EFFECTIVE TECHNICAL WRITING IN THE INFORMATION AGE

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Effective Technical Writing in the Information Age

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CHAPTER OVERVIEW

1: Improving Your Style

1.1: Introduction

Writing is easy. All you do is stare at a blank sheet of paper until drops of blood form on your forehead. - Gene Fowler

Suppose you have never believed that you are a good writer, and you seriously doubt that you can improve your style. Or supposed you have a draft ready but you just don't find it highly readable or interesting, and you know you must take it clearer and livelier somehow. Or supposed you are tempted to fall back on the idea that grades given to papers are purely subjective, having little foundation in anything but your picky old professor's pet peeves. If you find yourself huddling anywhere beneath this umbrella, then this chapter is for you.

Many student writers oversimplify the issue of style, defining it by the yardstick of whether their professor "likes" the way something is written. But let's be honest here: a good paper grader's subjectivity is guided by professional experience and concern for quality rather than by whim or personal taste. The frustrated professor who writes "Get your commas right!" or "Where is your grammar?" is clearly commenting on non-subjective problems of mechanics and grammar in your paper. That same professor may also write "Unclear" or "What?" or "Too many passives"—an indication that style is about more than correct grammar and perfect mechanics. A grammatically sound, well-punctuated sentence might be utterly unclear, while a sentence might be written clearly but without following basic grammatical principles. As writing teachers will tell you, the best stylists don't compose by following static rules of grammar; they are readers, thinkers, revisers, tinkerers—they see their writing as a craft, retreating to rules only to find sound pathways to revision.

This chapter is devoted to helping you improve your style. You will find discussion of the basics of grammar, topic sentences, paragraphs, using word lists, lessons on the stylistic conventions of technical writing, and links to websites with helpful stylistic exercises. Amidst these discussions, you should also detect a tonal undercurrent of style as creativity, style as grace. In a nutshell, this chapter helps you revise your work with an eye for correctness, clarity, and elegance—the key to improving your style.

Self-Study

For tutorials and guidance on grammar and improving your style, I highly recommend the lessons, exercises, and instructions at the following addresses:

"Grammar Guides" at australianhelp.com

"Guide to Grammar and Writing" webpage from Capital Community College

"The Communication Circle" webpage

1.2: A Strategy for Revising- Concision, Precision, Revision

Professors who care about writing will always make a strong plea for concision, precision, and revision (CPR). After college, the probability that your writing will be read is inversely proportional to its length and clarity. In the workplace, good writers are rapidly noticed and usually land in management positions; in academia, good writers eventually earn publication, and the best of these writers actually gain a readership who follows their work.

By applying CPR to whatever you write, you will reap maximum benefits. Some advice from *The Elements of Style*, by Strunk and White, drives the point home beautifully:

> *A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts.*

This sentence is important because it affirms that writing has utility—it performs a function. The sentence also demonstrates that, like a well-drawn photograph or a well-designed machine, a good sentence has stylistic elegance. Many good writers have memorized the above sentence and consciously apply it to their writing. You should too.

With the advice from Strunk and White in mind, read the poorly written paragraph that follows:

> *Increasing foreign competition and technological change, in a variety of forms, are now, as they always have been, disrupting various well-established patterns in terms of industrial organization. An apparent growing quality in the upward movement of economic change is also causing geographers' interest in regional adjustment problems to grow as well: problems that often focus concern on regional economic decline in a context of low rates of national productivity improvement, on loss of international competitiveness in sectors such as automobiles and primary metals.*

Perhaps we can sort out the meaning of this paragraph if we work hard enough, but why bother? The paragraph is simply not designed to communicate its message clearly; the writer seems to be more concerned with supplying text-based zones of terminology than with clearly analyzing a trend. This paragraph exemplifies the kind of obtuse writing that appears in the sciences, even in print, regularly. But let us improve this paragraph by applying principles of concision, precision, and revision.

Concision

We can begin by cutting the needless and virtually meaningless words from the first few sentences in the example paragraph above —words including "in a variety of forms," "as they always have been," "various," and "in terms of." These words are needless because their meaning is already understood in context by the thinking reader. If trends "always have been," for instance, the reader does not need to have their ongoing existence emphasized. By definition, "well-established patterns" would obviously be "various"; therefore we can strike the modifier "various" as unnecessary.

By beginning with concision, we strip away what is needless before we attempt actual revision. Our task of effective tinkering thus becomes much easier.

Precision

Next, more precision can be created in those phrases that are the least exact in their meaning—for example, "an apparent growing quality." Most importantly, we must find a way to make the meaning of the final sentence of the paragraph more precise. In its original form, that sentence is over 50 words long and includes 10 prepositions. Note also the imprecise clusters of nouns in this sentence, including "problems that often focus concern on regional economic decline" and "a context of low rates of national productivity improvement, on loss of international competitiveness." It is extremely difficult to fit such mouthfuls into the sentence's context.

Overall, the key to making the paragraph's meaning more precise is to choose clear, meaningful, representative nouns (e.g., "regional economic decline"), place them at the head of each sentence, and follow them with verbs that describe each noun's meaning in the sentence. As a rule, readers rely on one manageable noun, rather than several lengthy noun clusters, to carry the weight of a sentence's meaning.

Revision

After stripping away the needless words and phrases and refining the meaning of the nouns and verbs, we are poised to revise the sentence and improve its style. We can now begin to provide clearer connections from one sentence to the next via simple, standard transition words and thoughtful repetition of key terms. In the revision process, we can also begin to recognize how transitions as simple as "recently," "this," and "also" provide connective tissue, and how effective repetition of the key terms "decline" and "change" can bolster the reader's understanding of the material.

Here is a revised version of the paragraph after CPR.

> *Recently, increasing foreign competition and technological change have disrupted well-established patterns of industrial organization. This acceleration in economic change has heightened geographers' interest in regional adjustment problems, drawing attention to regional economic decline in such sectors as automobiles and primary metals. Regional economic decline often manifests itself through low rates of national productivity improvement and a loss of international competitiveness.*

Now the paragraph's intended topic (regional economic decline) is much clearer, and each sentence's meaning is clearly designed to relate to the sentence next to it. In a word, the paragraph is now designed to be graceful; before revision, it was at best untidy, at worst unfathomable.

Further Training in CPR

To further your skills in concision, precision, and revision, I strongly suggest two texts by Joseph Williams: *Style: Lessons in Clarity and Grace* and *Style: Toward Clarity and Grace*. The former sells for about $40 and includes writing exercises, while the latter retails for about $11. Both books are popular for their practicality and clarity, and because the author so effectively practices what he preaches. Applying the lessons you will learn from these books, you cannot help but improve your style.

Also, I urge you to buy *The Elements of Style*, by Strunk and White, which I originally referenced at the head of this section. The book is easy to use and can be read in just a few hours. Most bookstores sell it for about ten bucks, and if there's one style handbook that most of your professors probably have, this is it. Scientists and engineers recommend and use this book, because it covers the elements of good writing with concision and precision. I highly recommend that you spend a few dollars and purchase the print version. Your readers will be grateful.

Self-Study

You can visit an early version of *The Elements of Style*, by Strunk, for free at the following web page:

"Elements of Style" webpage from bartleby.com

1.3: Writing Paragraphs That Flow

The best stylists are those whose writing can be read fluidly, and they compose so that their paragraphs are manageable in size and unambiguous in meaning. Stylistically, paragraph flow is usually accomplished by concrete topic sentences and smooth logical connections among ideas. Within paragraphs, writers connect ideas and foster coherence by exploiting the four methods described below. Those words highlighted in color help to establish the connections between sentences.

- Link the subjects of juxtaposed sentences.

  To heat the sample, tungsten-halogen lamps are used below and above the fused silica tube. These lamps contain a tungsten filament and bromide gas inside a quartz bulb. By resistive heating alone, the lamps can attain temperatures of 300 °C to 400 °C.

- Link the end of one sentence to the beginning of the next sentence.

  The film is not completely oriented in a single direction, and the system includes a number of entanglements. These entanglements become frozen into position as the film crystallizes.

- Link sentences through implicit similarity, repetition, contrast, or causality.

  When a subject views an object initially as a circle, that image becomes imprinted on the brain. Even when the eye and brain can distinguish an ellipse from the circle, memory tricks the subject into seeing a circle.

  The addition of oxygen promotes soot formation, particularly at low temperatures. On the other hand, oxygen also removes aromatic rings and active intermediates by oxidation, thus suppressing soot formation at high oxygen concentrations.

  Because the wire is flexible, the sonde can rely on its own weight to pull it down the hole, essentially doing a free fall. Therefore, the sonde tends to get stuck easily in highly deviated holes.

- Establish a particular order and then follow through with that order.

  Norris describes three forms of exit morphology. In the first form, development has spread to both sides of the intersecting road, but is still limited to one side of the interstate. In the second form, development exists on both sides of the highway. In the third form, which Norris labels full development, services are located along both sides of the intersecting roads and along ancillary feeder roads.

Of course there are other ways of linking sentences, such as by time, and the preceding four methods are not meant to suggest that writing a sound paragraph is a purely mechanical act—a matter of just plugging in transition words or giving juxtaposed sentences similar subjects. But well-written paragraphs tend to rely on the four methods detailed above, and writers consciously used these methods to be certain they're communicating clearly. As you write and revise your paragraphs, especially when you sense that flow is needed, look for opportunities to exploit the above methods judiciously and you will be improving your style.

1.4: Topic Sentences

Most paragraphs, especially in technical fields, rely on solid topic sentences to convey their meaning clearly. Remember that topic sentences come in many forms and need not be the first sentences in paragraphs. However, if you have a paragraph that must be tidied up or you are composing a paragraph from scratch, offering a clear topic sentence as your opening statement is a good way to begin.

In technical writing, topic sentences take a number of forms. They often simply provide a general statement for the paragraph to support:

> *The role of coal in the hydrology of strip mines receives little attention in the literature. Most groundwater analyses of potential or current strip mines are simply concerned with . . .*

Sometimes topic sentences simply kick off a list of examples:

> *There are obvious advantages associated with the real-time information that a measurement-while-drilling system supplies. The first advantage is . . .*

Other topic sentences supply background or announce scenarios:

> *Ceramic tubes are now being used in the most aggressive environments. In industry . . .*

Some topic sentences combine the listing of examples and background material:

> *Three points about the geologic activity of wind and the development of landscapes in dry lands are relevant here. First . . .*

A simple, straightforward topic sentence is usually the best way to introduce general background, examples, scenarios, arguments, or even to establish a direct linkage to the preceding paragraph. Good writers use concrete and efficient topic sentences to control and unify their paragraphs. If you make it a practice to use the topic sentence as a tool to organize your thoughts, your paragraph content will fall into place more readily.

Self-Study

For more on topic sentences and some excellent practice exercises, visit the following sites:

"Practice in Composing Topic Sentences" page from about.com

"Tutorial on Topic and Topic Sentences" page from Cerritos College

1.5: Subject / Very Agreement

By far, the stylistic error I encounter most frequently as a writing teacher and editor is subject/verb agreement. As you already know, you have to be sure that paired subjects and verbs "go together" grammatically. What this usually means (especially when you write in present tense) is that if a subject is singular its accompanying verb gets an "s" added to it, but if the subject is plural the verb requires no "s" (i.e., "the material ages" and "the materials age" are both correct). Simple, right? Your ear confirms the subject/verb agreement for you. For many writers, though, confusion arises when the subject and verb are distanced from each other in the sentence. Consider this incorrect example:

> *The material applied to the blades of wind turbines age rapidly in tests.*

Do you see the problem? The word "age" should be "ages" in order to be compatible with the sentence's subject—"the material"—but since "age" is right next to the plural "turbines" it is easy to get the sentence grammar wrong.

In a case such as this, the path to achieving perfect subject/verb agreement is to dissect the sentence mentally to determine which noun or pronoun goes with which verb. You cannot always trust your ear, especially when the word you are using is a word such as "everybody," "everyone," or "one" (all of which are singular). Also, even though "United States" or "NASA" might sound to you as though it is plural, the United States is considered to be one country, and NASA (like other organizations or corporations) is one entity (i.e., "NASA redesigned its o-rings" is correct while "NASA redesigned their o-rings" is not). In contrast, a sentence subject that includes an "and" as part of the subject (e.g., "Rising productivity and long-range profit . . .") is typically a plural subject, and therefore a verb that goes with a plural subject (e.g., "are," "reveal") must be chosen.

A simple way to check whether your subjects and verbs are compatible is to supply a mental "they" for a plural subject and a mental "it" for a singular subject. (Grammatically, the phrase "The speed of the downdrafts was intense" is the same as "It was intense"; the phrase "Two of the variables are incorrect" is the same as "They are incorrect"). The longer or more complex your sentences are, the more likely you are to have to apply a mental test to your subject/verb agreement at times.

Especially if you find that you are having consistent subject/verb agreement problems, you must make it a habit to do the following:

- Identify the subjects and verbs of your sentences, putting aside the other elements of the sentence momentarily.
- Test the subjects and verbs for compatibility, if necessary by mentally supplying "they" for plural subjects and "it" for singular subjects.
- Remember that a sentence subject that includes an "and" is typically a plural and will therefore need a verb that agrees with a plural.
- If the meaning or grammar of the sentence is unclear, revise so that the subject and verb are closer together in the sentence. Thus, the sentence grammar will be simplified both for you and your reader.

Self-Study

To further test and polish your grammatical skills, try out the quizzes at the following sites:

Quiz on subject/verb agreement from Capital Community College

Fill-in-the-blank subject/verb agreement quiz from the City University of Hong Kong

1.6: Special Cases in Subject Verb Agreement

Part of why subject/verb agreement errors are so numerous is because of the "special cases" that often arise in English, e.g., when words including "everyone," "some," and "none" are part of the subject. Use the principles that follow to guide you through these special cases.

- Remember that the names of organizations and words such as "everyone," anyone," "each"—i.e., words that ask us to consider something one member at a time rather than collectively—are singular.

  Each of the student leaders agrees that . . .

  Anyone associated with the DEP understands that . . .

- When subjects are connected by the word "or," the subject closer to the verb determines its number.

  Either the pebbles or the sand is . . .

