of the sentence.
2. Circle the main action word. This verb is the key to the action (thing being done or state of being) of the sentence.
3. Whenever possible, organize the sentence around the subject and verb. Make the agent the subject and the action the main verb of the sentence.

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Weak

The solid was contaminated [main action] as a result of a leaking cleaning solution [main agent].

Improved

A leaking cleaning solution contaminated the solid.

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Here are some ways to tighten up your prose:

1. Make your paragraphs coherent. If necessary, rearrange sentences for better paragraph flow and logic.
2. Use the active voice whenever the passive voice is not clearly more appropriate.
3. Eliminate unnecessary words and phrases.
4. Simplify your sentences. Break long sentences into manageable units.
5. **Condense repetitious or closely related material.** Look for ways to combine or delete words and sentences that repeat information.

6. **Be specific.** Replace vague phrases and words with more descriptive ones.

7. **Use words accurately.** Look for phrases and words that don't stand up to scrutiny.

### Section 1.11

**Reviewing a Document**

After they are written, revised, and edited, almost all technical documents undergo one or more reviews. Common types of reviews are peer reviews by colleagues, technical reviews by experts, editorial reviews by colleagues or editors, and managerial reviews by supervisors.

### Section 1.11.1

**Peer Review**

After you have revised and edited your document, ask a colleague to read it over and review it. Peer review is often the first and sometimes the most useful step in the review process. Because colleagues are often closer to the project than other types of reviewers, they can often identify weaknesses in content and organization that other reviewers may miss. In addition, peer reviews are often less formal and less threatening than managerial or technical reviews.

Peer reviews of documents are a frequent and normal activity in most scientific and technical organizations, with most engineers and scientists alternating between the role of the individual requesting a review and that of the individual performing it.

Peer reviews are most useful when specific guidelines are followed in requesting the review and the reviewer follows some important strategies in performing it.

### Section 1.11.1.1

**Requesting a Peer Review**

Observe the following guidelines in asking a colleague to review your document.

1. Provide your reader with sufficient information on your motivation and goals, both explicit and implicit, in writing the document; the document's intended audience or audiences; and relevant background not included in the document.

2. Ask the reviewer to perform specific tasks or answer specific questions regarding content, organization, and appropriateness. Ask the reviewer questions similar to the ones given in Revising for Content and Revising for Organization. Do not ask overly general questions such as "Is the report understandable?" Instead, ask, "Are any terms used that some readers may not understand?"

3. Select tasks and questions appropriate to the reviewer's abilities and position. In most cases, do not ask colleagues to mark mechanical problems such as spelling unless they happen to notice them in passing.
Example of a Request for a Peer Review

Please review the following report. The report was requested by the marketing division to distribute to their sales force because several customers have expressed concern about the incongruities between the file structures of our operating system and the file structure of the World Wide Web. The purpose of the document is to give our sales and support persons several solutions to the problem that they can pass on to our customers. Please answer a few specific questions:

1. Have I explained the problem clearly enough on page 2 for our sales and support persons?
2. Will our sales and support persons be able to understand my descriptions of possible solutions well enough so that they can then explain them to our customers?
3. Can you think of any additional negative effects that might be produced by solutions 2 or 3?
4. I evaluate the positive and negative aspects of each solution after I present it. Would it be more effective to present all four solutions and then evaluate them together?

Of course, feel free to add any comments you have on ways to improve the report. Thanks for taking time to review it.

Section 1.11.1.2

Performing a Peer Review

Observe the following general strategies in reviewing a colleague's document.

1. Start by praising what the document does well.
2. Spend much of your time responding to the author's specific requests.
3. Avoid performing an editorial review, unless asked to by the author. Do not focus on spelling and mechanics. Instead, focus on helping the author revise organization and content.
4. Do not just criticize. Make suggestions on how to solve the problems you notice in the document.

Section 1.11.2

Technical Review

The technical accuracy of a piece of writing should be the first level of review, since it is a waste of time to work on a document that is wrong in content. Technical reviews are most often conducted by routing a document among one's peers. A technical review may also be conducted by technical referees who are experts in the relevant field. Generally, the technical review is concerned with one
or more of the following questions:

- Is the problem addressed one that is technically important?
- Does the document solve the problem it sets out to solve?
- Are the methodology and general practice technically sound?
- Does the research lead to other important questions?

