In the curriculum for your chosen engineering discipline, you will find many “hard” courses (mathematics, science, and engineering) with just a smattering of “soft” courses (English, history, and other humanities). The hard courses emphasize computations, whereas the soft courses emphasize communication, primarily written. Given that the engineering curriculum overwhelmingly emphasizes hard courses, a student might logically conclude that communications are not important in engineering.

Nothing could be farther from the truth. The emphasis on hard courses merely reflects the necessary trade-offs that faculty must make when designing a curriculum to fit within severe time constraints. In fact, writing and oral communications are an integral part of a practicing engineer’s job; some engineers report that they spend 80% of their time in these activities. Likely, these soft skills will affect the promotions of an engineer more than the hard skills, particularly if the ultimate objective is to become a manager.

A recent survey of corporations posed the following question: “What skills are lacking in recent engineering graduates?” The number one response was that engineers lack communication skills. Because corporations are collections of individuals working toward a common goal, good communication skills are essential and highly prized.

Engineers communicate both orally and in writing. Regardless of which method, engineers use both words and graphics to present their ideas. Until now, most of your education has focused on communication via words. As a budding engineer, you also must learn to communicate graphically. Many engineering ideas are simply too complex to be described by words and can only be communicated through drawings. (Undoubtedly, you have heard the expression, One picture is worth a thousand words.) Engineering graphics is a huge topic well beyond the scope of this text. There are many fine engineering graphics texts available; we trust that you will have the opportunity to study one.

In school, your goal should be to develop a set of skills that will enable you to become a successful practicing engineer. Honing your communication skills is essential to reaching that goal. Take every essay, report, and oral presentation seriously. This chapter will help you get started.
6.1 PREPARATION

Whether writing or giving an oral presentation, you must prepare using the following three steps: topic selection, research, and organization.

6.1.1 Topic Selection

Your topic may be given, or you may be able to select it. If you are selecting your own topic, you may wish to choose something you are already familiar with or perhaps something you wish to know more about.

6.1.2 Research

There are many sources for obtaining information, as described below:

- **Technical journals** are generally devoted to a single topic (e.g., heat transfer). Authors submit their papers to journal editors who then have the papers reviewed by experts in the field. This peer review process can take a year or longer, so the results reported in technical journals are often a few years old; however, they tend to be high quality because of the review process. Technical journals are the primary means by which new information is introduced into the engineering community.

- **Books** are written by authors who are familiar with a field and wish to describe it in a consistent, coherent manner. The primary source of their information is knowledge that was first reported in technical journals, so the information in books tends to be even older than that in technical journals. The great advantage of a book is that the information is in a single source rather than in multiple articles spread over many years in a plethora of journals.

- **Conference proceedings** are a collection of papers written by authors who speak at a meeting devoted to a particular topic. Sometimes the proceedings are made available at the meeting, so the information can be extremely recent—literally, data taken a few days or weeks prior to the meeting. However, in this case, the information has not been peer reviewed, so some of the information may be of lesser quality. To overcome this problem, some conferences peer review the proceedings, but this takes time and delays publication of the information.

- **Encyclopedia articles** are very short descriptions of a particular topic. They are peer reviewed, so the information is of high quality. Like books, the information in an encyclopedia is at least a few years old.

- **Government reports** are collections of research data taken by government-sponsored researchers. The reports are required by the funding agency and are maintained at the agency. In some cases, the reports are copied onto microfilm by the National Technical Information Service, so they are more widely available. The final reports are written immediately after each project is completed, so the information is very recent; however, it usually is not peer reviewed. Generally, if the information is important to a wide audience, it will be translated into a journal article where it will be subjected to peer review.

- **Patents** describe technology that is novel, useful, and nonobvious. To be valid, a patent must fully disclose the technology so that a person “skilled in the art” can translate the
A patent protects the intellectual property of the inventor for a fixed time period, typically 20 years from the time the patent was filed.

- **Popular press articles** appear in widely circulated magazines and newspapers. Usually, they are written by people with a journalism degree who have little technical background. Further, the information often must be printed quickly to meet a publication deadline, so the information may not be scrutinized. As a consequence, popular press articles dealing with technical subjects often report erroneous information. However, such articles may be useful for getting to the human side of a technical issue and may indicate how the lay public or politicians feel about controversial technical topics, such as nuclear energy, landfills, or dams. Also, they may indicate how a technical issue affects certain people, groups, or institutions.

- **Course notes** can be a good source of information; however, the information is not peer reviewed.

- **Internet sites** can be established by anyone with a computer and enough money to pay monthly connection fees. The Internet is an extremely democratic means for disseminating information. Because it lacks the scrutiny of peer review, however, erroneous information or extreme viewpoints can easily make their way into the information marketplace. Further, information on the Internet is extremely volatile and is available only as long as the computer and its connection are maintained.

Finding information is a technical skill; in fact, libraries have experts trained to find information in their vast archives. When doing your research, freely consult these experts. But be aware that they are not experts in your field, so there are benefits to becoming more self-sufficient. The following resources will help you find information:

- **Abstracts** are brief, one-paragraph descriptions of the contents in a journal or popular press article. The abstracts are accessible through keywords or author names. There are abstracts for chemistry, biology, physics, engineering, and popular press articles (*Reader’s Guide to Periodical Literature*). Abstracts are now accessible through computer searches using either CD-ROMs or the Internet.

- **Citations** or **references** are listed at the end of a publication, detailing where the information was obtained. Suppose you are a civil engineer interested in improving asphalt roads and you find a particularly good paper on asphalt chemistry by Charles Glover published in 1995. Glover’s citations are an excellent way to connect to other related literature before 1995.

- **Citations indices** list authors and publications that have cited them. For example, knowing that Charles Glover wrote an excellent asphalt article in 1995, you can look up his name in the citations index. If another author cited his work in 1998, it is likely that this author also is writing about asphalt chemistry, so you may be interested in obtaining her paper as well. Using the citations index, it is possible to find related articles after 1995.

- **Library catalogs** list the holdings of the library, often by subject and author, so this is a rapid way to find relevant literature in your library.

### 6.1.3 Organization

When organizing your presentation or writing, the most important rule to follow is
Again, imagine you are a civil engineer who seeks to improve our highways. If you were invited to an elementary school to speak to eight-year-olds about your work, you would certainly give a different talk than if you were invited to speak at a technical symposium on our highway infrastructure.

Once you know your audience, the next step is to determine the most important points you wish to make. Whether writing or speaking, it is usually impossible to communicate everything you know about a subject because of space or time constraints. Instead, you must carefully choose the key points and determine the most logical sequence for the ideas to flow together smoothly. An outline is very helpful for achieving this goal.

When structuring your writing or speech, you may want to employ the following strategies:

A chronological strategy gives a historical account of the topic. Again, imagining you are a civil engineer, you could present a history of roads by sequentially describing simple dirt paths, gravel roads, cobblestone streets, asphalt roads, and concrete multilane highways.