  Either the sand or the pebbles are . . .

- When "some," "all," or "none" are part of the sentence subject, the number of the verb matches the number of the noun to which "some," "all," or "none" refers. Note below how the subject ("sample," "samples," etc.) controls the number of the verb.

  Some of the sample is contaminated.

  Some of the samples are refrigerated.

  All of the bone is intact.

  All of his bones are broken.

  None of the ground is disturbed.

  None of the grounds are mowed.

- Although "and" in the subject usually indicates a plural, there are cases where the context is obviously singular, thus requiring a singular noun.

  Further research and development on fuel cells is necessary for them to achieve their potential as energy storage devices.

  Supply and demand is used to determine the equilibrium values of price and quantity.

- Nouns that are "collective" (automatically suggesting a group) take a plural verb when the group as a whole is meant; they take a singular verb when the group can be thought of as individual members. Commonly used collective nouns include "number," "majority," "series," and "variety." Note that when collective nouns refer to a singular group as a whole they are often preceded by the word "a"; when they suggest individual group members they are often preceded by the word "the."

  A number of people were affected by the tragedy.

  The number of samples contaminated was two.

  A series of western blots were performed to assay protein expression.

  The series of western analyses was found to be inconclusive.

- Units of measure are treated as collective nouns, taking a singular verb.

  For each patient, 10 mL of whole blood was collected in a clot tube.

- "Data" can be treated as a singular or plural noun, depending on whether the word refers to a collection of data as one unit or whether individual results are implied.

  Once the data is collected, the results can be tabulated.

  When data for 2007 and 2008 were compared, the researchers found that violent crime in the city had dropped by 12 percent.

1.7: Tricky Singular Plural Pairs

SINGULAR	PLURAL
alga	algae
appendix	appendixes or appendices
axis	axes
crisis	crises
criterion	criteria
curriculum	curriculums or curricula
formula	formulas or formulae
fungus	fungi
hypothesis	hypotheses
locus	loci
medium	media
nucleus	nuclei
phenomenon	phenomena
radius	radii
retina	retinas or retinae
spectrum	spectra
stimulus	stimuli
stratum	strata
thesis	theses

Be certain to use the correct form of these nouns, and be sure that the related verbs are compatible with the noun's status as singular or plural. Even though they may automatically sound wrong to your ear, the sentences below are all correct, with the subjects and verbs compatible in grammar.

The emission spectra of the bodies peak in the infrared.

The media are highly influential in shaping public opinion.

A stratum of sand was struck as they dug the well.

The radii of error spheres are more difficult to determine than the centers.

1.8: Verb Tense

Especially for those in technical fields, who typically write scientific reports and coordinate their own research findings with those of other researchers, decisions about the proper verb tense to use in a given situation can be befuddling. A quote by Groucho Marx is instructive here, as Groucho once quipped: "I have had a perfectly wonderful evening, but this wasn't it." Because Groucho employs the perfect tense here (using "have had," which suggests both present and past), he correctly notes that the wonderful evening could have been on any other night in his life.

The first rule of thumb is to word your sentences in such a way that verb tenses are simple and consistent. The easiest way to simplify context for both yourself and your reader is to use present tense when possible, because it is automatically reader-friendly and readily understood. But there is obviously more to this issue. Read on:

An accepted practice is that scientific truths, facts, and things happening during the reading of a paper can be treated best in present tense.

> *Nickel is generally deposited from sulfate, sulfate-chloride, or sulfamate electrolytes with or without additives.*
>
> *This paper evaluates material deformation in the brittle and ductile regimes.*

Your own findings or experimental procedures, the actual experimental procedures and results of others, and physically past events should usually be treated as simple past tense.

> *A drop of HNO3 was added to bring the distilled water to pH 3.*
>
> *In the 1930s, it was fashionable for scientists to write memos only in the passive voice.*

Future tense (using "will" or "shall" with a verb) is usually reserved for those things not yet completed. This tense is most useful when you want to talk about future events.

> *Copper use will become more sophisticated as new exploration technologies and new extraction techniques develop.*

Finally, the perfect tense (using "has," "have," or "had" as a helping verb) comes in handy when you are writing about a "double time"—that is, when you need to stress that one thing happened before another, or that something began in the past and was continued thereafter.

> *This particular radiometer has been used since 1985.*
>
> *Scientists had argued about the existence of molecules for centuries before it was universally agreed that matter was discrete rather than continuous.*

Contrary to what some writers think, you certainly may switch verb tense within a paragraph (even within a sentence, for that matter); you simply must be certain that the context implied by the verb tense matches the intended meaning.

Self-Study

For some quick tutorials and extensive exercises on verb tense, visit the following websites:

"Verb Tense Tutorial" page from englishpage.com

"Verb Tense Quiz" from eflnet.com

1.9: Using Active Verbs

When composing, we often automatically make lazy choices, especially when choosing verbs. We feel enticed by generic all-purpose verbs such as "deal with" or "show," which on the surface can sound snappy and technical. However, the more these verbs are used in a particular paper, the more meaningless they become. Even in journal articles, these verbs put in a shocking number of appearances and return for many unsolicited encores. Yet these words convey no analytical meaning at all and are barely informational. Much to the reader's frustration, "deal with" and "show" are often merely thinly disguised excuses for much more active analytical verbs such as theorize, suggest, imply, propose. For the reader, "Cheswick dealt with" or "Figure 4 shows" are far less meaningful than "Cheswick hypothesized" or "Figure 4 represents." As always, you should choose exact words in favor of nonspecific ones, especially when you can use an active verb.

In technical writing, learning to deploy active verbs on the page is one of the most obvious and easiest ways to improve your style. Active verbs—whether in present or past tense—are especially meaningful as you describe work that another author or you have completed or are in the process of completing. As a rule, you should try to choose active verbs in the following circumstances:

- As you prepare a literature review, where your job is to describe the work of others in concise, analytical terms.

  Phillip Bennett (2008) proposes a mechanism explaining increased silica solubility in the presence of two small organic acids.

- As you interpret your own experimental work, where your job is to explain observed trends.

  The results of this study challenge findings from similar studies about analyte concentration varying with sample location.

- As you present a thesis or objective statement, where your job is to forecast information that will follow in the paper.

  This study characterizes wetlands by their water chemistry and postulates that water chemistry varies with water source and wetland type.

- As you refer to figures, tables, or equations, where your job is to define the purpose of the figure, table, or equation.

  Figure 4 depicts grain growth that occurred after the ceramic was sintered for three hours.

What follows is a substantial list of active verbs. I assembled this list by scanning journal articles to see how the best authors described their work or the work of others. Each of these words is packed with individual, analytical meaning. When using this list, be sure to choose the best verb for the situation—verbs such as "construct," "challenge," and "extrapolate" are obviously completely different from each other, so you must use them with meaningful care.

Active Verbs That Describe Work and Analytical Thinking

yield	illustrate	illuminate	reveal	employ
mean	suggest	clarify	indicate	represent
prove	insist	propose	imply	assert
postulate	consider	infer	state	extrapolate
estimate	define	classify	invoke	analyze
compare	hypothesize	synthesize	summarize	disagree
generalize	narrate	evaluate	simplify	measure
note	predict	introduce	report	challenge
delineate	depict	construe	interpret	provide
acknowledge	distinguish	inform	specify	restrict
determine	detail	sum up	designate	point out
set forth	deduce	derive	characterize	guide
maintain	believe	speculate	present	orangaize
investigate	assess	determine	calculate	support
devise	construct	evaluate	attribute	obtain
assume	argue	reiterate	discover	decide

1.10: Describing Phenomena with Active Verbs

Which do you prefer—the phrase "to cut or split something into two theoretically and essentially equal parts," or the simple verb "bisect"? Which is easier to write and to read—the phrase "unite into what is essentially one body," or the simple verb "coalesce"? As you explain scientific phenomena, your readers will be highly pleased with you if you offer them lively, exact, direct, robust, vibrant, single-word verbs. Furthermore, your writing will be less wordy and more clear. However, many writers are tempted in the other direction. Trying to sound impressive, some would write "The device is prone to the submission of one pulse every 12 seconds" instead of the much simpler and more accurate "The device transmits one pulse every 12 seconds." Always beware of overcomplicating your verbs, and remember that their function is to describe actively and efficiently.

Many verbs are used continually in one field but rarely in another, so it is essential that you become familiar with those verbs that are standard vocabulary in your field. The verb "induce," which means "to produce an electric current or magnetic effect by induction," should be standard vocabulary for someone in physics or electrical engineering, while the verb "sinter," which means "to weld without melting," should be familiar and useful to those in metallurgy (it also doubles as a noun in geology).

Plenty of meaningful single-word verbs are out there just waiting for you to use them. One easy way to choose the best verb is to consult the brief (and certainly not exhaustive) list that follows to search for the kinds of active verbs that the best writers choose. The verbs are organized randomly to stress that they are not interchangeable nor to be used arbitrarily. Even though the exact verb that you need to describe a phenomenon may not be on this list, the verbs on the list do suggest the kind of verbs that you should choose. Many students tell me they turn to this list as they write a paper just to keep their minds tuned-in to using single-word active verbs. For efficiency, accuracy, and your own credibility as a technical writer, always aim for the best and simplest verb. If you are unsure of a verb’s exact meaning, be sure to look it up.

A Short List of Active Verbs That Describe Phenomena

discharge	overlie	emanate	radiate	scatter
exchange	separate	surround	combine	eliminate
emit	transmit	carry	bombard	exert
exude	interact	behave	exchange	absorb
converge	extend	constrain	force	elongate
contract	trend	plunge	occur	fracture
continue	mix	slow	quicken	produce
bond	interlock	fuse	deteriorate	migrate
encompass	access	traverse	join	dominate
deposit	underlie	overlap	originate	isolate
invade	permeate	evolve	divide	sinter
reclaim	restore	abandon	contain	accrue
precede	influence	saturate	circulate	forecast
orient	distribute	allow	lag	terminate
activate	cease	record	form	transect
condense	enrich	invert	convert	alter
link	superimpose	rotate	rupture	streamline
appear	require	ascend	descend	collapse
superpose	crystallize	bisect	cede	coalesce
disperse	disseminate	disintegrate	propel	repel
accelerate	transfer	penetrate	halt	curb

1.11: The Passive versus Active Voice Dilemma

Teachers actually get fired up about this issue. You may have had a frustrated (and frustrating?) professor write on your paper "Use passive voice!" or "Avoid passive voice!" during your studies, and your grammar checker will be happy to flag and condemn all passive sentences for you. Further, your English textbook might suggest that the active sentence "Jack hit the baseball" is better than the passive sentence "The baseball was hit by Jack." As well-intentioned as they might be, these tidbits of advice don't help much, do they? You are not likely to have anyone named Jack hitting any baseballs in your papers, and obviously *both* passive and active voice are powerful tools in the right hands.

You are probably already able to identify whether or not sentences are written in the passive or active voice, but if not, here is a refresher: In the simplest terms, an active voice sentence is written in the form of "A does B." A passive voice sentence is written in the form of "A is done by B." Both constructions are fine. In fact, notice how the sentences below, depending on the context in which they appear, are equally acceptable:

> *Passive voice: The rate of evaporation is controlled by the size of an opening.*
>
> *Active voice: The size of an opening controls the rate of evaporation.*

The passive choice slightly emphasizes "the rate of evaporation," while the active choice emphasizes "the size of an opening." Simple. So why all the fuss? Because the habit of overusing passive constructions rules too many writers, who habitually produce grammatically tangled sentences such as this one:

> *Groundwater flow is influenced by zones of fracture concentration, as can be recognized by the two model simulations (see Figures 1 and 2), by which one can see . . .*

Forget it. The sentence is becoming a burden for the reader, and probably for the writer too. As often happens, the passive voice here has smothered potential verbs and kicked off a runaway train of prepositions. But the reader's task gets much easier in the revised version below:

> *Two model simulations (Figures 1 and 2) illustrate how zones of fracture concentration influence groundwater flow. These simulations show . . .*

To revise the above, all I did was look for the two buried things (simulations and zones) in the original version that could actually *do* something, and I made the sentence clearly about these two nouns by placing them in front of active verbs. This is the general principle to follow as you compose in the active voice: Place concrete nouns that can perform work in front of active verbs representing the nature of the work done.

But suppose you are writing a report where you may not use "I", or you are writing about a sentence subject that can not actually *do* anything. What to do when the passive voice is the best, most natural choice?

The answer lies in writing direct sentences—in passive voice—that have simple subjects and verbs. Compare the two sentences below:

> *Photomicrographs were taken to facilitate easy comparison of the samples.*
>
> *Easy comparison of the samples was facilitated by the taking of photomicrographs.*

Both sentences are written in the passive voice, but for most ears the first sentence is more direct and understandable, and therefore preferable. Depending on the context, it does a clearer job of telling us what was done and why it was done. Especially if this sentence appears in the "Experimental" section of a report (and thus readers already know that the authors of the report took the photomicrographs), the first sentence neatly represents what the authors actually did—took photomicrographs—and why they did it —to facilitate easy comparison.

Note well: Using passive voice does not have to create ambiguity nor complicate wording. When you use the passive voice, seek economy and clarity. Avoid such empty and ambiguous phrases as "it might be thought that" (try "perhaps") or "it is to be supposed that" (try "presumably") or "the theory that is held by the writer of this report at the present time of this writing" (try "It is theorized that") or "one should think of" (try dropping it completely). At times the passive seems unavoidable, but the passive can often be switched to the active with some simple rewording, and *both* the active and the passive voice can be direct, efficient, and clear in context. In your writing, you must strive to use both of them well.

Self-Study

For examples and exercises on passive vs. active voice, check out these websites:

"Choosing between Active and Passive Voice Verbs When Writing" page from Kennesaw State University

Active and passive voice discussion and examples from a professor at Seton Hill University

1.12: When To Use The Active Voice

At least during your undergraduate studies, the nature of your writing assignments generally favors the active voice, because you usually write about general interest topics to educated laypeople and other scientists or engineers in a reader-friendly fashion. In general, a sentence that opens with a concrete simple subject followed by an active verb will serve you well; the rest of the sentence can reveal the new (and often necessarily wordy) information.