Although technical reviews are strictly matters of expertise and should not be confused with editorial reviews, technical and editorial issues are not always easy to separate, for the following reasons:

- Sometimes technical inaccuracy is caused by stylistic cloudiness.
- Small terminological errors can introduce monumental technical errors. If, for example, the approach of an aircraft is monitored in nautical miles, and the cockpit operating procedure of an airline pilot is given in statutory miles . . .

Section 1.11.3

Editorial Review

Editorial reviews aim to improve the readability of a manuscript. The reader examines the manuscript for ways in which it can be clarified and simplified. Then the reviewer either makes the changes and returns the marked-up manuscript to the writer or makes marginal notes and a written report for the writer's use in revising. The review often proceeds as follows:

1. **Read the draft for content: coverage and organization.** Read the draft all the way through before you start to make suggestions for adding or rearranging material, reordering paragraphs, or recasting sentences. Get a firm grasp of the author's purpose, problem statement, audience, and organization.

2. **Make marginal notes.** If you have to slow down in your reading or have to reread a section, mark it for revision. Make marginal notes of sections that are vague, awkward, inconsistent, or poorly supported. Note any grammatical or stylistic problems as you read along.

3. **Place potential problems in context.** Reread each area you marked in the first reading. Place the problem in the context of the audience, the reader's purpose, and the rules of grammar and style.

4. **Write down your recommendations.** Make written suggestions in the margins or on a separate sheet of paper. Identify

   - lack of clarity of purpose and problem
   - material inappropriate for a given audience
   - weak organization
     - overall document organization
     - format inconsistencies
     - paragraph structure
grammatical errors
- stylistic weakness

5. Read for **punctuation** and **mechanics**. Note patterns of misused punctuation, mechanics, and **spelling**, as well as any misuse of units, **acronyms**, **citations**, or **numbering** of pages, **sections**, **graphics**, or **equations**.

Section 1.11.4

**Managerial Review**

Reviewing can also be viewed as a way organizations manage work. In reviewing documents, the supervisor or the manager works with staff, often helping to reshape materials to fit group objectives. Team managers and research directors often establish **report**, proposal, or **oral presentation** schedules as a way of getting closure on projects. Time overruns are costly and potentially damaging.

The review process is often stressful, since staff and management perspectives are predictably different. The concerns of management may not be precisely aligned with those of the staff. That is, management is focused on long-term issues, which include administrative issues of cost, staffing, and work production. The staff, on the other hand, is often focused on the short-term issues of the project. Although the resulting tensions can lead to conflicts, they can also be helpful in getting individuals to focus their written work on organizational goals. The following list highlights some typical conflicts during the review process.

<table>
<thead>
<tr>
<th>Writer's Perspective</th>
<th>Supervisor's Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I want to show what I've been doing.</td>
<td>1. This document needs to advance the organization's objectives.</td>
</tr>
<tr>
<td>2. He won't tell me what he wants.</td>
<td>2. He throws rough drafts at me.</td>
</tr>
<tr>
<td>3. I don't understand her criticisms.</td>
<td>3. It takes three or four reviews.</td>
</tr>
<tr>
<td>4. He tries to put it in his style.</td>
<td>4. I have to fix a lot of bad prose.</td>
</tr>
<tr>
<td>5. I spend too much time writing.</td>
<td>5. She doesn't spend enough time writing.</td>
</tr>
</tbody>
</table>

--J. Paradis, D. Dobrin, R. Miller, "Writing at Exxon ITD"

Section 2.12

**Electronic Documents**

Electronic documents such as **electronic mail**, Web sites, and **hypertext** are rapidly becoming major forms of communication.

Electronic media offer many advantages for technical communication, including almost instantaneous transmission of information, easy distribution to a large number of recipients, and the ability to link one text to many others.

There are, however, many situations where printed documents are still the most appropriate form for
technical communication. Printed documents, for example, are often more private, secure, permanent, and portable than are electronic documents.

In deciding whether to put your document in electronic or print form, consider your audience's purpose in reading the document, and when, where, and how they will use it.

Section 2.12.1

Electronic Mail

Electronic mail (e-mail) allows for the almost instantaneous transmission of a message from one computer through a network to one or more other computers and is rapidly becoming one of the main forms of both professional and personal communication.