A spatial strategy describes the component parts of an object. In the case of a road, you could describe its various features (gravel substructure, asphalt surface, drainage system).

A debate strategy would describe the pros and cons of a particular approach. For example, you could describe the advantages and disadvantages of asphalt and concrete roads, with the goal of choosing which is best for a given situation.

A general-to-specific strategy presents general information first, and then gives increasingly detailed information and specific examples. For example, as a civil engineer describing methods for connecting one road with another, you could first describe general considerations (e.g., number of lanes, vehicle speed, amount of traffic) and then describe specific types of connections (four-way stop signs, traffic circles, stoplights, highway cloverleafs, etc.). In some cases, a specific-to-general strategy is a more effective way to communicate.

A problem-to-solution strategy is very effective for communicating with engineers because they are trained problem solvers. For example, a road for which you are responsible may have too many potholes. In a presentation to your boss, you could first describe this problem and then offer a variety of solutions (use a high-grade asphalt, deepen the roadbed, improve the drainage system, ban heavy trucks).

A motivational strategy is often employed by sales engineers. For example, imagine you sell a high-quality asphalt that will improve road life. Your presentation could have the following components:

1. You could get your client’s attention by showing a picture of a pothole swallowing an automobile.
2. You could create a need for your product by showing how much money your client spends fixing potholes.
3. You could satisfy their need by showing how your product reduces the formation of potholes.
4. You could help them visualize a better, pothole-free world.
5. You could get them to act by signing a purchase contract for your asphalt product.

No matter which strategy you employ, you should have an introduction, body, and conclusion.
6.2 ORAL PRESENTATIONS

When you become an engineer, you will give oral presentations in a variety of situations—you might need to make proposals to prospective clients, explain why your company should be allowed to build a new facility in a community, explain the results of a recent analysis to your boss, or present research results at a conference. Mastering oral presentations will increase your chances of being promoted to high-visibility positions within your company.

6.2.1 Introduction

During the introduction of your oral presentation, your goal is to win your audience over. If you cannot win them over within the first few minutes, you never will. Jokes are a classic way to win the audience; if you are skilled at telling jokes, use them. However, if you are unskilled, win your audience in other ways; there is no quicker way to lose them than by telling a joke badly. Instead, you may win your audience by using anecdotes, particularly if they are personal.

During the introduction, you must connect the audience with your world. They may not have thought about your topic before, so you must grab their attention. Find an aspect of your topic that everyone can relate to. For example, everyone can relate to potholes, so this is a good way to introduce the topic of high-quality asphalt.

Commonly, the first slide of an oral presentation is the title. There is nothing wrong with this approach; however, it may not help win your audience. There is little you can do with a title but read it to the audience, which insults their intelligence. Further, many engineering presentations have titles with technical phrases that are unintelligible to most members of the audience. A more effective opening is to find an aspect of your topic that everyone can relate to so you win your audience immediately. Then, present them with enough information that they can understand every word in the title slide. Using this approach, the title slide may appear a few minutes into the presentation. This may seem awkward—but how many television shows start with the title? It is much more common to start with an opening skit that grabs the audience’s attention and dissuades them from changing channels. After the skit, they show the title. This approach is very successful in television, and it can work effectively for you, too.

Often, a speaker includes an outline of the talk immediately following the title slide. Technically, this is not wrong; however, again it does little to win your audience. It is difficult to make an outline interesting, particularly if it contains technical words that few audience members understand. Instead, use “chapter” designators, which we describe next.

6.2.2 Body

The body is the heart of the presentation where you will spend the majority of your time. About 80% of the presentation is the body, with about 15% devoted to the introduction and about 5% devoted to the conclusion.

In the body, use “chapter” designators to let the audience know when you have changed topics. Suppose you were dividing your talk on road construction into the following topics: surveying, grading, roadbed preparation, and surfacing. Rather than listing these topics at the beginning of the presentation, it is more effective to have a chapter designator with the single word “Surveying” in large letters. This lets the audience know that
the next few slides relate to this topic. Then, have a chapter designator with the word “Grading” in large letters to let the audience know that you have switched topics. In this way, you can step through the various topics in your presentation. An alternate approach is to indicate all the topics in a list, but highlight the particular topic being considered during the particular chapter; thus, the same list appears multiple times throughout your presentation, but each topic in the list is highlighted only once. If you organize your presentation according to a spatial strategy, a very effective chapter designator is a graphic image of the object being described. Each chapter in the presentation would begin with a portion of the graphic image highlighted. For example, you could show a cut-away view of a road indicating the soil, gravel bed, and asphalt surface. You could begin each chapter by highlighting the particular feature of the road you will discuss next.

6.2.3 Conclusion

In the conclusion, you wrap up your presentation and summarize your key points. When preparing your conclusion, think hard about what you want to be the take-home message; that is, if the audience remembers only one or two things from your presentation, what do you want those to be?

6.2.4 Visual Aids

Table 6.1 shows the results of a study in which participants were given a presentation and then later tested to determine their retention of information. This study clearly shows that combining visual aids with oral comments is the best approach.

When preparing your visual aids, employ the KISS (Keep It Simple, Stupid) principle. Each visual aid must communicate your idea rapidly; otherwise, the audience will spend too much time interpreting your visual aid and not listening to your oral comments. Obviously, you would like to make the visual aid as interesting as possible to maintain their attention. Sometimes you can accomplish this using exaggeration. Also, as much as possible, use graphic images rather than words. As the speaker, you can easily create slides containing only words; however, the audience must read the words and form a mental image all while listening to your oral comments. Most likely you will lose them.

Among the many types of visual aids are the following:

- **Word charts** convey information using short phrases, or even single words. Use bullets when the order is of no particular importance; use numbered lists when the order is

| TABLE 6.1 |
| Message retention |

<table>
<thead>
<tr>
<th>Presentation</th>
<th>Testing 3 Hours Later (%)</th>
<th>Testing 3 Days Later (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral only</td>
<td>70</td>
<td>10</td>
</tr>
<tr>
<td>Visual only</td>
<td>72</td>
<td>20</td>
</tr>
<tr>
<td>Oral and visual</td>
<td>85</td>
<td>65</td>
</tr>
</tbody>
</table>

important. Table 6.2 shows an example of a word chart with bullets. Note that there are no complete sentences; the key is to use few words so the audience can read the chart in just a few seconds and then turn their attention to your oral comments.

- **Tables** present numerical data. Table 6.3 is an example of a table; note that both a title and units are included. Because it is difficult to visualize information in tabular form, it is better to convert the data into a chart or graph, if possible.

- **Charts and graphs** are images that rapidly convey numerical information. Figure 6.1 shows an example of a bar chart, a pie chart, and a graph. Note that each has a title, and units are indicated for the reported quantities.

- **Photographs** are very effective ways to communicate still images, whereas **videos** or **movies** are needed to convey moving images. All of these can add real force to a presentation.