Two common circumstances follow where passive voice is too often used, even though active voice is completely practical:

- Generally, use active voice in the topic sentences and the opening sentences of paragraphs—that way the topic for the paragraph is clearly announced:

  Crustal rocks contain an interesting historical record. First, they reveal . . .

  Batteries, inductors, and capacitors provide electrical energy storage. In batteries, high internal resistance allows for . . .

- When referring to another author's work or introducing a figure or table, it is often stylish and interpretive to put the author's name or the figure or table right into the subject of the sentence, then follow it with an active and literally correct verb:

  Feldman explains how the relative brightness of objects depends on the viewer's angle of observation.

  Figure 2 illustrates how fractal geometry can be used to create realistic landscapes.

The following excerpt from a meteorology paper demonstrates how admirable and efficient the active voice can be. This paragraph is especially impressive in that it explains the complex concept of vorticity through an analysis of the seemingly ordinary phenomenon of smoke rings. Note the consistent use of simple exact subjects followed by active descriptive verbs.

> *Figure 4 depicts a smoke ring in which the layers of a toroidal vortex ring are visible. As the picture shows, the smoke ring moves away from its source and trails smoke from its center. The trail of smoke behind the moving smoke ring indicates that the same viscous stress that caused the smoke ring to form also causes its eventual destruction. As the smoke ring continues to move (Figure 5), the outside boundary of the ring rotates toward the same direction as the relative motion of the surrounding air. The inside boundary rotates opposite in direction, and thus the change in relative velocity with distance across the boundary produces drag.*

Clearly, this is a paragraph that the writer toiled over, yet, thanks to the clear transitions and sensible use of the active voice, it is highly readable and efficient. This writer understood well how to marshal active verbs to explain phenomena. Note how, thanks to the active verbs, we can readily picture the described phenomena even without the figures being supplied.

One cautionary note, though: even though you are generally allowed to use "I" (or "we") in papers written largely in the active voice, you must beware of overuse. Simple transition words can represent the writer's thinking just as well as the use of "I." For instance, the word "apparently" can do the same job as "I believe that"; the word "however" is much better than "as I turn to another way of thinking about it." Also, using "I" can be distracting, especially because it might cause you to inject too much personal opinion or irrelevant subjectivity—technical papers are not the place to share digressive speculations or assert your personality. Remember that your focus is on information and your considered interpretation of that information. Strong interpretive verbs and confident, accurate pronouncements automatically suggest that an "I" is at work anyway, so concentrate on choosing simple transitions, concrete nouns, and muscular verbs.

1.13: When To Use The Passive Voice

As a student writer, you will frequently encounter circumstances favoring the passive voice, especially when you prepare technical reports based on labs you have completed. You might even be told never to use "I" or "we" in your papers. The convention of writing scientific reports (especially the "Experimental" section) largely in the passive voice is strong and sensible, and you should not fight it, but know how to work within the boundaries. When used correctly, the passive voice has the desired impact of focusing the reader's and writer's attention on methodology and data generation, and it helps to foster objectivity, universality, and efficiency.

Passive voice, couched within direct sentences containing simple subjects and verbs, is generally preferred in the following circumstances:

- Throughout the "Experimental" section of a scientific report, or anywhere that you must summarize your own or another author's experimental procedure or findings, but the actual inclusion of names would be awkward, distracting, or unconventional:

  Initially, a fractured steel specimen was plated with electroless nickel and secured in an epoxy mount by vacuum impregnation.

  The findings of the November 1997 report to NASA were based on DMTA, DSC, and FTIR test results.

- In formal abstracts (condensed summaries) that introduce papers:

  Sensitivity experiments are reviewed to investigate the influence of Pacific sea surface temperature anomalies on blocking in the Northern Hemisphere.

- When it makes sense to emphasize the receiver of the action rather than the doer:

  The samples should be monitored regularly and should be dried carefully once they are cool.

  Winter wheat is planted in the autumn and ripens in the following spring or summer.

- When emphasis or variety demands it, or when the flow of your paragraph suggests that a passive construction is the most clear choice:

  One facet of multiple phase transformation can be seen through an examination of the gas gathering process. This process . . .

1.14: 1-14- Transition Words

The best stylists become masters at artfully placing transition words in pivotal positions—i.e., places where the sentence or paragraph meaning "shifts" slightly. What follows is a handy list of common transition words and their functions. If you open sentences appropriately with these words it will help your writing to flow. One caveat though: Always keep the literal meaning of a transition word in mind as you use it—therefore, do not use "for example" unless you are introducing an example that links to the preceding information; do not use "nevertheless" unless you are offering a contrasting point. Note how this paragraph has required

a minimal use of transition words; they should not be forced in where they do not belong. When you do use them, keep their broader functions (i.e., "causality," "emphasis," etc.) directly in mind.

Causality	**Emphasis**	**Amplification**
Accordingly	Above all	Again
Consequently	Certainly	Also
For this reason	Clearly	Apparently
Hence	Indeed	Besides
Therefore	In fact	Equally important
Thus	In short	Finally
	Obviously	First, Second, etc.
Intention	Of course	Further
For this purpose		In addition
In order to do this	**Closure**	Moreover
To this end	In conclusion	
With this in mind	In sum	**Detail**
	On the whole	Especially
Location	To summarize	In particular
Beyond		In regard to
Here	**Similarity**	Namely
Nearby	Likewise	Specifically
Opposite	Similarly	To enumerate
Overlying (underlying)		
There	**Time**	**Comparison/Contrast**
To the right (left)	Afterward	However
	At the same time	In contrast
Concession	Before	In relation to
At any rate	Earlier	Nevertheless
At least	Eventually	On the other hand
	In the meantime	Still
Example	Sometimes	
For example	Later	**Interpretation**
For instance	Next	Fortunately
To demonstrate	Preceding this	Interestingly
To illustrate	Simultaneously	Significantly

	Soon	Surprisingly

Self-Study

For more transition word lists, check out these URLs:

"Transitional Words and Phrases" list from the University of Richmond Writing Center

"Transition Words" page from Michigan State University

1.15: Special Stylistic Issues in Technical Writing

To become an effective technical stylist, you must understand some of the key governing conventions. A few stylistic issues emerge as worthy of special attention here, especially since professors can be particularly sensitive to them. See the lessons in this section not as binding restrictions on your style, but as opportunities to understand (and in some cases, debunk) some oft-repeated rules of professional communication. In technical writing, as in chess, it is prudent to wield your creativity only within the rules.

Eliminating Contractions

Contractions—in which an apostrophe is used to "contract" two words into one by joining parts of them—are considered to be informal, conversational expression. In the formal writing that you do for your classes, or as you submit formal work for an editor's or superior's perusal, you simply do not have the option of using contractions unless you are quoting something that contains contractions. If you use contractions in formal writing you may appear sloppy and unprofessional. The safest idea is to avoid them entirely. If you avoid contractions, you will discover that your writing becomes more emphatic and leans toward the active voice, so the benefits are multiple. Remember: in technical writing, apostrophes contracting two words (e.g., "it's," "they've," "who's") signal that the two words can and should be written out separately.

Curbing Feelings and Personification

Of course scientists and engineers have feelings, but use of the word "feelings" or the verb "feel" in technical writing often leads the writer into trouble. Phrases such as "I feel that the best answer is 3.2" or "we feel that this conclusion is correct" can draw large frowns from your readers. "Feel" has emotional connotations, and feelings are not a relevant part of rational conclusions in your writing, at least not on the page. Also, the needless use of the term can lend the appearance of uncertainty, especially when applied to quantities or conclusions as it is above.

A related issue is the use of unintentional personification—i.e., assigning human traits to inanimate objects—in technical writing. In a phrase such as "when the drillstring feels the weight," the seemingly literal claim that an inanimate object such as a drillstring "feels" anything is clearly inaccurate. Similarly, a sentence such as "Boeing stock enjoyed a 2% increase today" could imply that stocks have emotions. Although such a sentence may well appear in the daily newspaper, its tone would not suit a technical paper. In technical writing, avoid unintentional personification, which is always revealed by the verb you use to express a noun's action.

Choosing Gender-Neutral Language

From a stylistic standpoint, one of the best things about the need for writers to choose gender-neutral language is that it forces them to explore the options that have always been available to them. Most students are aware that they should choose gender-neutral language when they write and give oral presentations, but if it just causes them to use "his/her" repeatedly then they are not living up to their obligations to keep their writing highly readable and efficient. Also, writing a sentence such as "Someone should lend their voice to this problem" is still grammatically unacceptable because "someone" is singular and "their" is plural. Most good writers attack the problem in the following ways:

- By simply being more specific or creative about word choice (writing "humans" rather than "man").
- By using plural nouns rather than singular ones when appropriate ("scientists" rather than "a scientist"), or by avoiding gender-specific pronouns ("the author" rather than "he").
- By writing "he or she" (not "he/she") when it is not awkward or overly repetitive to do so.
- By changing some words to other parts of speech, thereby avoiding gender-specific pronouns ("walking" might work better than "he walked" as long as the grammar of the revision is sound).
- By alternating between using "he" and "she" (as I have done in this handbook), especially in longer pieces.

With these tactics in mind, consider the following example:

> *The consumer himself has the power to reduce fuel costs: If he sets his residential thermostat 2 degrees higher in the summer and 2 degrees lower in the winter, he saves energy.*

In a revised version of this sentence, the gender-specific language of the original is avoided:

Consumers have the power to reduce fuel costs: By setting their residential thermostats 2 degrees higher in the summer and 2 degrees lower in the winter, they save energy.

Standard English usage still calls for the masculine form ("he" or "his") to refer correctly to either gender in writing, but rely on this only when you have to. In technical writing, do not let your concern for gender-neutral language cause your usage to be too unconventional ("personhole cover"? "personkind"? "s/he"?); instead, do exercise your options as a writer wisely, and remember that our language is always in flux. Keep your eye on it.

Self-Study

Do you crave more on gender-neutral language? Then pay these academic sites a visit:

"Statement on Gender and Language" from the National Council of Teachers of English

"Gender-neutral Language" article by Dennis Jerz, Seton Hill University

Keeping Jargon in its Place

Jargon, especially that which has grown out of computer usage, genuinely enriches our language, so I do not want to give it a bad rap. (Why not delight, for example, in jargon such as "debug," "flame," and "FUBAR"?) However, many professors and employers criticize the use of jargon (sometimes called "buzzwords" or "gobbledygook"), especially in formal writing, so you must understand how to recognize it and when it is unacceptable.

The forms of jargon range from redundancy ("red in color"), overly formal wordiness (using "at this point in time" rather than "currently"), and specialized technical slang (using "airplane rule" to describe the concept that greater complexity increases the likelihood of failure). Clearly, when jargon takes the form of redundancy and wordiness, simple editing is critical; when jargon becomes specialized slang, we must consider audience and context to decide on how much jargon is appropriate. A hip group of hackers might know that "angry fruit salad" refers to visual design that includes too many colors, but a general, educated audience would not.

When discerning whether to use jargon, employ the following principles:

- When tempted toward a wordy construction or fancy word, elect the simpler wording or word (e.g., "today" rather than "in today's modern society"; "sandy" rather than "arenaceous").
- When you feel jargon is necessary in speaking or writing but your audience members might not understand it, explicitly define the terms you use (as I did in the previous paragraph), or define terms by creating context for them in the sentence.
- Use technical slang, but do not overuse it, in presentations, in conversation with peers, in interviews, in e-mails and memos, and in cover letters, but only when your audience is certain to understand your meaning.

Self-Study

Professional and government organizations are just as concerned about overuse of jargon as your professors are. Check out these sites for tips and an action plan to reduce jargon and communicate more clearly:

"Jargon in Technical Writing" article from the Weed Science Society of America

"National Action Plan to Improve Health Literacy," from the U.S. Department of Health and Human Services

Destroying Dangling Modifiers

Dangling modifiers are a common occurrence in technical writing and are easily overlooked by the writer, who assumes the reader will automatically follow the sentence's meaning. Especially when you use passive voice, it is easy to create dangling modifiers—that is, descriptive words that seem to "dangle off by themselves" because they do not accurately describe the words next to them. Most often, writers dangle modifiers at a sentence's beginning. Grammatically, a group of words preceding a sentence's main subject should directly describe the subject; otherwise, that group of words can become a dangling modifier. The following sentences contain dangling modifiers:

Using an otoscope, her ears were examined for damage.

Determining the initial estimates, results from previous tests were used.

Even though these sentences are understandable, grammatically they are unacceptable, because the first implies that the ears used the otoscope, while the second implies that the results themselves determined the initial estimates. The words that describe a sentence subject must be sensibly related to the subject, and in these two sentences that is not the case. Although here the intended meaning can be discerned with some minimal work, readers often have a hard time sorting out meaning when modifiers are dangled, especially as sentences grow longer.

Revisions of these sentences to avoid dangling modifiers involve changing wording slightly and shuffling sentence parts around so that the meaning is more logical:

Her ears were examined for damage with an otoscope.

Results from previous tests were used to determine the initial estimates.

Particularly when you are writing the "Experimental" section of a technical report, or anytime when you must use the passive voice regularly, take special care to watch out for dangling modifiers. The more frequently dangling modifiers are used, the more likely a sentence's meaning can become obtuse. The result is sentences that may be both unclear and inelegant.

Self-Study

Further reading on dangling modifiers is available from these two university sites:

Exercise on modifier placement from Capital Community College

"Avoiding Misplaced and Dangling Modifiers" article from Towson University

Using "I" and "We"—the First Person

A few years ago, an old dog taught me a new trick. I edited a technical report for a gentleman who works for a government agency and has authored over 200 papers. He was highly respectful of all my editorial suggestions, but corrected me on one. I told him that he was bucking convention by using "we" throughout his report, and that the standard was to avoid using the term in technical writing, just as I had been told by others. He assured me that he had "breezily been getting away with it" for 40 years, and I agreed just as breezily that he should not change his practice after such a winning record. Finally, I came away from our interaction with an important question: Was this scientist-author a maverick, or was he in fact practicing the customary?