Characteristics of E-Mail

Like a telephone conversation, e-mail is immediate and informal. Like a memorandum, it is more precise than an oral conversation, it provides a record of the communication, and it can send a single message to a large number of people.

Unlike telephone conversations or memoranda, e-mail should not be considered private. E-mail is sent through public networks where messages are often copied multiple times during transmission. Whereas the basic unit of a memorandum is the single 8½-by-11-inch page, the basic unit of an e-mail is the 22-line screen. Consequently, e-mails should be kept short and concise. Finally, because e-mails are generated so easily, many individuals receive scores of messages every day.

Guidelines for Writing Effective E-Mail

- As in other forms of communication, start with you—a statement acknowledging the recipient.
- Keep your message short.
- Make heading clear and exact.
- If something is urgent, mark it "Urgent."
- Include a short introduction indicating exactly to what you are responding, even if the original message is included.
- If the e-mail is important, print it out and proofread it carefully before you send it.
- Take time to cool off.
- Remember that a message can end up anywhere.
- Remember that electronic privacy doesn't exist.
- E-mail etiquette is still evolving:
  - Avoid using all capital letters.
  - Do not forward an e-mail without permission.
Section 2.12.2

Web Sites

The World Wide Web supports the creation and transmission of an unlimited number of multimedia documents composed of text, graphics, animation, video, and audio. Multimedia Web documents are assembled and reside on computer servers scattered around the globe that can be accessed by anyone, anywhere, at any time.

Web communication is different from hard-copy publication because hypertext and the Web support non sequential navigation through online documents that are in essence "authored" by readers as they follow one of a potentially unlimited number of pathways through a "document."

Guidelines for Composing Web Documents and Web Sites

• Provide a graphical map of your Web site to help your audience conceptualize the organization, extent, and usefulness of information available there.

• Limit presentation of information to one screenful whenever possible (unless you are maintaining an online archive of reports originally published in hard copy).

• Limit the size of video and audio files to be downloaded (downloading video clips even a few minutes long can be a time-consuming process, turning the World Wide Web into the World Wide Wait).

• Follow the general guidelines for graphical representation when creating figures and other static illustrations.

• Show the context or reason for a link to another file or part of a file (or to another Web site) so that your audience can decide beforehand if they want to go there.

Vast online archives of scientific and engineering reports are now available over the Web.

Section 2.12.3

Hypertext

Hypertext is a compositional tool as well as a conceptual approach to communication. As a compositional tool, hypertext markup languages allow the author of a hypertext to establish links among the parts of a document, or between any number of complete documents, for ease of reference or for amplification of an idea. Since the reader of a hypertext can choose to follow these links or not (and in some contexts, such as a Web site, establish new links), hypertext tools also permit the reader to become an "author" as well. The "final"hypertext document, therefore, may take any number of forms, depending upon the needs of the audience.

Hypertext technical documents are very useful for training and for communicating instructions and procedures.
Guidelines for Creating Hypertext Links

- Consider the audience for your document, their limitations and demands.
- Let subject matter determine the kind and number of links between documents (or Web sites). Unexplained and arbitrary links will make your audience feel "lost in hyperspace."
- Structure the pathway of links in a coherent, useful way. Move your reader from general principles or important first steps down into subsidiary elements of your topic.
- Establish a context for a link when that link is to related but not crucial supporting material. That way, readers can decide if they want to access that information at that time.

Section 3.3.2

Abstract

An abstract is a brief summarizing statement, usually between 75 and 150 words long. It gives the reader a synopsis of the problem, method, results, and conclusions of your document. The abstract takes the form of a paragraph, usually with 5-10 sentences. It appears at the top of a journal article, just under the title, or on the page following the title page of a report. In the latter instance, the abstract appears on a page by itself.

Abstracts are often collected into volumes and must be able to stand alone. They are read by parties who are trying to decide whether or not to read the main document. Sometimes they are read by people who want to get the big picture before reading the main document. Abstracts can save readers an immense amount of time.

An abstract includes these elements:

1. **Problem.** Note the key topic or problem of your document.
2. **Method.** State your main approach to solving the problem.
3. **Results.** Provide one or two important results.
4. **Conclusion.** Note your main conclusion.

Descriptive Abstracts

In descriptive abstracts, which are often written before a project is completed, the emphasis is placed on the problem and method. Such abstracts may be required for conference paper proposals or for progress reports.