- **Schematics** (Figure 6.2) are line drawings of objects or processes, and **illustrations** (Figure 6.3) are graphic images used to explain concepts.

- **Maps** (Figure 6.4) rapidly communicate geographic information.

- **Physical objects** can be very effective in presentations. People are interested in examining physical objects (perhaps because it brings back childhood memories of show-and-tell) and it can make the abstract become concrete. However, passing the objects can be very disruptive, so this aid works best with smaller audiences, or if done during the question-and-answer period.

The visual media you select can make a big impact on your oral presentation. Here are some options:

- **Transparencies** have the advantage of being rapidly and inexpensively reproduced using a copier or computer printer. Also, the information is available in a random-access manner, making it possible to select easily any desired transparency at any point in your presentation. Generally, color transparencies are not as vibrant as slides.

- **Slides** have stunning colors and resolution, so they are the visual medium of choice. However, they require a longer lead-time to prepare, and the information is available...
only in a sequential-access manner, making it difficult to select any desired slide at any point in your presentation.

- **Computer projections**, using programs such as PowerPoint, are very flexible; you can change a presentation minutes before giving the talk. Also, you can embed eye-catching visual effects, sound effects, and even moving images in the presentation. However, the resolution of the projected images is not as high as slides. Also, given the complexity of computer technology, unexpected glitches can happen in the middle of your presentations, which can detract from your message. Often, people who give presentations using computer projections also have back-up slides in case there is a computer glitch.

- **Blackboards**, even though they are old-fashioned, are effective for interacting spontaneously with the audience. However, because of the time it takes to draw on a blackboard, it is not effective for rapidly conveying information. Also, there is no permanent record of the information placed on the blackboard. And, because your back is to the audience when you write, using a blackboard to excess can impede interaction with the audience.

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**FIGURE 6.2**  
Example of a schematic.

**FIGURE 6.3**  
Example of an illustration showing how acid rain is produced from sulfur in coal.

**FIGURE 6.4**  
Map showing locations of manufacturing facilities.
• **Butcher paper** is large sheets of paper that are typically mounted on an easel. Butcher paper allows for spontaneous interaction with the audience, and has the added advantage of maintaining a permanent record. Pre-prepared presentations on butcher paper can allow for rapid information transfer. Butcher paper is a favorite visual medium in brainstorming sessions.

• **Handouts** of the presentation are often used with a small, important audience. For example, if making a sales presentation, provide copies of your presentation to the clients so they can pay attention to you rather than getting distracted by taking copious notes.

### 6.2.5 Speech Anxiety

In 1974, *The Bruskin Report*\(^1\) revealed that some adults are more fearful of public speaking than financial problems, loneliness, and even death. Why would people rather die than give a speech? Most likely, the reason is that at least once in our lives, each of us has been embarrassed in front of a group. The experience may have been so humiliating that the body does not want to repeat it. Uncontrollable physiological responses to speech anxiety include sweating, shakiness, stomach distress, and an increased heart and breathing rate.

How should you respond to speech anxiety? Well, you could surrender yourself to it and become a basket case every time you must speak publicly, or you could refuse to give public speeches. Neither of these is a viable option for an aspiring engineer such as yourself; your job will require you to give oral presentations. You might try to ignore the physiological symptoms, but sometimes they are simply too powerful to ignore. Instead, you should learn to harness the energy that comes from speech anxiety and direct it into your presentation.

There are a number of tricks you can use to overcome speech anxiety:

• The most powerful trick is to be well-prepared; those who are ill-prepared have good reason to be nervous.

• The first few minutes of a presentation are the most important. Recall that this is the critical time when you are trying to win the audience. It is also the time you will be most nervous, as the transition from being an anonymous audience member to becoming the center of attention puts a strain on your body. The best way to survive this initial period is to memorize the first few sentences so you can deliver them in “autopilot” mode. Also, take a deep breath before you utter your first words to calm your nerves.

• If you were to meet each audience member individually, you could become friends, so think of them collectively as your friends. You can reinforce this notion by picking out a few friendly faces in various parts of the room and speaking to them. Don’t look at the people who are obviously bored or disinterested; they will suck the energy out of you.

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• Allow yourself to make mistakes. We all trip over words or drop things. Most people in the audience will filter out your mistakes and not even notice them; however, they will notice if you respond to your mistake by becoming agitated or confused.

• The physiological manifestations of speech anxiety are based upon the “fight-or-flight” response. When your body is in a stressful situation, it is poised to do battle or to flee. Adrenaline flushes through the body, putting the nerves on edge and tightening the muscles. You can counteract these effects with endorphins that are released with intense physical exercise, such as running. By exercising one or two hours before your presentation, you will find yourself to be less nervous, which will help your presentation go well. After having many positive public speaking experiences, you will find that you get less speech anxiety each time, and the need for endorphins will eventually subside.

6.2.6 Style

According to the Mehrabian Study, only 7% of what you communicate is verbal. The remainder is nonverbal communication, such as body language (55%) and voice strain (38%). Thus, you can be well-prepared and still give a bad presentation if your nonverbal communication is poor. Some tips on nonverbal communication follow.

• Look the audience members in the eye. It is said that the eyes are the gateway to the soul. If you will not look audience members in the eye, you will be perceived as being either a liar or a coward, neither of which is desirable. If you are nervous, you can look at their foreheads; they will never know the difference.

• As you speak, scan the audience so you are not talking to a lone friendly face. You want everyone to be involved with your presentation.

• Speak forcefully and confidently. Use your singing voice, which is supported by the diaphragm. Do not speak from the throat; doing so will make you hoarse. If you speak softly, the audience may not hear you, and may even see you as insecure.

• Use a pointer to direct the audience’s attention to a particular part of your visual aid. If you want the audience to stop looking at the visual aid and direct their attention to you, step away from the visual aid.

• Do not stand where you block the view to the visual aids. If you use a transparency, do not point directly to the transparency, as this usually blocks somebody’s view. Instead, point directly to the screen.

• Avoid distracting habits such as jiggling change in your pocket. Do not overuse distracting phrases, such as “you know” or “ummm.”

• Watch your body language. Do not be stiff, meaning you are scared, or overly relaxed, meaning you do not care. To show respect for the audience, wear nice clothing and be well groomed.

• Be enthusiastic. If you do not care about your presentation, why should the audience?

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6.3 WRITING

Engineers employ technical writing, which is very different from the literary writing you learn in most English classes. Consider this passage:

\[
\begin{align*}
Helen, \ thy \ beauty \ is \ to \ me \\
\quad \text{Like those Nicèan barks of yore} \\
\quad \text{That gently, o’er a perfumed sea,} \\
\quad \text{The weary way-worn wanderer bore} \\
\quad \text{To his own native shore.}
\end{align*}
\]

*Edgar Allan Poe*

To express these ideas in technical writing, we would simply say

*He thinks Helen is beautiful.*

Although this technical writing does not elicit the emotions of Poe’s passage, that is not the goal. Instead, the goals are that technical writing be

- *Accurate*. In engineering, it is essential that the information be correct.
- *Brief*. Readers of technical writing are busy and do not have time to sift through a lot of words.
- *Clear*. Be sure that your technical writing can be interpreted only one way.
- *Easy to understand*. Your goal is to express, not impress.