To form an answer, I pulled 40 journals at random from one of my university's technical library's shelves. The journals ranged from the international refereed *European Journal of Mineralogy* to the more advertising-driven *Spray Technology and Marketing*. To my surprise, in 32 out of the 40 journals, the authors indeed made liberal use of "I" and "we" (referred to grammatically as "the first person"). In one case (an article in *Water Resources Journal*), the authors used "we" in nearly every paragraph. I realized then that I had been upholding a principle that was either outmoded or at least in flux, without considering the convention in the published literature. A lesson learned.

Nevertheless, addressing the issue here is not as simple as saying "go ahead and use the first person freely." Here are some considered guidelines to follow:

- You can use the first person in an abstract or introduction to stress the foundations of your particular approach, express authorial intentions, or emphasize your scientific convictions:

  In this paper, I argue that . . .

  In contrast to other authors, we conclude that . . .

- When the first person does not suit you or your reader's taste, but you need to be self-referential, consider the common alternatives such as "this author," "this paper." Keep in mind, though, that these options can sound a bit stilted.
- In memos, especially when they involve one-on-one communication between you and one other party, use the first person (and the word "you") as needed, in particular in the introduction and conclusion.
- Use the first person plural ("we") when you wish to include the reader as part of a collective, thinking body:

  We can agree that something must be done about the quality of care in HMO programs.

- Limit your use of the first person so that you do not create circumstances requiring you to use it repeatedly. For example, by convention, avoid using the first person in the "Experimental" section of a technical report—if you begin to use "we" in this section, you would continually have to repeat its use for consistency.
- Be particularly cautious with first-person terms suggesting ownership—e.g., "my" and "our." It would be awkward to write "I connected my patchcord" or "We closed our tank," in that the issue of ownership is irrelevant to the science and interpretation.
- By convention, you may use the first person plural ("we") to introduce equations:

    We can calculate the green densities of the pellets with the equation . . .

Despite what I have outlined above, recognize that some professors and editors will adamantly reject the use of first person pronouns in technical writing. Revise accordingly when needed.

Using "This," "It," and Other Pronouns

Do you want to annoy and confuse your readers? Then paste a paragraph together with "this" or "it" as a connecting word in nearly every sentence. Moreover, do not refer to anything specific with the "this" or "it"—keep the meaning vague. (For the highly literal among you, please note that I have just employed mild sarcasm.) Without realizing it, many writers habitually plant a "this" or "it" wherever they sense that flow is needed. However, they often create confusion by doing so. Most of the time when you use "this" or "it" you are actually referring to a specific noun or verb that is nearby, or to an idea that has just been implied if not explicitly stated. To avoid confusion, one sound practice is to name whatever the "this" refers to immediately after it (i.e., "this phenomenon," "this principle," "this variation"). Note how much clearer the following sentences are because "this assumption" is used rather than just "this" by itself:

The burial by thrusting is believed to occur rapidly. This assumption, however, is difficult to test.

Here, "this assumption" clarifies that a belief is being described rather than the burial by thrusting or its rapid occurrence.

Commonly, "it is" is overused as a sentence beginning. "It is this water that could become . . ." is better written as "This water could become . . . ." When the use of "it" is vague or unnecessary, try to simply eliminate the word.

The same principle described above applies to pronouns such as "that" and "these": Do not overuse them, and when you do be sure that the reader can easily discern the words or ideas being referred to.

Because I decided against making this manual too much of a grammar text, I have only scratched the surface here on the subject of effective pronoun usage (e.g., I have not even touched on the dreaded "who" and "whom" distinction). If you find that you consistently have trouble with pronouns, I recommend further study.

Self-Study

For more guidance on proper pronoun usage, I highly recommend these instructive websites:

Exercises on pronoun/antecedent agreement from D'Youville College's Online Writing Lab

Exercises on pronoun/antecedent agreement from Capital Community College

Writing with Infinitives—to Split or not to Split?

A split infinitive is a phrase in which one or more words are placed between the word "to" and its accompanying verb. "To boldly go" is a split infinitive (a famous one, in fact, even to non-Trekkies) because "boldly" is interrupting the more basic pattern "to go." Split infinitives are pet peeves of many professors (and grammar checkers too), so you must consider how you will handle this issue. Read on:

The grammatical thorn that emerges when infinitives are split essentially has to do with the concept of unit interruption. Our ears (and the "rules" of our language) prefer that certain units not be interrupted. For instance, for many writers, "have worked diligently" is more acceptable than "have diligently worked," in that the verb "have worked" is not interrupted in the first instance. (Also, work in itself cannot be "diligent," per se, and the phrasing "have diligently worked" could imply otherwise.) To dramatize the point further, consider the serious, especially irksome unit interruption that occurs in an incorrect phrase we have all heard: "a whole nother."

Now consider this sentence, which contains a split infinitive:

The plastic contains a catalyst that causes it to completely and naturally disappear in a few months.

In this sentence, some readers would insist that "to" and "disappear" are too far away from each other, in that their grammatical purpose here is to serve as one uninterrupted unit. A revised version of the sentence would bring together the two words in question, thus:

The plastic contains a catalyst that causes it to disappear completely and naturally in a few months.

Now, "completely and naturally" is more obviously describing the intact phrase, "to disappear." As in this case, usually the words that split an infinitive can go outside the infinitive or be omitted altogether.

Nevertheless, split infinitives do appear in writing, and many writers (including me) find them acceptable as long as they are infrequent and that they do not disturb either sense or sound. At times, in fact, split infinitives are the most logical, euphonious choice:

After the mishap, he was encouraged to never report to work again.

It is comforting to finally understand differential equations.

The bottom line: If you split infinitives, do so infrequently, and understand that some of your professors might view them as unacceptable or sloppy style.

Ending Sentences with Prepositions

Prepositions—small connecting words such as at, about, to, under—are used to clarify relationships between other words, especially between verbs and the receivers of the verb's action. We have all heard admonishments against ending sentences with prepositions, but such a rule never really existed—as with the principle of not splitting infinitives, it was mostly passed down by grammarians who were attempting to make written English conform to the rules of Latin. Even the purist grammar handbook that I began using in the 1980s, Martha Kolln's *Language and Composition*, calls the notion that sentences may not end with prepositions an "absurd warning."

Of course, as a matter of style, ending a sentence with a preposition can give undue stress to the preposition, leaving the reader with the feeling that the sentence has ended weakly (e.g., "He wasn't sure which sample to look at."). Therefore, if a sentence ending with a proposition sounds weak to you, revise it by moving or eliminating the preposition, but do not defy meaning or the natural word order.

And for those who would argue with you over this issue and insist on the "rule," point out to them that it is sometimes just darned inconvenient and illogical not to end a perfectly understandable and strong sentence with a preposition. You can even cite two authorities on language: William and Winston. Shakespeare's *Henry V* includes the line, "Who servest thou under?" And the always quotable Winston Churchill, to demonstrate the inconvenience when the so-called rule is followed, is reported to have put his feelings on the matter thus:

This is the sort of English up with which I will not put.

So there. 🙂

CHAPTER OVERVIEW

2: Punctuation, Mechanics, Capitalization, and Spelling

2.1: Introduction

Habits in writing as in life are only useful if they are broken as soon as they cease to be advantageous. - W. Somerset Maugham

This chapter is about habit. As Samuel Beckett once noted, "Habit is the ballast that chains the dog to his vomit.” It is amazing how consistently we repeat the exact same little errors out of mere habit. However, we can tackle these habits by identifying them as patterns and writing with an eye for them. As a graduate student, I once misspelled the word "separate” (using an "e” in the middle) 16 times on an exam. My professor circled the offending letter each time and glibly noted, "I wish you could spell better.” His chiding cured me, and (knock wood) I have not misspelled "separate” since. Many students find that they have picked up the habit of putting commas in automatically before prepositions or even after conjunctions rather than before. Once such habits are identified, however, they can be addressed effectively.

No matter how niggling they may seem, details about punctuation, mechanics, capitalization, and spelling are important to master. Even with the spell checker and grammar checker eternally activated, we can make plenty of tiny mistakes that deeply affect sentence meaning. I know of an engineer who has repeatedly reported inaccurate dollar amounts to clients because of his sloppy proofreading. I have read government reports by well-published scientists where the colon was misused more than a dozen times in a single report. Even capitalization rules can be highly important to meaning: a student in geology, for example, must be aware of whether or not to capitalize "ice age” (yes when you mean the specific glacial epoch; no when you mean any of a series of cold periods alternating with periods of relative warmth). Finally, small mechanical errors (such as abbreviating a term or acronym improperly) reflect a general sloppiness and disregard for convention.

So work on the little things. Seek to understand punctuation marks as units affecting grammar and meaning, and accept proper spelling, capitalization, and mechanics as professional necessities. This chapter will help you to do so without immersing you into a grammatical swamp.

Self-Study

For further lessons on punctuation, visit these pages:

"A Brief History of Punctuation" article from about.com

"Brief Overview of Punctuation" article from Purdue's Online Writing Lab (OWL)

2.2: Hyphens

A wise writer once said, "If you take hyphens seriously you will surely go mad." Hyphens belong to that category of punctuation marks that will hurt your brain if you think about them too hard, and, like commas, people disagree about their use in certain situations. Nevertheless, if you learn to use hyphens properly, they help you to write efficiently and concretely, and you will have to use them regularly because of the nature of technical writing. Because concepts in science and engineering frequently rely on word blends and complex word relationships, the best writers in these fields master the use of the hyphen.

The Hyphen's Function

Fundamentally, the hyphen is a joiner. It joins:

- two nouns to make one complete word (kilogram-meter);
- an adjective and a noun to make a compound word (accident-prone);
- two words that, when linked, describe a noun (agreed-upon sum, two-dimensional object);
- a prefix with a noun (un-American);
- double numbers (twenty-four);
- numbers and units describing a noun (1000-foot face; a 10-meter difference)
- "self" and "well" words (self-employed, well-known);
- ethnic labels (Irish-American);
- new word blends (cancer-causing, cost-effective);
- prefixes and suffixes to words, in particular when the writer wants to avoid doubling a vowel or tripling a consonant (anti-inflammatory; shell-like).

The rule of thumb I apply when using the hyphen is that the resulting word must act as one unit; therefore, the hyphen creates a new word—either a noun or a modifier—that has a single meaning. Usually, you can tell whether a hyphen is necessary by applying common sense and mentally excluding one of the words in question, testing how the words would work together without the hyphen. For example, the phrases "high-pressure system," "water-repellent surface," and "fuel-efficient car" would not make sense without hyphens, because you would not refer to a "high system," a "water surface," or a "fuel car." As your ears and eyes become attuned to proper hyphenation practices, you will recognize that both meaning and convention dictate where hyphens fit best.

Self-Study

The following websites offer exercises on using the hyphen properly, as well as the correct answers to the exercise questions:

Hyphen practice from the Chicago-Kent College of Law

Examples of Properly Used Hyphens

Some examples of properly used hyphens follow. Note how the hyphenated word acts as a single unit carrying a meaning that the words being joined would not have individually.

small-scale study
two-prong plug
strength-to-weight ratio
high-velocity flow
well-known example
frost-free lawn
self-employed worker
one-third majority
coarse-grained wood
decision-making process
blue-green algae
air-ice interface
silver-stained cells
protein-calorie malnutrition
membrane-bound vesicles
phase-contrast microscope
long-term-payment loan
cost-effective program
time-dependant variable
radiation-sensitive sample
long-chain fatty acid

When Hyphens Are Not Needed

By convention, hyphens are not used in words ending in -ly, nor when the words are so commonly used in combination that no ambiguity results. In these examples, no hyphens are needed:

finely tuned engine	blood pressure	sea level
real estate	census taker	atomic energy
civil rights law	public utility plant	carbon dioxide

Prefixes and Suffixes

Most prefixes do not need to be hyphenated; they are simply added in front of a noun, with no spaces and no joining punctuation necessary. The following is a list of common prefixes that do not require hyphenation when added to a noun:

after	anti	bi	bio	co
cyber	di	down	hetero	homo
infra	inter	macro	micro	mini
nano	photo	poly	stereo	thermo

Common suffixes also do not require hyphenation, assuming no ambiguities of spelling or pronunciation arise. Typically, you do not need to hyphenate words ending in the following suffixes:

able	less	fold	like	wise

Commonly Used Word Blends

Also, especially in technical fields, some words commonly used in succession become joined into one. The resulting word's meaning is readily understood by technical readers, and no hyphen is necessary. Here are some examples of such word blends, typically written as single words:

blackbody	groundwater	airship
downdraft	longwall	upload
setup	runoff	blowout

2.3: Apostrophes

As you already know, apostrophes are used to form both contractions—two words collapsed into one—and possessives. Handily, we can virtually ignore the issue of contractions here, since they are so easily understood and are rarely used in technical writing. With possessives, the apostrophe is used, typically in combination with an "s," to represent that a word literally or conceptually "possesses" what follows it. The apostrophe is also used for general terms to indicate the singular possessive case.

a student's paper	the county's borders
a nation's decision	one hour's passing
miner's inch	author's revisions

Apostrophes with Words ending in "s"

Although practices vary, for words that already end in "s," whether they are singular or plural, we typically indicate possession simply by adding the apostrophe without an additional "s."

Presidents' Day	Student Affairs' Office
Mars’ atmosphere	interviewees’ answers

Apostrophes with Acronyms and Numerals

In technical writing, acronyms are frequently pluralized with the addition of an "s," but there is no need to put an apostrophe in front of the "s" in that your intention is simply to pluralize rather than show possession. When referring to decades, form the plural by adding an "s," but do not use the apostrophe in any position.

Correct	*Incorrect*
SSTs	SST's
the 1960s	the 1960's
she is in her 30s	she is in her 30's

When numerals or letters serve as the name of something and an "s" is needed, use an apostrophe before the "s" to make it clear that the letters are not part of the name.

Correct	*Incorrect*
Boeing 747's	Boeing 747s
mind your p's and q's	mind your ps and qs

When Possessives are Implied without the Apostrophe

Convention and frequency of usage sometimes dictate that the apostrophe is dropped. In proper names that end in "s," especially of geographic locations, acamedic institutions, and government entities, the apostrophe is often omitted. Likewise, in everyday

combinations and with acronyms where possession is automatically understood or contextually irrelevant, the apostrophe is not needed.