**Title: Machine-Intelligent Gust Front Detection**

Doppler weather radar imagery [method] is being used to detect gust fronts [problem] as part of a program at Lincoln Laboratory to anticipate hazardous weather conditions [problem]. The project goal, under contract with the Federal Aviation Administration, is
to develop a Machine-Intelligent Gust Front Algorithm (MIGFA) [method] as part of a suite of hazardous-weather detection functions.

M. W. Merritt et al., "Wind-Sheer Detection with Pencil Beam Radars," *Lincoln Laboratory Journal*

Compare this with the example of the informative abstract following.

**Informative Abstracts**

In informative abstracts, which are written after the project has been completed, care is given to providing information on the results and conclusion of the project.

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**Title: Machine-Intelligent Gust Front Detection**

Techniques of low-level machine intelligence, originally developed at Lincoln Laboratory to recognize ground vehicles obscured by camouflage and foliage, are being used to detect gust fronts in Doppler weather radar imagery [method and problem]. A Machine-Intelligent Gust Front Algorithm (MIGFA) has been developed [result] as part of a suite of hazardous-weather detection functions being prepared under contract with the Federal Aviation Administration. Initially developed for use with the latest generation Airport Surveillance Radar equipped with a wind shear processor (ASR-9WSP), MIGFA was deployed for operational testing in Orlando, Florida during the summer of 1992. MIGFA has demonstrated levels of detection performance that have not only markedly exceeded the capabilities of existing gust front algorithms, but are also competing well with human interpreters [result and conclusion].

--M. W. Merritt et al., "Wind-Sheer Detection with Pencil Beam Radars," *Lincoln Laboratory Journal*

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**Executive Summaries**

Executive summaries may be written to summarize the key questions and findings of documents, mainly reports. They are directed to readers--generally managerial--who will not read further. An executive summary, unlike an abstract, is a document in miniature that may be read in place of the longer document. Executive summaries are placed immediately after the title page of a report. They typically range between 10 and 25 percent of the original document.

**Structure and Content**

The structure of executive summaries is similar to that of abstracts.
About 25 percent of the executive summary is devoted to the problem and method, and the remaining 75 percent is given to the results and recommendations.

**Format**

Presentation of executive summaries is especially important, since speed and the convenience of the reader are the main objects. The material should be organized into enumerated chunks, given descriptive headings, and highlighted. These special formatting characteristics are shown in the following example.

1. **Preventive maintenance at the XYZ plant.** The preventive maintenance program at the XYZ plant was rudimentary—still in the early stages of development. Neither its scope nor its procedures had been defined. Accordingly, several plant activities, including systems maintenance, testing, calibration, and operations were routinely carried out with inadequate or no procedures. The instrument calibration program was incomplete and inconsistent, with the exception of the equipment under the control of the Equipment Test and Inspection Group.

2. **Maintenance backlog and funding.** The maintenance backlog continued to increase, while there was a decrease . . .

**Section 3.4.1**

**Introduction**

The introduction to your document should lead your readers into your paper and give them an idea of what to expect (also see Forecasting). It should not be simply a restatement of the abstract even though it will contain some of the same material.

Introductions often do the following:

- State the subject of your document as clearly as possible
- Define the problem you are addressing, your approach to the problem, and why this problem is important
- State the purpose of your document
- Define the scope of your document
- Provide necessary and relevant background information

Because the introduction leads your reader into your document, try to begin with a general
statement about the topic before moving on to specific issues. This strategy will help make the topic accessible to your readers, especially those who are not specialists in the field.

See

Sample Title and Introduction: Astronautical Engineering Design Report
Sample Title and Introduction: Mechanical Design Report
Sample Title and Introduction: Biology Report
Sample Title and Introduction: Information Systems Report

for sample titles and introductions.