6.3.1 Organization

In engineering, the typical types of written communications are business letters (which are sent outside the organization), memoranda (which are sent inside the organization), proposals (which are solicitations for funding), technical reports (which are used internally), and technical papers (which are published in the open literature). Table 6.4 summarizes the content of each document. The specific order of the content and the format depend upon the organization for which you are writing.

6.3.2 Structural Aids

In your written communication, be sure to employ headings and subheadings; these break the document into digestible chunks and let the reader know when you have changed topics. Paragraphs should begin with a topic sentence to inform the reader what the paragraph is about. In general, paragraphs should contain more than one sentence, unless it is presenting a particularly emphatic idea. When connecting ideas in a paragraph, be sure to use transition words, such as *but, however, in addition*, and so forth.

6.3.3 Becoming a Good Writer

Everyone has problems with writing; the problems differ only by degree. Unlike some engineering problems that you can solve by applying an algorithm that results in the correct answer every time, there is no such algorithm that guarantees good writing. Instead, you learn to write by trial and error and by reading examples of good writing. Learning to
TABLE 6.4
Contents of typical engineering documents

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>To:</td>
<td>Title page</td>
<td>Title page</td>
<td>Title page</td>
</tr>
<tr>
<td>Recipient address</td>
<td>Through:</td>
<td>Contents</td>
<td>Contents</td>
<td>Abstract</td>
</tr>
<tr>
<td>Salutation (Dear ...)</td>
<td>From:</td>
<td>Background</td>
<td>Background</td>
<td>Text</td>
</tr>
<tr>
<td>Text</td>
<td>Date:</td>
<td>Scope of work</td>
<td>List of figures</td>
<td>List of tables</td>
</tr>
<tr>
<td>Introduction</td>
<td>Subject:</td>
<td>Methods</td>
<td>List of tables</td>
<td>Executive summary</td>
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<tr>
<td>Body</td>
<td>Text</td>
<td>Time table</td>
<td>Text</td>
<td>Text</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Introduction</td>
<td>References</td>
<td>Introduction</td>
<td>Methods</td>
</tr>
<tr>
<td>Closing (Sincerely)</td>
<td>Body</td>
<td>Appendixes</td>
<td>Math derivations</td>
<td>Results</td>
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<td>Signature</td>
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<td>Methods</td>
<td>Conclusions</td>
</tr>
<tr>
<td>Stenographic reference</td>
<td>Enclosures</td>
<td>Budget</td>
<td>Results</td>
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</tr>
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<td>Enclosures</td>
<td></td>
<td>Personnel</td>
<td>Conclusions</td>
<td>Nomenclature</td>
</tr>
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<td></td>
<td></td>
<td>Letters of support</td>
<td>Recommendations</td>
<td>References</td>
</tr>
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<td></td>
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<td></td>
<td>Acknowledgments</td>
<td>Appendices</td>
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<td>Nomenclature</td>
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<td></td>
<td></td>
<td></td>
<td>References</td>
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</tbody>
</table>

1–5 pages without enclosures | 1–5 pages without enclosures | 1–1000+ pages | 5–1000+ pages | 1–40 pages

write properly requires a lifelong commitment. Slowly, over time and with practice, this skill sinks in.

Good writing requires editing; rarely does a well-written document emerge extemporaneously. The author actually must wear two hats: those of the writer and the reader. After writing a passage, you must clear your mind and read it from the viewpoint of your readers, considering their backgrounds, biases, and knowledge. (Remember: Know your audience.) Can you understand what was written, from the reader’s viewpoint? This is not easy to do; after all, you just wrote it, and you know what you were trying to communicate. If you have the luxury of time, put the writing away for a while so you can forget what you were trying to say, and later see what you actually wrote. Alternatively, you can have someone else read your work.

Unlike natural laws, which are valid for all time and all locations, language “laws” constantly evolve. Although some grammatical rules are fairly fixed (e.g., end a sentence with a period), other rules change with time or location (e.g., “color” in the United States, “colour” in Britain). The French language has L’Académie Française to define proper French, but no such governing body exists for the English language. This lack is both a blessing and a curse. English freely borrows words from all over the world, allowing for many subtle shades of meaning; but then we are stuck with inconsistent spelling. Without a governing authority, English is a matter of convention. Some of the conventions are arbitrary—and some are absurd—but many allow the brain to process words rapidly and unambiguously into understanding. To impose some order on the chaotic English language, many organizations employ a style manual. Here, we describe some of the most common conventions; however, you will certainly find exceptions as you go out into the world.
6.3.4 Building Better Sentences

As you construct sentences, consider the following issues:

1. **Use parallel construction.** When comparing related ideas, use similar sentence construction.
   
   *Incorrect:* Scientists acquire knowledge and engineers are concerned with applying knowledge.
   
   *Correct:* Scientists are concerned with acquiring knowledge, whereas engineers are concerned with applying knowledge.

   Also employ parallel construction with lists.

   *Incorrect:* Civil engineers build roads, building construction, and waterworks planning.
   
   *Correct:* Civil engineers build roads, construct buildings, and plan waterworks.

2. **Avoid sentence fragments.** Use complete sentences in your writing.
   
   *Incorrect:* Joining a professional society, important to furthering your career.
   
   *Correct:* Joining a professional society is important to furthering your career.

3. **Use clear pronoun references.** Be sure that the noun referenced by the pronoun is clear.
   
   *Incorrect:* Procedure A is used for a high-concentration sample. *This* results from the benefits of advanced technology.
   
   *Correct:* Procedure A is used for a high-concentration sample. *This procedure* results from the benefits of advanced technology.
   
   *Correct:* Procedure A is used for a high-concentration sample. *This sample* results from the benefits of advanced technology.

4. **Avoid long sentences.** Break overly long sentences into multiple short sentences.
   
   *Incorrect:* The procedure for operating the chemical reactor starts by first opening Valve A by turning the handle counterclockwise when viewed from the top, then turning on Pump A and waiting 15 min while simultaneously watching the temperature gauge to ensure that the reactor does not overheat, in which case, open Valve B, which introduces cooling water to cool the reactor.
   
   *Correct:* The procedure for operating the chemical reactor follows: First, open Valve A by turning the handle counterclockwise when viewed from the top. Then, turn on Pump A and wait 15 min while simultaneously watching the temperature gauge. If the reactor overheats, open Valve B, which introduces cooling water to cool the reactor.

5. **Avoid short sentences.** Combine overly short sentences into longer sentences that flow more fluidly.
   
   *Incorrect:* The procedure for operating the chemical reactor follows: First, open Valve A. Open Valve A by turning the handle counterclockwise. The proper viewing position is from the top. Then, turn on Pump A. Wait 15 min.
Simultaneously, watch the temperature gauge. If the reactor overheats, open Valve B. Opening Valve B introduces cooling water. Cooling water cools the reactor.