United States government	Hells Canyon
Veterans Highway	Harpers Ferry
mens room	Johns Hopkins University
an FDA regulation	the NIOSH position
the Virginia legislation	an 1860 law

Self-Study

For the confused and curious, here are some "Apostrophes for Dummies" websites:

"Guidelines for Using Apostrophes Correctly" page from about.com

"Using Apostrophes to Show Possession" page from dummies.com

2.4: Quotation Marks

Despite what you may see practiced—especially in advertising, on television, and even in business letters—the fact is that the period and comma go inside the quotation marks all of the time. Confusion arises because the British system is different, and the American system may automatically look wrong to you, but it is simply one of the frequently broken rules of written English in America: The period and comma go inside the quotation marks.

> *Correct: The people of the pine barrens are often called "pineys."*
>
> *Incorrect: The people of the pine barrens are often called "pineys".*

However, the semicolon, colon, dash, question mark, and exclamation point fall outside of the quotation marks (unless, of course, the quoted material has internal punctuation of its own).

> *This measurement is commonly known as "dip angle"; dip angle is the angle formed between a normal plane and a vertical.*
>
> *Built only 50 years ago, Shakhtinsk—"minetown"—is already seedy.*
>
> *When she was asked the question "Are rainbows possible in winter?" she answered by examining whether raindrops freeze at temperatures below 0 °C. (Quoted material has its own punctuation.)*

Self-Study

More advice on quotation marks, including conventions for using them with direct and indirect quotations, is available online at:

Advice on using quotation marks from Purdue's Online Writing Lab (OWL)

Advice on using quotation marks from St. Cloud State University

2.5: Semicolons, Colons, and Dashes

Punctuation marks: terribly powerful in the right hands. Punctuation marks are silent allies, and you can train yourself to exploit them as such. Punctuation marks do not just indicate sound patterns—they are symbols that clarify grammatical structure and sentence meaning. And, as I demonstrate in the writing of this paragraph, punctuation marks showcase your facility with the language. What follows are some basics about three of the most powerful and most commonly misused punctuation marks.

The Semicolon

The semicolon is often misused in technical writing; in fact, it is often confused with the colon. Grammatically, the semicolon almost always functions as an equal sign; it says that the two parts being joined are relatively equal in their length and have the same grammatical structure. Also, the semicolon helps you to link two things whose interdependancy you wish to establish. The sentence parts on either side of the semicolon tend to "depend on each other" for complete meaning. Use the semicolon when you wish to create or emphasize a generally equal or even interdependent relationship between two things. Note the interdependent relationship of the two sentence parts linked by the semicolon in this example:

> *The sonde presently used is located in the center of the borehole; this location enables the engineer to reduce microphonics and standoff sensitivity.*

Here, we see how the second half of the sentence helps to explain a key detail (the sonde location) of the first half. The semicolon, along with the repetition of the word "location," helps to draw our attention to the explanation.

The semicolon is also handy for linking a series of parallel items that could otherwise be confused with each other. One savvy student used the semicolon in a job description on her resume as follows:

> *As an engineering assistant, I had a variety of duties: participating in pressure ventilation surveys; drafting, surveying, and data compilation; acting as a company representative during a roof-bolt pull test.*

The Colon

The colon: well-loved but, oh, so misunderstood. The colon is not just used to introduce a list; it is far more flexible. The colon can be used after the first word of a sentence or just before the final word of a sentence. The colon can also be used to introduce a grammatically independent sentence. Thus, I call it the most powerful of punctuation marks.

The colon is like a sign on the highway, announcing that something important is coming. It acts as an arrow pointing forward, telling you to read on for important information. A common analogy used to explain the colon is that it acts like a flare in the road, signaling that something meaningful lies ahead.

Use the colon when you wish to provide pithy emphasis.

> *To address this problem, we must turn to one of the biologist's most fundamental tools: the Petri dish.*

Use the colon to introduce material that explains, amplifies, or summaries what has preceded it.

> *The Petri dish: one of the biologist's most fundamental tools.*

> *In low carbon steels, banding tends to affect two properties in particular: tensile ductility and yield strength.*

The colon is also commonly used to present a list or series, which comes in handy when there is a lot of similar material to join:

> *A compost facility may not be located as follows: within 300 feet of an exceptional-value wetland; within 100 feet of a perennial stream; within 50 feet of a property line.*

The Dash

The dash—which is typically typed as two hyphens or as one long bar (available on your word processor's "symbol" map)—functions almost as a colon does in that it adds to the preceding material, but with extra emphasis. Like a caesura (a timely pause) in music, a dash indicates a strong pause, then gives emphasis to material following the pause. In effect, a dash allows you to *redefine* what was just written, making it more explicit. You can also use a dash as it is used in the first sentence of this paragraph: to frame an interruptive or parenthetical-type comment that you do not want to de-emphasize.

Jill Emery confirms that Muslim populations have typically been ruled by non-Muslims—specifically Americans, Russians, Israelis, and the French.

The dissolution took 20 minutes—much longer than anticipated—but measurements were begun as soon as the process was completed.

Finally, the dash we typically use is technically called the "em dash," and it is significantly longer than the hyphen. There is also an "en dash"—whose length is between that of the hyphen and the em dash, and its best usage is to indicate inclusive dates and numbers:

July 6–September 17 pp. 48–56.

Like the em dash, the en dash is typically available on your word processor's symbol map, or it may even be inserted automatically by your word processor when you type inclusive numbers or dates with a hyphen between them. When you type the hyphen, en dash, and em dash, no spaces should appear on either side of the punctuation mark.

Self-Study

For more good-natured advice on using these commonly misused punctuation marks, visit these two fun sites:

"Semicolons, Colons, and Dashes" webpage from about.com

2.6: Commas

These little demons compound and trivialize the nightmares of many a professor after an evening of reading student papers. A sure way to irritate educated readers of your work is to give them an overabundance of opportunities to address your comma problems. It is easy but dangerous to take the attitude that Sally once did in a *Peanuts* comic strip, asking Charlie Brown to correct her essay by showing her "where to sprinkle in the little curvy marks."

You have probably heard the common tips on using commas: "Use one wherever you would naturally use a pause," or "Read your work aloud, and whenever you feel yourself pausing, put in a comma." These techniques help to a degree, but our ears tend to trick us and we need other avenues of attack. However, it seems impossible to remember or apply the 17 or so grammatical explanations of comma usage that you were probably introduced to way back in 8th grade. (For example: "Use commas to set off independent clauses joined by the common coordinating conjunctions. . . . Put a comma before the coordinating conjunction in a series.") Perhaps the best and most instructive way, then, for us to approach the comma is to remember its fundamental function: it is a separator. Knowing this, it is useful to determine what sorts of things generally require separation. In sum, commas are used to separate complete ideas, descriptive phrases, and adjacent items, and before and after most transition words.

Comma Rules

Complete ideas need to be separated by a comma because, by definition, they could be grammatically autonomous, but the writer is choosing to link them. Complete ideas are potentially whole sentences that the writer chooses to link with a conjunction such as "and" or "but."

> *Digital recordings made it possible to measure the nuclear magnetic signal at any depth, and this allowed for a precise reading to be taken at every six inches.*

Note how the second half of this sentence contains both a subject ("this") and a verb ("allowed"), indicating that a second complete idea is presented, and thus a comma is required.

Descriptive phrases often need to be separated from the things that they describe in order to clarify that the descriptive phrases are subordinate (i.e., they relate to the sentence context, but are less responsible for creating meaning than the sentence's subject and verb). Descriptive phrases tend to come at the very beginning of a sentence, right after the subject of a sentence, or at the very end of a sentence.

> *Near the end of the eighteenth century, James Hutton introduced a point of view that radically changed scientists' thinking about geologic processes.*
>
> *James Lovelock, who first measured CFCs globally, said in 1973 that CFCs constituted no conceivable hazard.*
>
> *All of the major industrialized nations approved, making the possibility a reality.*

In each of these cases, note how the material separated by the comma (e.g., "making the possibility a reality") is subordinate—i.e., it carries context in the sentence, but the primary sentence meaning is still derived from the subject and verb. In each example, the phrase separated by the comma could be deleted from the sentence without destroying the sentence's basic meaning.

Adjacent items are words or phrases that have some sort of parallel relationship, yet are different from each other in meaning. Adjacent items are separated so that the reader can consider each item individually.

> *Weathering may extend only a few centimeters beyond the zone in fresh granite, metamorphic rocks, sandstone, shale, and other rocks.*
>
> *The river caught fire on July 4, 1968, in Cleveland, Ohio.*
>
> *This approach increases homogeneity, reduces the heating time, and creates a more uniform microstructure.*

In the first sentence, the commas are important because each item presented is distinctly different from its adjacent item. In the second example, the dates (July 4, 1968) and places (Cleveland, Ohio) are juxtaposed, and commas are needed because the juxtaposed items are clearly different from each other. In the third example, the three phrases, all beginning with different verbs, are parallel, and the commas work with the verbs to demonstrate that "This approach" has three distinctly different impacts.

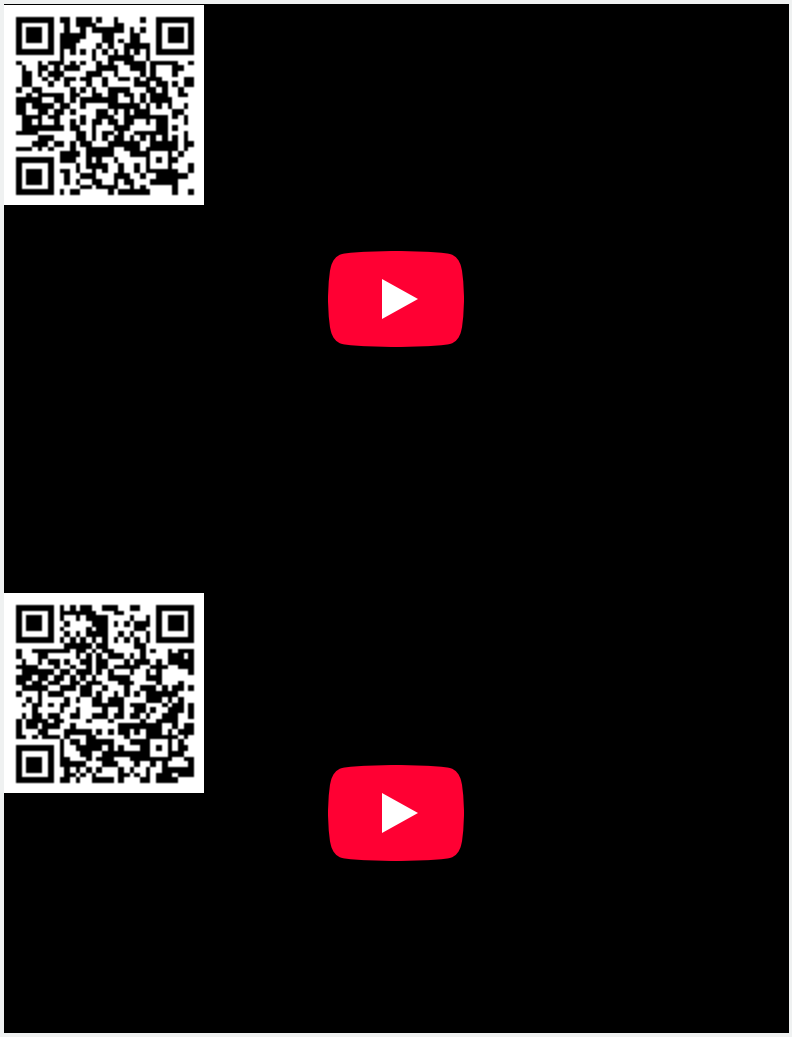
Finally, transition words add new viewpoints to your material; commas before and after transition words help to separate them from the sentence ideas they are describing. Transition words tend to appear at the beginning of or in the middle of a sentence, and, by definition, the transition word creates context that links to the preceding sentence. Typical transition words that require commas before and after them include however, thus, therefore, also, and nevertheless.

Therefore, the natural gas industry can only be understood fully through an analysis of these recent political changes.

The lead precursor was prepared, however, by reacting pure lead acetate with sodium isopropoxide.

Note

There are plenty of websites devoted to lessons on comma usage for those who wish to self-study. Here are two fun and creative sites:



Using a Comma Before "And"

It is true that commas are sometimes optional, depending on sentence meaning and the writer's taste, and many writers choose not to put a comma before the "and" in a series (also known as the "serial comma") involving a parallel list of words. For example, some would write the sentence "I am industrious, resourceful and loyal," using no comma before the "and." This practice is fine as long as you are consistent in applying it. However, I, and the grammar handbooks I consult, recommend a comma even in these circumstances, because—even in the example provided—there is a slight pitch and meaning change between the terms "resourceful" and "loyal."

Most importantly, if the "and" is part of a series of three or more phrases (groups of words) as opposed to single words, you should use a comma before the "and" to keep the reader from confusing the phrases with each other.

> *Medical histories taken about each subject included smoking history, frequency of exercise, current height and weight, and recent weight gain.*

By always using a comma before the "and" in any series of three or more, you honor the distinctions between each of the separated items, and you avoid any potential reader confusion. The bottom line is this: When you use a comma before the "and" in a series of three or more items or phrases, you are always correct.

That noted, be aware that some professors and many journals will not favor the use of the comma before an "and" in a series (for the journals, it is literally cheaper to print fewer commas).