Section 3.4.1.8

Sample Title and Introduction: Information Systems Report

A New Procedure for Ensuring Data Integrity in Flight Reservation Systems

In the current flight reservation system, a remote operator performs 5-15 transactions to arrange a flight reservation before finally sending an "end-transaction" message. This final message serves as a commit message to the server, which then records the transaction to disk and modifies its database. Before the end-transaction message is sent, the reservation data is held on the system's local disk. In the event of a system crash, the main processor (or a lower performance backup processor) reboots and resumes communication with all agents. However, this procedure has no mechanism for dealing with unfinished transactions, and, consequently, a system crash may produce inconsistent data between the remote operator's client and the reservation system's server. [the document's problem statement]

The airline currently uses three separate procedures to prevent and address these inconsistencies. First, it instructs all agents that when a system crash occurs, they should erase the entire transaction and resubmit it. Second, the airline runs certain consistency check algorithms every night off-line. These algorithms, however, are simply best-guess estimates and will not identify most unfinished transactions. Finally, all reservations, including unfinished transactions, are copied onto magnetic tape. If a customer complains about inconsistency, the airline can check this record.
Section 3.4.1.3

Scope

To be effective, scientific and technical documents have to limit their scope, the depth and breadth of their investigations. A scientific or technical report limits the scope of its discussions in response both to the boundaries of the inquiry itself and to the purpose and expertise of its audience. See Document Density.

A short statement of the scope of a document, describing what will be discussed, and what will not be discussed is often included as part of the introduction. In the following example, the author narrows the scope of the discussion of neural systems that control locomotion from humans or animals in general to one specific vertebrate, the lamprey.

Since the late 1960s, my colleagues and I have been attempting to unravel the design of the neural systems that coordinate locomotion in various experimental animals in hope that this research will help scientists understand some of the intricacies of the human nervous system. Much is yet to be learned, but we have finally produced a blueprint for the neural networks responsible for movement in a simple vertebrate, a type of jawless fish known as a lamprey.

--Sten Grillner, "Neural Networks for Vertebrate Locomotion," Scientific American
The Writing Timeline

Writing is a process both linear and recursive. It is linear because effective writers construct documents in well-defined and ordered stages. It is also recursive, however, because at any point an author may need to return to a previous stage.

Starting to Write
The first stage is concerned with planning and document design and may or may not be collaborative. Identify the purpose of the document by clarifying both the reasons for its creation and its specific objectives. Often, technical and scientific documents are written as answers to a specific problem, which is articulated in a problem statement.

Technical and scientific documents are tools designed to be used by their readers. Accordingly, define your audience – the person or persons who will be reading the document. Then determine your audience's level of expertise and their purpose in using the document. It is also important to assess the attitude of the audience toward both you and the document's subject matter.

Once you have identified the document's purpose and audience, you should be able to determine the document's general type and specific formatelements.

Organizing Material
Once you have defined the purpose, the problem, the audience, and document type, assemble your information. Sketch out a preliminary outline to organize it. Keeping purpose and audience in mind, sketch out graphics, such as tables, to display your data. Take care to give your reader a roadmap of the document.

Drafting
Like other stages, drafting may be collaborative. In any event, using your outline and preliminary graphics, write a first draft, a rough working version in which you get your ideas on paper. At this point in the process, do not be overly concerned about grammar, style, or usage. However, make sure that important reference information is available and that you follow a format appropriate to your document's type and purpose. Include graphics to illustrate and condense the information in your document.

Revising
Revision is not correcting grammatical errors or changing a few words; it is "re-seeing" your writing. If possible, put your first draft away for a day or two. Then, revise your document in three stages. First, check that the paper's format conforms to the conventions for its document type. Next revise for organization. Finally, bearing in mind document density, revise the content. Be certain that you have given proper credit to your sources and, if pertinent, that you have followed an appropriate citation style.

Editing
Edit paragraphs and sentences to make them easier to read by improving their clarity, conciseness, and coherence. Check that your choice of words is appropriate to the document's purpose and audience. Then correct any problems in grammar, including parts of speech, sentence parts, or types of sentences; usage; punctuation; mechanics; and spelling. Often need to perform a separate edit to catch specific types of problems in grammar and usage. Writers who are bilingual or not native speakers of English
**Reviewing**

The last major step for most technical documents is one or more reviews. Writers of most technical and scientific documents ask peers to review their manuscripts for accuracy, *clarity*, coherence, and *appropriateness*. In many cases, a *technical expert* will review the document for technical content. An *editor* may review the document to ensure that it conforms to the organization's style and to correct any remaining problems. There may be *legal reviews* as well. Finally, a supervisor or a manager may review the document to ensure that it achieves the organization's purpose and is appropriate to the audience.