**Correct**  (See previous item.)

(Note: Occasionally using short sentences can make writing more interesting and varied.)

6. **Use active voice.** Active sentences require fewer words and are more interesting to read.

**Incorrect**  Temperature is dependent upon the heat input.

**Correct**  Temperature depends on the heat input.

Other examples are shown in the table below:

<table>
<thead>
<tr>
<th>Incorrect</th>
<th>Correct</th>
<th>Incorrect</th>
<th>Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>place emphasis on</td>
<td>emphasize</td>
<td>is an indication of</td>
<td>indicates</td>
</tr>
<tr>
<td>is compliant with</td>
<td>complies with</td>
<td>is a representation of</td>
<td>represents</td>
</tr>
</tbody>
</table>

7. **Avoid vague words.** Use precise words to replace general words.

**Incorrect**  The sensor read 150°F.

**Correct**  The thermometer read 150°F.

**Incorrect**  The community suffered through a period of economic troubles.

**Correct**  For five years, the community had over 10% unemployment.

8. **Reduce prepositions.** Overusing prepositions (*of, in, by, on, out, to, under, etc.*) makes understanding difficult.

**Incorrect**  The establishment of a panel of experts in safety was needed for investigation of accidents by miners in Pennsylvania.

**Correct**  A panel of safety experts was established to investigate accidents by Pennsylvania miners.

9. **Eliminate redundancies.** Excess words take time to process and may lead to confusion.

**Incorrect**  The pH value was 7.2.

**Correct**  The pH was 7.2.

10. **Avoid bureaucratic language.** The following table shows that bureaucratic phrases can be replaced by fewer words:

<table>
<thead>
<tr>
<th>Incorrect</th>
<th>Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>by means of</td>
<td>by</td>
</tr>
<tr>
<td>in the event of</td>
<td>if</td>
</tr>
<tr>
<td>for the reason that</td>
<td>because</td>
</tr>
<tr>
<td>with regard to</td>
<td>about</td>
</tr>
</tbody>
</table>
11. *Avoid informal language.* Using informal language is analogous to wearing jeans and a T-shirt while giving an important sales presentation.

*Incorrect*  We plugged numbers into the equation.  
*Correct*  We substituted numbers into the equation.

*Incorrect*  The shaft can’t rotate. (Contractions are considered casual language.)  
*Correct*  The shaft cannot rotate.

12. *Avoid pompous language.* Do not use a 50-cent word when a nickel word will do the job.

<table>
<thead>
<tr>
<th>Incorrect</th>
<th>Correct</th>
<th>Incorrect</th>
<th>Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>prior to</td>
<td>before</td>
<td>personnel</td>
<td>people</td>
</tr>
<tr>
<td>utilize</td>
<td>use</td>
<td>subsequent</td>
<td>next</td>
</tr>
<tr>
<td>initiate</td>
<td>start</td>
<td>terminate</td>
<td>end</td>
</tr>
</tbody>
</table>

13. *Avoid sexist language.* In the past, if the sex of a person was indeterminate, the default sex was “he.” In modern usage, “he or she” can be used, although this can lead to clunky sentences. An alternate approach is to mix “he” and “she” throughout your writing, or you can use plurals by saying “they.”

14. *Avoid dangling modifiers.* Dangling modifiers are words or phrases that describe something that has been left out of the sentence.

*Incorrect*  Determining the experiment to be a failure, the entire project was canceled.  
*Correct*  Determining the experiment to be a failure, the project manager canceled the project.  
*Correct*  Because the experiment was a failure, the entire project was canceled.

15. *Avoid split infinitives.* Infinitives are verbs preceded by the word *to*. In many places, it is best to keep these two words together.

*Undesirable*  Eddie decided to quickly drive down the road.  
*Preferred*  Eddie decided to drive quickly down the road.

However, to provide emphasis, an infinitive may be split.

*Example*  To pass the course, Edna needs to thoroughly study the class notes.

Increasingly, split infinitives are accepted unless they are awkward or ambiguous, so this is an example of a grammatical rule that is changing.

### 6.3.5 Punctuation

Although punctuation may seem insignificant, improper punctuation can lead to gross misunderstandings.

1. *Hyphens.* Use hyphens to avoid ambiguity.

*Incorrect*  The specifications call for eight foot long pipes.  
*Correct*  The specifications call for eight foot-long pipes.  
*Correct*  The specifications call for eight-foot-long pipes.
Use a hyphen when spelling out fractions or numbers less than 100.

Examples
two-thirds
seventy-eight

A hyphen can be used to combine nouns of equal things.

Example Because he does both fundamental and applied work, John is a scientist-engineer.

Use a hyphen to create compound units.

Example The accident rate is reported per person-mile.

Use a hyphen to create compound adjectives.

Examples We need a face-to-face meeting to resolve this dispute.
The process requires high-pressure pipe.
Use 5-in diameter pipe.
Incorrect The pipe diameter is 5-in.
Correct The pipe diameter is 5 in.
Example This car can be powered by a six- or eight-cylinder engine.

Do not use a hyphen with adverbs ending in “ly.”

Incorrect This is a highly-explosive process.
Correct This is a highly explosive process.

2. Colons. Use colons to introduce a list.

Example The following skills are used by engineers: analysis, creativity, and communication.

Colons can be used to introduce equations, provided a complete sentence precedes the colon.

Example The following equation results from Newton’s second law:

\[ F = ma \]

where

\[ F = \text{force} \]
\[ m = \text{mass} \]
\[ a = \text{acceleration} \]

Note that a colon does not appear after the word where. Similarly, do not put a colon after the following words: when, if, therefore, is, by, are, such as, especially, and including.

3. Commas. Use commas to separate items in a list of three or more items.

Example The primary tools of an engineer are a pencil, a calculator, and a computer.

Use commas to separate nonessential or nonrestrictive clauses, that is, clauses that are parenthetical or that could be deleted without changing the meaning of the sentence.

Example The shaft seal, which is supposed to work at high speeds, failed.
Use commas to separate long independent clauses joined by and, or, but, or nor.

*Example* In the United States we use an English measurement system, but slowly we are adopting the SI system.

Use commas to set off introductory clauses.

*Example* Before turning on the amplifier, be sure it is grounded.

Use commas to separate multiple adjectives that could be joined by and.

*Example* The automobile has shiny, red paint.

4. *Parentheses.* Use to set off parenthetical lists, clarifications, acronyms, abbreviations, or asides.

*Example* Ellen’s technical courses (heat transfer, fluids, and thermodynamics) are canceled.

*Example* Mike suggested that we use high-pressure (schedule 80, not schedule 40) pipe.

*Example* Units of measure are regulated by the National Institute of Standards and Technology (NIST).

(Note: Always spell out an abbreviation upon first use.)

*Example* The primary salt in seawater is sodium chloride (NaCl).