Self-Study

Plenty of online debate is devoted to the serial comma issue. Here are some related thoughts from "Punctuation Man" and the "Grammar Girl":

- Punctuation Man endorsing the serial comma
- Grammar Girl weighing in on the serial comma

Comma Overuse

Perhaps the best way to troubleshoot your particular comma problems, especially if they are serious, is to identify and understand the patterns of your errors. We tend to make the same mistakes over and over again; in fact, many writers develop the unfortunate habit of automatically putting commas into slots such as these:

- between the subject and verb of a sentence
- after any number
- before any preposition
- before or after any conjunction

Thus, incorrect sentences such as these appear in papers:

> *The bushings, must be adjusted weekly, to ensure that the motor is not damaged.*
>
> *Many botanists still do not fully appreciate these findings even after 22 years, following the publication of the discovery paper.*
>
> *Other manufactured chemicals that also contain bromine are superior for extinguishing fires in situations where people, and electronics are likely to be present.*
>
> *The price of platinum will rise, or fall depending on several distinct factors.*

If the commas above look fine to you, then you may be in the habit of using commas incorrectly, and you will need to attack your specific habits, perhaps even in a routine, repetitive fashion, in order to break yourself of them. Similarly, it is common for someone to have to look up the same tricky word dozens of times before committing its proper spelling to memory. As with spelling, commas (or the absence of commas) must be repeatedly challenged in your writing. As you perfect your comma usage you are also recognizing and reevaluating your sentence patterns, and the rewards are numerous. There is no foolproof or easy way to exorcise all of your comma demons, but reminding yourself of the comma's basic function as a separator and justifying the separation of elements whenever you use the comma is a good beginning. I often recommend to students with comma problems that they re-read their work one last time, just focusing on their comma use, before turning in a paper as a final version. In the end, you simply must make a habit of reading, writing, and revising with comma correctness in mind, and remember that commas have much to do with sentence wording, which is always in the control of the writer.

To demonstrate this last point, Lewis Thomas, a clever essayist as well as a physician and poet, shows us how to use commas effectively—as well as how to word a long sentence so that commas are not overused—in this excerpt from "Notes on Punctuation":

The commas are the most useful and usable of all the stops. It is highly important to put them in place as you go along. If you try to come back after doing a paragraph and stick them in the various spots that tempt you you will discover that they tend to swarm like minnows into all sorts of crevices whose existence you hadn't realized and before you know it the whole long sentence becomes immobilized and lashed up squirming in commas. Better to use them sparingly, and with affection, precisely when the need for one arises, nicely, by itself.

2.7: The Period

Though a seemingly trivial punctuation mark, the period does present some knotty challenges, especially in technical writing. We all know to place a period to signal the termination of a simple sentence that makes a statement. However, here are a few more specialized rules:

- Do not use a period in combination with other punctuation marks unnecessarily, especially when a quotation is involved. In such an instance, end the sentence naturally on whatever punctuation mark is logical (e.g., a question mark).
- Avoid using periods at the ends of abbreviated units of measure, except when the period might be confused with another word. (Therefore, so that it's not confused with the word "in," use "in." to abbreviate "inches.")
- When using a period in conjunction with parentheses, the period comes after the parentheses are closed if the parenthetical comment itself is part of the larger sentence (as in the first bulleted sentence above, and this one). The period comes inside the parentheses only when the parentheses themselves contain a complete independent sentence. (See the example in the second bulleted sentence above, as well as this sentence.)
- By convention, if an abbreviated word (such as "etc.") ends a sentence, let a single period signal the sentence's end—two periods in a row would be incorrect.
- In acronyms commonly understood or commonly used in your field (ASTM, EPA, US, GIS), do not use periods after the capital letters.
- Do use periods after abbreviations and acronyms that are forms of address, initials within proper names, earned degrees, and when expressing measures of time (Dr. Bauer; M.S. degree; Steven S. Wilson, Jr.; 5:00 p.m.; 10 B.C.).

Self-Study

For everything you always wanted to know about the period, but neglected to ask, visit these sites:

Punctuation rules from infoplease.com

2.8: Parentheses

We are used to using parentheses to identify material that acts as an aside (such as this brief comment) or to add incidental information, but in technical writing the rules for using parentheses can be more nuanced. Some more specialized functions of parentheses include:

- To introduce tables or figures within a sentence:

  In pulse-jet collectors (Figure 3), bags are supported from a metal cage fastened onto a cell plate at the top of the collector.

- To represent converted units:

  The funnel used for this experiment was 7 in. (17.8 cm) in length.

- When enumerating:

  The system has three principal components: (1) a cleaning booth, (2) an air reservoir, and (3) an air spray manifold.

- To indicate product manufacturer names:

  The filtering process involves a 10-mm Dorr-Oliver cyclone (Zefon International).

- To introduce an acronym after it has been written out:

  Units will be expressed in cubic feet per minute (cfm).

Finally, it should be noted that punctuation used alongside parentheses needs to take into account their context. If the parentheses enclose a full sentence beginning with a capital letter, then the end punctuation for the sentence falls *inside* the parentheses. For example:

> *Typically, suppliers specify air to cloth ratios of 6:1 or higher. (However, ratios of 4:1 should be used for applications involving silica or feldspathic minerals.)*

If the parentheses indicate a citation at the end of a sentence, then the sentence's end punctuation comes after the parentheses are closed:

> *In a study comparing three different building types, respirable dust concentrations were significantly lower in the open-structure building (Hugh et al., 2005).*

Finally, if the parentheses appear in the midst of a sentence (as in this example), then any necessary punctuation (such as the comma that appeared just a few words ago) is delayed until the parentheses are closed.

2.9: Abbreviations and Acronyms

Abbreviations (the shortened form of a word or phrase) and **acronyms** (words formed from the initial letters of a phrase) are commonly used in technical writing. In some fields, including chemistry, medicine, computer science, and geographic information systems, acronyms are used so frequently that the reader can feel lost in an alphabet soup. However, the proper use of these devices enhances the reading process, fostering fluid readability and efficient comprehension.

Some style manuals devote entire chapters to the subject of abbreviations and acronyms, and your college library no doubt contains volumes that you can consult when needed. Here, I provide just a few principles you can apply in using abbreviations and acronyms, and in the next section I offer a table of some of the forms most commonly used by student writers.

Abbreviations

- Typically, abbreviate social titles (Ms., Mr.) and professional titles (Dr., Rev.).
- In resumes and cover letters, avoid abbreviations representing titles of degrees (e.g., write out rather than abbreviate "Bachelor of Science").
- Follow most abbreviations with a period, except those representing units of measure ("Mar." for March; "mm" for millimeter). See the table that follows for further guidance.
- Typically, do not abbreviate geographic names and countries in text (i.e., write "Saint Cloud" rather than "St. Cloud"; write "United States" rather than "U.S."). However, these names are usually abbreviated when presented in "tight text" where space can be at a premium, as in tables and figures.
- Use the ampersand symbol (&) in company names if the companies themselves do so in their literature, but avoid using the symbol as a narrative substitute for the word "and" in your text.
- In text, spell out addresses (Third Avenue; the Chrysler Building) but abbreviate city addresses that are part of street names (Central Street SW).
- Try to avoid opening a sentence with an abbreviation; instead, write the word out.
- When presenting a references page, follow the conventions of abbreviation employed by a journal in your field. To preserve space, many journals commonly use abbreviations, without periods, in their references pages (e.g., "J" for Journal; "Am" for "American").

Acronyms

- Always write out the first in-text reference to an acronym, followed by the acronym itself written in capital letters and enclosed by parentheses. Subsequent references to the acronym can be made just by the capital letters alone. For example:

  Geographic Information Systems (GIS) is a rapidly expanding field. GIS technology . . .

- Unless they appear at the end of a sentence, do not follow acronyms with a period.
- Generally, acronyms can be pluralized with the addition of a lowercase "s" ("three URLs"); acronyms can be made possessive with an apostrophe followed by a lowercase "s" ("the DOD's mandate").
- As subjects, acronyms should be treated as singulars, even when they stand for plurals; therefore, they require a singular verb ("NIOSH is committed to . . .").
- Be sure to learn and correctly use acronyms associated with professional organizations or certifications within your field (e.g., ASME for American Society of Mechanical Engineers; PE for Professional Engineer).
- With few exceptions, present acronyms in full capital letters (FORTRAN; NIOSH). Some acronyms, such as "scuba" and "radar," are so commonly used that they are not capitalized. Consult the table that follows in the next section to help determine which commonly used acronyms do not appear in all capital letters.
- When an acronym must be preceded by "a" or "an" in a sentence, discern which word to use based on sound rather than the acronym's meaning. If a soft vowel sound opens the acronym, use "an," even if the acronym stands for words that open with a hard sound (i.e., "a special boat unit," but "an SBU"). If the acronym opens with a hard sound, use "a" ("a KC-135 tanker").

Click here to download a pdf of a table of commonly used abbreviations and acronyms.

Click here to open a table of commonly used abbreviations and acronyms

Table of Commonly used Abbreviations and Acronyms

Use this table to check the proper spelling, capitalization, and punctuation of commonly used abbreviations and acronyms. For a much more detailed listing of abbreviations and acronyms, you can check in the back pages of many dictionaries, or consult

the Chicago Manual of Style(also available online to subscribers) or the free online version of the United States Government Printing Office Style Manual.

A or amp	*ampere*
a.m.	*ante meridiem, before noon*
Assembler	*Assembler computer language*
atm	*standard atmosphere*
Ave.	*avenue*
B.A.	*Bachelor of Arts*
BASIC	*BASIC computer language*
Blvd.	*boulevard*
BP	*boiling point*
B.S.	*Bachelor of Science*
Btu	*British thermal unit*
^oC	*degrees Celsius*
cd	*candela*
CDC	*Centers for Disease Control*
CFR	*Code of Federal Regulations*
CIA	*Central Intelligence Agency*
cm	*centimeter*
COBOL	*COBOL computer language*
Corp.	*corporation*
D	*darcy*
DEP	*Department of Environmental Protection*
DOD	*Department of Defense*
DOT	*Department of Transportation*
engg.	*engineering*
engr.	*engineer*
e.g.	*exempli gratia, for example*
EPA	*Environmental Protection Agency*
et al.	*et alii, and others*
etc.	*et cetera, and so forth*
^oF	*degrees Fahrenheit*
FBI	*Federal Bureau of Investigation*
FCC	*Federal Communications Commission*

FDA	*Food and Drug Administration*
fig.	*figure*
FORTRAN	*FORTRAN computer language*
ft	*foot*
gal.	*gallon*
ha	*hectare*
h	*hour*
HP	*horsepower*
HTML	*hypertext markup language*
Hz	*hertz*
i.e.	*id est, that is*
in	*inch*
Inc.	*incorporated*
K	*Kelvin*
kg	*kilogram*
kw	*kilowatt*
kWh	*kilowatt-hour*
l or L	*liter*
LAFTA	*Latin American Free Trade Association*
lb	*pound*
m	*meter*
mHz	*megahertz*
min.	*minute*
mol	*mole*
M.S.	*Master of Science*
NASA	*National Aeronautics and Space Administration*
neg	*negative*
NIH	*National Institutes of Health*
NIOSH	*National Institute for Occupational Safety and Health*
NM	*nautical mile*
NOAA	*National Oceanic and Atmospheric Administration*
NSF	*National Science Foundation*
OPEC	*Organization of Petroleum Exporting Countries*
OSHA	*Occupational Safety and Health Administration*

p.	*page*
Pascal	*Pascal computer language*
Ph.D.	*Philosophiae Doctor, Doctor of Philosophy*
p.m.	*post meridiem, after noon*
pos	*positive*
pp.	*pages*
pt.	*pint*
qt.	*quart*
radar	*radio detecting and ranging*
RPM	*revolutions per minute*
scuba	*self-contained underwater breathing apparatus*
sec. or s	*second*
sq	*square*
STP	*standard temperature and pressure*
temp	*temperature*
Univ.	*university*
URL	*uniform resource locator*
USGS	*United States Geological Survey*
vol.	*volume*

Self-Study

For comprehensive online acronyms dictionaries, especially for technical fields such as chemistry and medicine, I recommend these sites:

Online acronyms dictionary

Searchable acronyms database, sorted by discipline

2.10: Expressing Temperatures and Numbers

Style manuals, professional societies, and journals specific to your field publish thorough guidelines about how to handle small matters of mechanics. For instance, *Suggestions to Authors of the Reports of the United States Geological Survey* addresses such issues as whether to use the chemical name or symbol in writing; the American Meteorological Society's *Authors' Guide* dictates how one should express time, time zone, day, month, and year in writing. Chase down such sources within your field for specifics on matters of mechanics.

Two especially noteworthy issues of mechanics that arise regularly in technical writing are how to handle temperature measurements and numbers. Some guidelines on these matters follow.

Referring to Temperature Measurements

Degree measures of temperature are normally expressed with the ° symbol rather than by the written word, with a space after the number but not between the symbol and the temperature scale:

> *The sample was heated to 80 °C.*

Unlike the abbreviations for Fahrenheit and Celsius, the abbreviation for Kelvin (which refers to an absolute scale of temperature) is not preceded by the degree symbol (i.e., 12 K is correct).

Writing about Numbers

The rules for expressing numbers in technical writing are relatively simple and straightforward:

- All important measured quantities—particularly those involving decimal points, dimensions, degrees, distances, weights, measures, and sums of money—should be expressed in numeral form (e.g., 1.3 seconds, $25,000, 2 amperes).
- Unless they appear as part of a string of larger related numbers, counted numbers of nine and below should be written out. Numbers 10 and above should be in numeral form.
- If possible, a sentence should not begin with a number, but if it does the number should be written out.
- Treat similar numbers in grammatically connected groups alike.

Following these rules, here are some examples of properly expressed numbers:

> *The depth to the water at the time of testing was 16.16 feet.*
>
> *For this treatment, the steel was heated 18 different times.*
>
> *Two dramatic changes followed: four samples exploded and thirteen lab technicians resigned.*

Self-Study

Check out these handy resources related to expressing numbers and numerals in text:

- Technical writing tips for using numbers from a company president offering online technical writing courses
- "Using Numbers, Writing Lists" advice from Capital Community College website

2.11: Capitalization

As a technical writer, who must often refer to such things as geographic locations, company names, temperature scales, and processes or apparatuses named after people, you must learn to capitalize consistently and accurately. What follows are ten fundamental rules for capitalization. Check out the first rule. It gets fumbled in papers all the time.

Capitalize the names of major portions of your paper and all references to figures and tables. Note: Some journals and publications do not follow this rule, but most do.

my Introduction	Airshaft 3
see Figure 4	Table 1
Appendix A	Graph

Capitalize the names of established regions, localities, and political divisions.

Wheeling Township	the French Republic
Lancaster County	the United Kingdom
the Wheat Belt	the Arctic Circle

Capitalize the names of highways, routes, bridges, buildings, monuments, parks, ships, automobiles, hotels, forts, dams, railroads, and major coal and mineral deposits.