*Example* The boss announced that because of his fine work, Fred will be promoted (although everyone knows it’s because he married the boss’s daughter).

5. *Dashes.* Use -- to emphasize parenthetical statements. (The proper symbol is —, but -- will do in a pinch.)

*Example* Open the steam valve—the one with the red handle, not the blue handle—by turning it counterclockwise.

*Example* Open the steam valve--the one with the red handle, not the blue handle--by turning it counterclockwise.

6. *Semicolon.* Do not use a comma to separate two phrases that could stand alone as independent sentences; instead, use a semicolon.

*Incorrect* The engineering student worked hard in school, therefore he landed a good job.

*Correct* The engineering student worked hard in school; therefore, he landed a good job.

Use a semicolon to separate phrases that have commas.

*Example* The following individuals attended the meeting: Martin Fields, vice president, Ford Motor Company; Alfred Reno, chief executive officer, General Motors; and Jennifer Anderson, president, Chrysler.

7. *Apostrophe.* To show possession for a single individual, use ’s.

*Example* The engineer’s book was published.
To show possession for a plural noun ending in \textit{s} or \textit{es}, simply add the apostrophe.

\textit{Example}  When the fraternity house burned, the engineers’ books were lost.

Generally, if the noun ends in an \textit{s} sound, add ‘\textit{s}.

\textit{Example}  The waitress’s order

However, with some names that end in the \textit{s} sound, simply add the apostrophe.

\textit{Example}  Gauss’ law

It is best to use the possessive form only for animate creatures; however, it is sometimes employed with inanimate nouns.

\textit{Example}  The earth’s orbit

8. \textit{Quotation marks}. Use to identify quotations.

\textit{Example}  The astronaut’s exact words were, “Houston, we have a problem.”

Also, quotation marks identify a word or phrase that is used in an unconventional way.

\textit{Incorrect}  With this word processor, press enter to start a new line.
\textit{Correct}  With this word processor, press “enter” to start a new line.

In proper American usage, a comma or period appears inside the quotation.

\textit{Incorrect}  To use this computer program, memorize the following commands: “start”, “stop”, and “help”.
\textit{Correct}  To use this computer program, memorize the following commands: “start,” “stop,” and “help.”

What idiot made this rule?

\subsection*{6.3.6 Word Demons}

“Word demons” have similar meanings or similar spellings, and are often confused with one another.

1. \textit{Effect} (n.): result
   \textit{Effect} (v.): to cause; to bring about
   \textit{Affect} (v.): to act upon

\textit{Example}  The effect of high-intensity noise is ear damage.
\textit{Example}  High-intensity noise effects ear damage.
\textit{Example}  High-intensity noise affects the cochlea.

2. \textit{Compliment}: to praise
   \textit{Complement}: to complete or balance

\textit{Example}  Mary’s boss complimented her fine presentation.
\textit{Example}  Humanities courses complement technical courses, leading to a well-balanced education.
3. **Continuous**: uninterrupted  
   **Continual**: recurring  
   *Example* Because it must operate 24 hours per day, the electric motor was designed for continuous duty.  
   *Example* Although it operated much of the time, the motor was plagued by continual overheating.

4. **Datum**: single piece of information  
   **Data**: multiple pieces of information  
   *Example* Last night, we added another datum to our temperature log book.  
   *Example* These data indicate that over the past century, the average night-time temperature has increased by 1°F.

Note: Some style manuals treat *data* as a collective noun. In this case, the following sentence would be accepted:  
   *Example* The data indicates that over the past century, the average night-time temperature has increased by 1°F.

5. **Fewer**: used with integers  
   **Less**: used with real numbers or things that cannot be counted (e.g., love)  
   *Example* Because we sold fewer automobiles, our company had less income last month.

6. **Farther**: greater physical distance  
   **Further**: to a greater degree or extent  
   *Example* The sun is farther away from the earth than the moon.  
   *Example* Further investigation showed that the engineer was unqualified to sign the construction documents.

7. **i.e.**: abbreviation of Latin *id est* (that is to say)  
   **e.g.**: abbreviation of Latin *exempli gratia* (for example)  
   *Example* Engineers are better lovers; i.e., they have fewer divorces than many other professionals.  
   *Example* A mechanical engineer must take technical courses (e.g., heat transfer, fluid flow, design).

Note: A comma always follows *i.e.* or *e.g.*

8. **Principle** (n.): a rule, law, or code of conduct  
   **Principal** (adj.): most important  
   **Principal** (n.): leader, head, person in authority  
   *Example* KISS (Keep It Simple, Stupid) is a basic engineering principle.  
   *Example* John is the principal investigator for the project.  
   *Example* Due to her misbehavior, Joyce was sent to see the principal.

9. **It’s**: contraction of *it is*  
   **Its**: possessive of *it*
Example  It’s raining outside.
Example  Its engine overheated.

10. **There**: that place
    **Their**: relating to them
    **They’re**: contraction of they are

    Example  There is the wrench.
    Example  Their wrench is on the ground.
    Example  They’re going outside and taking the wrench.

11. **That**: First word of a phrase that is essential for meaning.
    **Which**: First word of a phrase that is not essential for meaning. (If adding “by the way” makes sense, use which.)

    Example  Of the tools that are carried on a sailboat, the screwdriver is needed most.
    Example  The screwdriver, which can also open cans of paint, is needed to tighten loose screws.

12. **Lose**: to misplace
    **Loose**: not tight

    Example  Do not lose that screw or we will have to find another.
    Example  That screw is loose.

13. **Since**: from a time in the past until now
    **Because**: for the reason that

    Example  Since the first hominid made a tool, humankind has had engineers.
    Incorrect  Since the heating element failed, the oven could no longer maintain the desired temperature.
    Correct  Because the heating element failed, the oven could no longer maintain the desired temperature.

    (Note: This rule is not always rigidly enforced as some style manuals allow since to be used in place of because.)

14. **While**: during the time that
    **Whereas**: although

    Correct  While studying for the exam, Fred suddenly became hungry.
    Incorrect  Cargo planes are used to carry things, while passenger planes are used to carry people.
    Correct  Cargo planes are used to carry things, whereas passenger planes are used to carry people.

    (Note: This rule is not always rigidly enforced as some style manuals allow while to be substituted for whereas.)

15. **Respectively**: in the order given
    **Respectfully**: showing respect
Experiments 1, 2, and 3 were performed on Tuesday, Thursday, and Friday, respectively.

Example Respectfully, I disagree with your conclusion.

6.3.7 Equations and Numbers

To aid understanding, separate equations from the text line, as follows:

\[ F = \frac{Q \rho}{A} \]

Notice that the numerator is written above the denominator. Although this equation could have been written \( F = Q \rho / A \), this should be done only if the equation is incorporated into the text line.

Properly used italics can help clarify mathematical symbols. The following table shows when italics should, and should not, be used.