Highway 13	Route 1
Michigan Avenue	the White House
Alton Railroad	the Statue of Liberty
Herrin No. 6 seam	the Queen Elizabeth

Capitalize the proper names of persons, places and their derivatives, and geographic names (continents, countries, states, cities, oceans, rivers, mountains, lakes, harbors, and valleys).

Howard Pickering	Great Britain
Chicago	British
New York Harbor	Gulf of Mexico
Rocky Mountains	Florida
Aleutian Islands	the Aleutian low

Capitalize the names of historic events and documents, government units, political parties, business and fraternal organizations, clubs and societies, companies, and institutions.

the Second Amendment	the Civil War
Congress	Bureau of Mines
Republicans	Ministry of Energy

Capitalize titles of rank when they are joined to a person’s name, and the names of stars and planets. Note: The names earth, sun, and moon are not normally capitalized, although they may be capitalized when used in connection with other bodies of the solar

system.

Professor Walker	President Barron
Milky Way	Venus

Capitalize words named after geographic locations, the names of major historical or geological time frames, and most words derived from proper names. Note: The only way to be sure if a word derived from a person's name should be capitalized is to look it up in the dictionary. For example, "Bunsen burner" (after Robert Bunsen) is capitalized, while "diesel engine" (after Rudolph Diesel) is not. Also, referring to specific geologic time frames, the *Chicago Manual of Style* says not to capitalize the words "era," "period," and "epoch," but the American Association of Petroleum Geologists says that these words should be capitalized. I choose to capitalize them, as those who write in the geological sciences should by convention.

Coriolis force	Fourier coefficients
English tweeds	Walker Circulation
Hadley cell	Petri dish
Boyle's law	Russell volumeter
Planck's constant	Klinkenberg effect
Middle Jurassic Period	Mesozoic Era
the Industrial Revolution	the Inquisitio

Capitalize references to temperature scales, whether written out or abbreviated.

10 ^{o}F	Fahrenheit degrees
22 ^{o}C	Celsius degrees

Common Capitalization Errors

Just as important as knowing when to capitalize is knowing when not to. Below, I set forth a few instances where capital letters are commonly used when they should not be. Please review this advice carefully, in that we all have made such capitalization errors. When in doubt, simply consult a print dictionary.

Do not capitalize the names of the seasons, unless the seasons are personified, as in poetry ("Spring's breath"). (It is, of course, highly unlikely that you would personify a season in a technical paper.)

spring	winter

Do not capitalize the words north, south, east, and west when they refer to directions, in that their meaning becomes generalized rather than site-specific.

We traveled west.	The sun rises in the east.

In general, do not capitalize commonly used words that have come to have specialized meaning, even though their origins are in words that are capitalized.

navy blue	india ink
pasteurization	biblical

Do not capitalize the names of elements. Note: This is a common capitalization error, and can often be found in published work. Confusion no doubt arises because the symbols for elements are capitalized.

tungsten	nitrogen
oxygen	californium

Do not capitalize words that are used so frequently and informally that they have come to have highly generalized meaning.

north pole	big bang theory
arctic climate	midwesterner

2.12: Spelling

To understand the limited power of the spell checker, enjoy the following poem, whose origins are unknown.

I have a spelling checker
It came with my PC;
It plainly marks four my revue
Mistakes I cannot sea.
I've run this poem threw it,
I'm sure your pleased too no,
Its letter perfect in it's weigh,
My checker tolled me sew.

Just as so many of us rely on calculators to do all our math for us—even to the point that we do not trust calculations done by our own hand—far too many of us use spell checkers as proofreaders, and we ultimately use them to justify our own laziness. I once received a complaint from an outraged professor that a student had continually misspelled "miscellaneous" as "mescaline" (a hallucinogenic drug). The student's spell checker did not pick up the error, but the professor certainly did, and he told me that he even speculated privately that the student who wrote the paper did so while on mescaline.

So proceed with caution when using spell checkers. They are not gods, and they do not substitute for meticulous proofreading and clear thinking. There is an instructive moment in a M*A*S*H episode, when Father Mulcahy complains to Colonel Potter about a typo in a new set of Bibles—one of the commandments reads "thou shalt commit adultery." Father sheepishly worries aloud that "These lads are taught to follow orders." For want of a single word the intended meaning is lost. Always proofread a hard copy, with your own two eyes.

Six Rules for Spelling

I have a crusty old copy of a book called *Instant Spelling Dictionary*, now in its third edition but first published in 1964, that I still use frequently. I adapted the six basic spelling rules that appear below from that dictionary. Even without memorizing the rules, you can improve your spelling simply by reviewing them and scanning the examples and exceptions until the fundamental concepts begin to sink in. When in doubt, always look up the word. And do not forget that desktop dictionaries work just as well as electronic ones.

Rule 1

In words ending with a silent "e," you usually drop the "e" before a suffix that begins with a vowel.

survive + al = survival

divide + ing = dividing

fortune + ate = fortunate

Common Exceptions:

manageable	singeing	mileage
advantageous	dyeing	acreage
peaceable	canoeing	lineage

Rule 2

In words ending with a silent "e," you usually retain the "e" before a suffix than begins with a consonant.

arrange + ment = arrangement

forgive + ness = forgiveness

safe + ty = safety

Common Exceptions:

ninth (from nine)	argument (from argue)
wisdom (from wise)	wholly (from whole)

Rule 3

In words of two or more syllables that are accented on the final syllable and end in a single consonant preceded by a single vowel, you double the final consonant before a suffix beginning with a vowel.

refer + ing = referring

regret + able = regrettable

However, if the accent is not on the last syllable, the final consonant is not doubled.

benefit + ed = benefited

audit + ed = audited

Rule 4

In words of one syllable ending in a single consonant that is preceded by a single vowel, you double the final consonant before a suffix that begins with a vowel. (It sounds more complex than it is; just look at the examples.)

big + est = biggest

hot + er = hotter

bag + age = baggage

Rule 5

In words ending in "y" preceded by a consonant, you usually change the "y" to "i" before any suffix that does not begin with an "i."

beauty + ful = beautiful

accompany + ment = accompaniment

accompany + ing = accompanying (suffix begins with i)

If the final "y" is preceded by a vowel, however, the rule does not apply.

journeys	obeying	essays
buys	repaying	attorneys

Rule 6

Use "i" before "e" except when the two letters follow "c" and have an "e" sound, or when they have an "a" sound as in "neighbor" and "weigh."

i before e (e sound)	***e before i (a sound)***
shield	*vein*
believe	*weight*
grieve	*veil*
mischievous	*neighbor*

Common Exceptions:

weird	foreign	forfeit
either	ancient	neither
sovereign	siege	height
seize	surfeit	leisure

2.13: Everyday Words that are Commonly Misspelled

If you do find yourself over-relying on spell checkers or misspelling the same word for the 17th time this year, it would obviously be to your advantage to improve your spelling. One shortcut to doing this is to consult the following list of words that are frequently used and misspelled. Many smart writers even put a mark next to a word whenever they have to look it up, thereby helping themselves identify those fiendish words that give them the most trouble. To improve your spelling, you must commit the

words you frequently misspell to memory, and physically looking them up until you do so is an effective path to spelling perfection.

A	C	F	M	S
abandon	calendar	fallacy	magazine	saccharine
abandoned	camouflage	familiar	maintenance	sacrifice
abundant	candidate	family	manageable	safety
absence	career	fascinate	maneuver	satellite
academic	careful	fascism	manner	schedule
academically	category	favorite	manual	scientists
accelerator	ceiling	February	marriage	scintillate
accept	challenge	fiery	mathematics	separate
acceptable	channel	finally	meant	sergeant
accessible	chaos	financial	medicine	shepherd
accidentally	character	financially	medieval	shining
accommodate	characteristics	fission	mileage	shrubbery
accompanied	chief	fluorine	millennium	similar
accompanying	chiefly	foreign	miniature	sincerely
accomplish	choose	foresee	miscellaneous	sophomore
accumulate	chose	foreseeable	mischievous	souvenir
accuracy	chosen	forfeit	missile	specifically
accustomed	clothes	forty	misspelled	statistics
achievement	clothing	forward	mortgage	strenuous
acknowledge	coarse	fourth	muscle	stretch
acknowledgment	column	frantically	**N**	stubbornness
acquaintance	coming	friend	narrative	subtle
acquire	commercial	fulfill	naturally	subtly
acquit	commission	**G**	necessary	succeed
acre	commitment	generally	necessity	success
acreage	committee	genius	nineteen	succession
across	communism	government	ninety	succinct
actually	communists	grammar	ninth	sufficient
address	compel	grammatically	noticeable	summary
admission	compelled	grandeur	noticing	summation
admittance	competition	Great Britain	nuclear	summed

adolescent	completely	grievance	nuisance	supersede
adolescence	concede	guarantee	numerous	supposed
advantageous	conceivable	guerrilla	**O**	suppress
advertisement	condemn	guidance	occasion	surely
aerial	condemned	H	occasionally	surprise
against	conferred	handicapped	occur	surrounding
aggravate	confused	happily	occurred	syllable
aggressive	connoisseur	harass	occurring	symmetry
aisle	conscience	heard	occurrence	symmetrical
a lot (never alot)	conscientious	height	official	**T**
allotting	conscious	here	omission	tariff
almost	consists	hindrance	omit	technique
already	continuous	hoping	omitted	temperament
always	controlled	hopeless	oneself	temperature
amateur	controlling	humorous	operate	their
among	controversial	hundred	opinion	therefore
amount	convenient	hurriedly	opponent	thorough
analysis	coolly	hygiene	opportunity	though
analyze	criticism	hypocrisy	opposite	through
ancestry	crowded	hypocrite	oppression	tobacco
announcement	cruelty	**I**	ordinarily	tomorrow
annual	curiosity	ideally	originally	tragedy
apparatus	curriculum	ignorant	**P**	transferred
apparent	**D**	illogical	pamphlet	trespass
apparently	dealt	imagine	paraffin	truly
appearance	deceive	imitate	parallel	Tuesday
appreciate	decision	immediately	parliament	twelfth
appropriate	deferred	immense	particular	tyranny
appropriately	definite	impossible	particularly	**U**
approximate	definitely	incidentally	pastime	unanimous
approximately	definition	independent	peaceable	unconscious
arctic	descend	individually	peculiar	uncontrollable
arguing	description	ingenious	perceive	undoubtedly
argument	desirable	initially	permissible	unforeseen

article	desperate	initiative	perseverance	unmistakably
artistically	develop	innocent	persistence	unnatural
association	different	innocuous	pollute	unnecessary
athlete	dilemma	inoculate	pollution	until
athletic	disagree	intellectual	population	usable
attendance	disappear	intelligence	possess	useful
attitude	disappoint	intelligent	possession	usually
awful	disapprove	insistent	possible	**V**
awkward	disaster	interest	possibly	vacuum
B	disastrous	interfered	practically	valuable
balance	discern	interference	preference	various
bankruptcy	discipline	interrupt	preferred	vegetable
bargain	discussion	iridescent	prejudice	vehicle
basically	dispel	irrelevant	prejudiced	vengeance
battalion	disservice	irreplaceable	primitive	villain
beautiful	dissipate	**J**	privilege	violence
becoming	distinct	jewelry	probably	vicious
before	duly	judgment	proceed	visible
beginning	during	judicial	procedure	**W**
believe	**E**	**K**	profession	warring
beneficial	echoes	knowledge	professor	weather
benefited	efficiency	knowledgeable	publicly	Wednesday
biased	efficient	**L**	purpose	weird
biggest	eighth	laboratory	**Q**	where
boundary	eliminate	later	quantify	whether
Britain	ellipse	lenient	quantity	whistle
bulletin	embarrass	liable	quiet	wholly
bureaucratic	eminent	liaison	quite	whose
business	empty	library	R	writing
	endeavor	lightning	realize	written
	enemy	likely	rebellion	
	enthusiastically	listening	recede	
	entirely	literature	receive	
	entrance	loneliness	recession	

	environment	loose	recommend	
	equipment	lose	reference	
	equipped	lying	referring	
	especially		remembrance	
	essential		reservoir	
	except		rhythm	
	excellent		ridiculous	
	excess			
	existence			
	experience			
	explanation			
	extremely			

2.14: Words that are Commonly Misspelled in Technical Writing

A	D	H	N	S
abrasive	data base	half-life	Newton's law	salinity
absorption	deposition	halogen	nucleation	seismic
aggregate	desiccant	hatchable	nucle	side band
Aleutian	diffraction	heat-treat	**O**	sinusoidal
algae	diffusion	histogram	opaque	solenoid
algorithm	discrete	histology	operable	solid state
alkali	dissymmetry	horsepower	optical	soluble
alkyl	divisible	hybridization	orogeny	space-time
analogous	Doppler effect	hydraulic	oscillation	spectrometer
angular	Doppler radar	hysteresis	**P**	spectroscopy
anomalous	drainage	**I**	parameter	steam-distilled
anomaly	**E**	in situ	peninsula	stochastic
aperture	ebullient	incandescent	permeability	strata
aquatic	ebullition	infinitesimal	Petri dish	stratigraphic
aqueous	eigenfunction	inflection	phosphorus	stratigraphy
aquifer	eigenvalue	infrared	photo-ionization	subsidence
asbestos	emission	interference	photocell	**T**
asymmetry	emissivity	isotropic	piezoelectric	terranes
B	end point	isotropism	Planck's constant	test tube
bandwidth	equilibrium	**L**	plateau	tidal
base line	equinox	least squares	polarization	tonnage
blackbody	evaporation	logarithm	polygon	tornadoes
brackish	eyepiece	luminance	polymerization	transit time
buoyancy	**F**	luminescence	porosity	transmissible
buoyant	facies change	luminescent	precipitation	transmissivity
C	Fahrenheit	luminosity	predominant	transmittance
capacitance	feedback	luminous	**R**	troposphere
Celsius	ferromagnetism	**M**	radiant	trough
cetacean	ferrous	manganese	radio frequency	typhoon
chromatography	filterable	mean life	radioactive	**U**
clear-cut	flow chart	measurable	radiocarbon	unionized
climatology	fluorescence	metallurgical	refractive	**V**
coaxial	fluorescent	metallurgy	resistant	valence

combustible	Fourier series	midpoint	resistivity	viscometer
condensation	Fresnel equations	monetar	retardance	viscosimeter
conductivity	**G**		reversible	viscosity
configuration	geyser		rock salt	viscous
corollary	glacial			visible
corrosion	gradient			**W**
crustacean				wave front
crustal				wave packet
crystalline				wave system
crystallography				wave theory
				wavelength
				wettability
				X
				xenolith