<table>
<thead>
<tr>
<th>Italics</th>
<th>No Italics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latin letters (a, A, b, B, etc.)</td>
<td>Greek letters (( \alpha ), ( \beta ), ( \gamma ), etc.)</td>
</tr>
<tr>
<td>Abbreviations (e.g., LMTD)</td>
<td>Abbreviations (e.g., LMTD)</td>
</tr>
<tr>
<td>Units (lb, gal, mL)</td>
<td>Numbers</td>
</tr>
<tr>
<td>Numbers</td>
<td>Words</td>
</tr>
<tr>
<td>Mathematical functions (e.g., sin, cos)</td>
<td>Mathematical functions (e.g., sin, cos)</td>
</tr>
<tr>
<td>Chemical formulas (e.g., NaCl)</td>
<td>Chemical formulas (e.g., NaCl)</td>
</tr>
<tr>
<td>Parentheses ( ) and brackets [ ]</td>
<td>Parentheses ( ) and brackets [ ]</td>
</tr>
</tbody>
</table>

Consult Chapter 13 on the SI system for more rules on units.

For decimal numbers less than one, use a leading zero.

Incorrect  .756  
Correct    0.756

In technical writing, a common dilemma is whether to report the Arabic number, or spell it out. To address this dilemma, consult the following table:

<table>
<thead>
<tr>
<th>Arabic Numbers</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>With units of measure</td>
<td>The reaction takes 4 min.</td>
</tr>
<tr>
<td></td>
<td>The mass is 5 g.</td>
</tr>
<tr>
<td>In mathematical or technical contexts</td>
<td>The voltage is 3 orders of magnitude greater.</td>
</tr>
<tr>
<td></td>
<td>The velocity increased by 2 fold.</td>
</tr>
<tr>
<td>For items and sections</td>
<td>Use Wrench 3 to tighten the pipe.</td>
</tr>
<tr>
<td></td>
<td>Section 7 shows a cross-sectional view.</td>
</tr>
<tr>
<td>For numbered objects (e.g., tables, figures, experiments)</td>
<td>Use the data from Experiment 3.</td>
</tr>
<tr>
<td></td>
<td>Refer to Figure 4 to see the correlation.</td>
</tr>
<tr>
<td></td>
<td>Table 2 shows the chemical formulas.</td>
</tr>
<tr>
<td></td>
<td>The tests involved 3, 8, or 15 subjects.</td>
</tr>
<tr>
<td>For all numbers in a series, even if some numbers normally would be spelled out</td>
<td>That is the 11th explosion this year.</td>
</tr>
</tbody>
</table>
6.3.8 Subject/Verb Agreement

A common error in technical writing occurs when subjects and verbs do not agree.

Incorrect  The telescope and associated hardware is the major tool of astronomers.
Correct   The telescope and associated hardware are the major tools of astronomers.

The following table shows the conventions for subject/verb agreement:

<table>
<thead>
<tr>
<th>Plural</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound subjects (joined by and)</td>
<td>Cattle and goats are ruminant animals.</td>
</tr>
<tr>
<td>Either/or and neither/nor constructions with plural nouns</td>
<td>Either scientists or engineers are going to fly on the space shuttle.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Singular</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound subjects that appear as a single unit</td>
<td>Research and development is the main activity.</td>
</tr>
<tr>
<td>Subjects modified by each or every</td>
<td>Each nut and screw is made of titanium.</td>
</tr>
<tr>
<td>When the subject is one of the following pronouns: each, either, neither, one, anybody, somebody</td>
<td>Neither of the animals is alive.</td>
</tr>
<tr>
<td>Collective nouns</td>
<td>The engineering staff is getting a raise.</td>
</tr>
<tr>
<td>Units of measure</td>
<td>To the beaker, 5 g of salt is added.</td>
</tr>
<tr>
<td>Either/or and neither/nor constructions with plural nouns</td>
<td>Either a scientist or an engineer is going to fly on the space shuttle.</td>
</tr>
<tr>
<td>Noun clauses that are subjects</td>
<td>What the schools need is donations.</td>
</tr>
</tbody>
</table>

6.3.9 Miscellaneous Issues

1. Verb tense. In technical writing, the present tense is preferred. Use past tense only for those things that you did in the past. Consider the following examples:

Present  The correlation in Figure 3 shows that machining cost increases with smaller tolerances.
Past    The flask was cleaned with chromic acid.

2. First person. In formal writing, use of the first person is discouraged.

Informal  We studied the combustion of methane.
Formal    The combustion of methane was studied.
However, avoiding first person often prevents use of the active voice, so some style manuals allow use of first person, even in formal writing.

3. **Capitalization.** Only proper nouns are capitalized.

   *Incorrect* I want to become a Mechanical Engineer.
   
   *Correct* I want to become a mechanical engineer.

   *Incorrect* To learn more about this field, visit the mechanical engineering department.
   
   *Correct* To learn more about this field, visit the Mechanical Engineering Department.

   *Incorrect* As a new hire, you are required to visit the President of the company.
   
   *Correct* As a new hire, you are required to visit the president of the company.

   *Incorrect* Our new leader is president James Garland.
   
   *Correct* Our new leader is President James Garland.

Naming a common noun transforms it into a proper noun. Study the following examples:

*Example* This procedure has five steps.

*Example* In this new procedure, Step 1 should be altered.

*Example* John is so efficient, he completed four experiments in a single day.

*Example* The most interesting results were reported in Experiment 3.

*Example* The reactor has 10 valves.

*Example* Cooling water is introduced by opening Valve C.

4. **Italics.** Italics are used for foreign words employed in English sentences, scientific names of organisms, defined words, and names of long publications. (Books and journals are italicized; articles have quotation marks.)

   *Example* Well, as they say in France, *vive la différence*.

   *Example* Her intestinal problems were caused by a new strain of *E. coli*.

   *Example* A *heptagon* is a seven-sided figure.

   *Example* Ed was elated when his article was accepted in the prestigious journal *Science*.

5. **Articles.** *The* is used for a specific noun.

   *Example* The plane was overloaded when it took off, so it crashed.

*A* is used for an unspecified noun starting with a consonant sound.

   *Example* If a plane is overloaded when it takes off, it will crash.

*An* is used for an unspecified noun starting with a vowel sound.

   *Examples* an ulcer an unicorn

   an RSVP a rebel

   an hour a human

6. **Figures and Tables.** Figures and tables must be described and referenced in the text. Place the figure or table just after the first reference to it.

   *Example* On the next page, Figure 1 shows that costs increase exponentially with tighter tolerances.
7. **Lists.** Start lists with simple items and proceed to the more complex items.

   *Example*  
   Rosa owns the following vehicles: a bicycle, a motor scooter, and a red Mercedes with a sunroof.

8. **Spelling.** Use a dictionary to check your spelling. Word processors can check spelling, but they are not perfect. Consider the following sentence from a student’s report:

   *Example*  
   All computer engineering students take curses in electrical circuits.

9. **References.** Each publication has its own standards for citing references. Below are some examples:

   *Example*  

   *Example*  

10. **Consistency.** Sometimes, grammatical rules are unclear or arbitrary. In these cases, choose what you think is best and be consistent throughout your document.

### 6.4 **SUMMARY**

Mastering engineering communications is essential. Not only will it help your career, but it could also avert disaster. Imagine the possible consequences of a poorly written operating manual for a nuclear power plant.

Before you start writing or preparing your speech, you must select a topic, conduct research, and organize your thoughts. When organizing, remember that the overwhelming consideration is, “Know your audience.” Regardless of whether you are communicating orally or in writing, the communication will have an introduction, a body, and a conclusion.

For a speech, you must provide visual aids to help convey your ideas. The key is for the visual aids to communicate rapidly so the audience can focus on what you are saying; they cannot decipher a complex slide and listen to you talk at the same time. Because graphical images are more rapidly processed by the audience, convey your thoughts graphically, if possible, rather than with written text. In oral presentations, words convey only a small part of your message; body language and voice strain convey the majority of the information.

In technical writing, the goals are accuracy, brevity, clarity, and ease of understanding. With these goals, you are fortunate to be able to communicate in English. The English language has more words than any other language in the world, allowing those who master it to convey subtle shades of meaning. As with any language, there are numerous rules and conventions that mark good writing. Those who ignore these rules send out the message that they are sloppy thinkers. If an engineering report is written poorly, the reader could logically conclude that an author who cannot master the rules of English probably cannot master technology either, a conclusion that invalidates the whole report.
Further Readings


**PROBLEMS**

6.1 Edit the following sentences to improve the grammar and style.

(a) The CIA has spies.

(b) High temperature adversely effects metal strength.

(c) Some plant species (i.e. Drosera, Sarracenia, and Utricularia) are carnivorous.

(d) This data indicates that our reactor will blow up in 9.0 seconds.

(e) You just violated a fundamental economic principal.

(f) Please check the companies records to determine when the shipment was made.

(g) The bird sang it’s song.

(h) We have the following precious metals in our safe; gold, silver, and platinum.

(i) 7 cars are in the parking lot.

(j) We just received fifty five dollar bills from the bank.

(k) We need a variable speed pump for this application.

(l) He drives a red four door car.

(m) In the past the chemical industry was based on acetylene not ethylene.

(n) The accountant, the lawyer, engineer, and physician are all professionals.

(o) Larry worked for Ford and General Motors. They gave him a raise.

(p) Open the back panel. Loosen the screw. Turn the screw counterclockwise. Use a Phillips screwdriver.

(q) During our evening watch, a shooting star was observed.

(r) The indicator showed the car was going 55 mph.

(s) From the point of view of John, this project will fail.

(t) By means of a survey, the industrial engineer improved worker efficiency.

(u) We stuck these numbers into Einstein’s formula.

(v) Subsequent to that, we initiated a program to determine which personnel could be terminated in their current job function and utilized in alternate job functions.

(w) We used a jointly-developed computer program.

(x) Here, you must use a 6 in wrench.

(y) Julius has always wanted to be an Electrical Engineer.

(z) Affirming your urgency, the parts will be sent by express mail.

(aa) Diligent study being the main factor in a student’s success.

(bb) In college, Mary excelled in thermodynamics, therefore, she designs jet engines as a practicing engineer.

(cc) Because of the strike, we produced less computers last month.

(dd) Of the subjects which George took in school, he found thermodynamics to be most useful.

(ee) Since the bolt was too large, it would not fit in the hole.

(ff) Petroleum engineers are responsible for finding and producing oil while chemical engineers refine oil into a variety of products.

(gg) Its mass is .789 kg.

(hh) In the circuit shown in figure 1, resistor A is a variable resistor.

(ii) Larry found the following items in his backpack: a calculus book with torn pages, a ruler, and a calculator.

6.2 A basic principle of effective writing is to eliminate unnecessary words. The following writing samples were taken from student papers. Edit them to reduce the number of words. Also, correct grammatical problems if you find them.

(a) A low circulation rate will reduce the load on the cyclone and decrease catalyst attrition. This can lead to much greater catalyst retention.

(b) At at temperature of 400°F, the sulfur is very viscous. This can be a problem in the first condenser, causing clogging of the tubes.
(c) After extended exposure, the catalyst accumulates coke deposits, and if left untreated, becomes deactivated. In the process, catalyst with some coke deposits is withdrawn from the reactor and sent to the continuous catalyst regenerator.

(d) The accelerators used presently are linear accelerators and cyclotrons. Linear accelerators and cyclotrons are fixed-target accelerators. These types of accelerators use a single particle accelerated at a fixed target.

(e) The coils are arranged along the walls and roof of the combustion chamber. In the combustion chamber, heat is primarily transferred by radiation.

(f) This ammonia plant is currently producing an ammonia product. It could, however, be producing more product at less cost.

(g) The more “bioballs” that are in the filter, the more effective filtration is, therefore, the biological filtration section is the largest in the filter bed.

(h) Though this device will work equally well when measuring the pressure of a gas or a liquid, matter in the liquid state will be assumed in the following discussion.

(i) There are two broad areas of Statistical Process Control; the first deals with the application of statistical techniques to the monitoring and control of industrial processes and the second deals with the inspection and acceptance of incoming material, finished product and product in progress.

(j) The measurement of the pressure in the line would be proportional to the expansion of the balloon.

(k) The third sensor discussed was a sensor involving a pipe connecting the feed line to a propeller, which, in turn, was connected to a shaft in an isobaric chamber.

(l) Hooke’s law is generally applied to mechanical systems involving springs, and it states that the force exerted by the spring is directly proportional to the length it is compressed.

(m) During this time, the pressure of the hydrogen must be maintained at the proper pressure in order to avoid any possible mishaps. A sensor device located in this pipe to measure the pressure would ensure the maintaining of a suitable pressure. This pressure sensor would send an electrical signal to the process control computer.

(n) Mechanical engineers have many possible routes to take with their careers.

(o) While working they will be asked to do several kinds of jobs. They may be asked to work in design and analysis areas.

(p) To most people, aerospace engineering is thought to be working on space ships. The job of an aerospace engineer is much more than that.

(q) Computer aided engineering is affecting the entire profession because with the use of computers it is taking less time to design and correct a problem, and it is more accurate than doing everything by hand.

(r) During the student’s senior year, the student focuses on their directed and technical electives, which allows them to choose a specialization in the aerospace field. These specializations include aerodynamics and fluid mechanics, structures and materials, dynamics, control and flight mechanics, and propulsion.

(s) Operations in the biomedical engineering field is the supervision of the use of technology in the medical environment. Most of this type of biomedical engineering is called “clinical engineering”.

(t) The environmentally acceptable future will not be achieved without an increase in the use of nuclear engineering. There are many parts to this specific type of engineering. Nuclear engineers work in the medical field, with food safety and supply, a wide range of industrial applications, and creating energy.