Self-Study

Word lists of additional commonly misspelled technical terms appear at these sites:

Extensive list of commonly misspelled technical terms

"A Short Guide to Technical Writing" page from the University of Utah

CHAPTER OVERVIEW

3: Commonly Misused Terms and Phrases

3.1: Introduction

When I woke up this morning my girlfriend asked me, " Did you sleep good?" I said, "No, I made a few mistakes."—Steven Wright

This chapter is for everyone. We have all made the mistakes described herein. How many times have you found yourself puzzling over the distinction between "affect" and "effect," "it's" and "its"? It is not surprising that we maintain such uncertainties, because in any town in America you can find billboards and road signs and ads and newspapers with outright usage errors such as these printed boldly for all to see:

"Man Alright After Crocodile Attack" ("Alright" should be "All Right")

"This Line Ten Items or Less" ("Less" should be "Fewer")

"Auction at This Sight: One Week" ("Sight" should be "Site")

"Violent Storm Effects Thousands" ("Effects" should be "Affects")

Perhaps there is little need here to preach about the value of the material in this chapter. Quite simply, in formal writing, conventions have been established to aid us in choosing the best term for the circumstances, and you must make it your business to learn the rules regarding the trickiest and most misused terms. You can also dig up style handbooks with recommendations on using tricky terminology within your discipline. For instance, *Geowriting: A Guide to Writing, Editing, and Printing in Earth Science*, by Robert Bates, gives advice on using such terms as "areal," "lithology," "terrane," and "zone"; medical students can turn to *The Aspen Guide to Effective Health Care Correspondence* or *Writing, Speaking, and Communication Skills for Health Professionals* for advice on commonly used contractual terms including "yellow-dog contract" and "apostolate." If you do not mind investing about 40 bucks, you could purchase *The Chicago Manual of Style*, essentially a bible for book publishers, which answers almost every conceivable style question. Finally, recognize that companies and institutions often develop their own style guides for internal use to address common issues. As an example, my home institution of Penn State publishes an Editorial Style Manual, which addresses local style issues related to such things as campus building names and academic titles. Never hesitate to look up a term for its proper usage if you are uncertain—there is a lot to be said for being correct.

Self-Study

Studying our mistakes can be great fun. As evidence, visit the three sites below. The first is a clever infographic(a visual representation of information), the second is a searchable and comprehensive list, and the third a series of practice quizzes.

33 Commonly Misunderstood Words and Phrases Infographic from GrammarCheck

Common errors in English usage page from Washington State University

"Notorious Confusables" page from Capital Community College

3.2: Absorb / Adsorb

I decided to include these terms because they are used so commonly in science writing, and because even though the spell checker and grammar checker do not distinguish between them, the thinking student obviously must do so. "Absorb," which describes a general process, means "to soak in." A more specialized term, "adsorb" describes the surface of a solid or liquid accumulating gas, vapor, or dissolved matter:

> *This product claims to absorb excess dietary fat.*
>
> *Once the bacteria adsorb to the aluminosilicate mineral surface, they secrete organic molecules.*

3.3: Accept / Except

“Accept” is a verb meaning “receive with consent”:

> *Paraguay did not accept the proposed treaty.*

“Except” is sometimes a verb (meaning “exclude”) but it is more commonly used just as the word “but” is used:

> *We could verify all of the important factors except one.*

3.4: Accurate / Precise

As your cleverest professors might be fond of saying: "A measurement can be accurate without being precise; a measurement can be precise without being accurate." A simple demonstration of this distinction: We can refer to a wrapped collection of hay as a bale (an accurate measurement) without precisely counting its strands; we can scatter the hay and number the strands (a precise measurement) but not accurately call it a bale. More to the point, we cannot claim that a particular event occurred "precisely 20,000 years ago" or that a particular ore reserve weighs "precisely 1 million tonnes"; by definition, such values are measured coarsely rather than exactly. In relation to the weather, we would properly refer to an accurate (true) forecast, but a precise (exact) temperature.

"Accuracy" denotes how closely a measurement approaches its true value. An accurate measure, then, is one that conforms well to an implied or stated benchmark:

> *The accuracy of the test results was verified by running 50 of the samples a second time.*
>
> *This particular scale is accurate to the nearest kilogram.*

"Precise" means marked by a high degree of exactitude:

> *One pint is precisely 568.245 milliliters.*

In the simplest terms, accuracy is about conformity to truth or fact, while precision is about exactness.

Self-Study

For an interesting look at the distinctions between "accurate" and "precise," visit these pages:

Accuracy vs. precision demonstrated by rifle shots at a bull's eye target

"What is the Difference Between Accuracy and Precision?" article by meteorologist Jeff Haby

3.5: Affect / Effect

You are not alone if you commonly confuse "affect" and "effect." These two terms were confused in print as early as 1494. The key to correct usage here is to determine whether the term is being used as a noun or verb, and to discern the intended meaning.

"Affect" is usually used as a verb. (I think of the "a" in "affect" standing for "active verb.") To "affect" is to "influence":

> *The moon affects the tides.*

"Effect" is usually used as a noun, and it means "outcome or result":

> *Inflation is one of the effects of war.*
>
> *Brackish water has negative effects on certain vegetation.*

Finally—to the horror of many—"effect" can also be used as a verb to mean "to bring about," as in the phrase "to effect a change," while "affect" can be used as a noun (usually in psychology) to mean "conscious subjective emotion." Such usages, though infrequent, highlight why you must be particularly careful to choose the correct term for the circumstances, keeping in mind both the intended meaning and the intended part of speech.

Self-Study

To master the difference between "affect" and "effect," study up at the following fun websites:

"Affect" vs. "effect" at grammarlyblog

Article "You Can Affect an Effect (but you shouldn't effect an affect)"

Grammar Girl's "Quick and Dirty Tips" on effect vs.affect

3.6: Alot / Allot

"Alot" is never correct. It is supposed to be two words—therefore: "a lot." Never write a note to your composition professor at the end of the semester assuring her that you "really learned alot."

"Allot" is to "assign a portion to":

> *Twenty minutes were allotted to each speaker.*

3.7: Alright / All right

All wrong. “Alright” is listed in most dictionaries as a common misspelling of what should be two words. In your writing, use “all right”:

> *Once you hear the high-pitched squeal of the recipient’s fax machine, it is all right to send your document.*

3.8: Alternate / Alternative

As an adjective, “alternate” means “every other,” and it is usually used in relation to time or objects:

> *We were asked to focus on alternate lines of the figure. (Every other one.)*

“Alternate” is also a verb, meaning “to switch back and forth in turns”:

> *The wet season alternates with the dry season.*

“Alternative” denotes that a choice was made between at least two things:

> *He chose the polygon method as the best alternative for measuring compressible subsonic flow.*

3.9: Among / Between

“Among” is appropriate to describe broad relationships when more than two things are involved:

Deforestation is among the world’s environmental problems.

Laboratory experiments identified general relationships among crushing parameters, product size, and coal properties.

“Between” is used to describe specific relationships involving only two things:

A satisfactory agreement was reached between the two countries.

Current usage also permits “between” when each entity is considered individually or severally in relation to the others:

Between them, each client agreed that this solution was best.

Ratios were calculated between each of the four fixed-location sites and two moveable sites.

3.10: Amount of / Number of

“Amount of” works with noncountables; “number of” works with countables:

> *The amount of heat is lowered every three minutes. (“Heat” is noncountable.)*
>
> *A number of toggle switches were used in the design of this device. (“Toggle switches” are countable.)*

3.11: And / Or

If you have ever read a lengthy legal document, you have probably encountered an abundant use of "and/or." Nevertheless, in good conscience, I cannot recommend that you use this construction in your writing, because the best style handbooks preach against it and label its use unprofessional. Besides, both "and" and "or" by themselves effectively link ideas that can be considered either individually or collectively. For example, in the second sentence of this paragraph, I used "and" to link "preach against it" and "label its use unprofessional," even though not every style handbook would necessarily do both of these. In other words, "and" can be used to suggest likely combinations of ideas, while "or" can be used to help the reader consider just one idea at a time.

If you feel, as some writers do, that you want to use "and/or" just to be fastidious, instead you should simply word the sentence appropriately to cover the different possibilities:

> *Instead of: "The new propeller design is expected to reduce cavitation and/or drag."*
>
> *Write: "The new propeller design is expected to reduce cavitation, or drag, or both."*

3.12: Area / Region / Section

Use “region” for large geographic units and “area” for smaller ones. Also, keep your usage consistent—the “region” of one paragraph should not become the “area” of another:

> *There are two compost facilities located in the township area, but five located in nearby regions.*

“Section” is best reserved for land sections and cross-sections:

> *Last year, the research team successfully mapped six sections throughout the northeastern part of the state.*

3.13: As / Like

These two words are not interchangeable. “As” means “to the same extent, degree, or in the way that”:

> *The engine responds as it should.*

“Like” means “similar to”:

> *The spadix of a jack-in-the-pulpit looks like a club.*

3.14: Aspect

Literally, an "aspect" is "the idea of a thought viewed by the mind"—in other words, a "thing." Thus, its value is highly limited; yet many writers produce vacant sentences such as "This paper will deal with many aspects of my topic," or "The problem has many aspects, and the first aspect is the most important aspect." Such sentences simply are not worth the ink (nor the electrons).

If the word "thing" is unacceptable (and it usually is), then "aspect" should be too. When you are tempted to use this word, consider alternatives that carry more specific meaning, such as "principle," "property," "factor," "dilemma," "reason," "part." Use the exact, most direct term that best conveys the sentence meaning.

3.15: Assure / Ensure / Insure

In meaning, these three verbs seem to be nearly interchangeable; all three denote a certainty or guarantee being made. However, in practice, the best writers do distinguish among these terms, as follows:

“Assure” is used to refer to interaction between people:

> *The editor assured me that my conclusion was incorrect.*

“Ensure” is used more broadly to mean “to make certain”:

> *The company uses monthly financial disclosures to ensure clients of its solvency.*

“Insure” is favored in instances of guaranteeing life or property against risk:

> *To insure your home against floods, you must purchase extra insurance separate from your homeowner’s policy.*

3.16: Between . . . and / From . . . to

These combinations are not interchangeable, but many writers mistakenly combine “between” with “to” and “from” with “and.” When defining two or more end parameters, “between” is most effectively linked with “and”; “from” most effectively linked with “to” (and more than one “to” may be used in a series of linked terms or phrases):

> *The Ministry plans to construct between 50 and 60 cyclone shelters.*
>
> *From May 1997 to May 2000, the city’s population swelled by 400,000 people.*
>
> *Citizens’ negative responses to Census 2000 ranged from the indifferent to the surly to the downright obscene.*

Also, the hyphen between two values (such as “5-10”) functions invisibly as the word “to” or “through,” but it should only be used alone. Therefore, “It moved 5-10 meters” is correct, while “It moved from 5-10 meters” or “It moved between 5-10 meters” is not.

3.17: Bi / Semi

These two prefixes create some confusion, because they both mean “occurring twice during.” By convention, a writer can correctly use “bimonthly” and “semimonthly” to mean either “twice a month” or “once every two months.” To avoid confusion, I recommend that you follow these standard usage practices:

biweekly = once every two weeks;
bimonthly = once every two months;
semiweekly = twice a week;
semimonthly = twice a month;
semiannually = twice a year.

If confusion still might result in context, avoid using the prefixes and simply write out the time-frame clearly (“every two weeks”; “twice per month”).

3.18: Can / Could

Both “can” and “could” are best used to express factual possibility and scientific likelihood. As opposed to “may” and “might,” which imply permission or human interpretion, “can” and “could” emphasize capacity and likelihood:

> *Experiments show that polluted water can be purified by slow percolation through rocks and sediments. (“Can” emphasizes the capacity for purification.)*
>
> *The results suggested that low-energy photons could have been causing the problem. (“Could” suggests scientific likelihood.)*

3.19: Cite / Site / Sight

“Cite” is a verb meaning “to mention” or “to make reference to”:

She cited the Journal of Atmospheric Sciences in her paper.

“Site” is a noun meaning “location”:

Raleigh is the site of the new mine.

“Sight” is both a noun and a verb that refers to seeing:

We sighted the white smoke plumes before we reached the lime mine. It was quite a sight.

3.20: Coarse / Course

"Coarse" means "of low quality, not fine in texture." The most common meanings for "course" are "a curriculum unit" or "the direction of continuing movement":

> *Most of the rock we encountered was coarse sandstone.*
>
> *A graduate is one who has successfully completed a course of study.*

3.21: Compared to / Compared with

Use "compared to" to point out *similarities* between things:

> *RAM can be compared to ROM in that both involve memory storage.*

Use "compared with" when noting both *similarities* and *differences*:

> *By way of Bernoulli's principle, the mechanics and function of a dragonfly's wings can be compared with those of a dolphin's fins.*

For further discussion of usage issues related to making comparisons, see Grammar Girl's handy "Between," "Compared to," and "Compared with" discussion.

3.22: Complement / Compliment

One could argue that most writers confuse these terms as an error of spelling rather than usage—all the more reason to distinguish between them carefully and avoid an embarrassing, sloppy habit. The distinction is simple: "complement" (note the "e" in the middle) means "something that completes"; "compliment" (note the "i" in the middle) means "to express praise" or "thanks to":

> *Jupiter Scientific Publishing Company recently published The Bible According to Einstein: a Scientific Complement to the Holy Bible for the Third Millennium.*
>
> *The compliments provided in the "Acknowledgments" section of this manual are provided compliments of the author.*

Spelling "complement" correctly is especially important in fields such as biochemistry, where "complement components" and "complement pathways" are cited frequently.

Self-Study

For a nifty and extensive look at how to use "complement" vs "compliment," visit this website:

How to use "complement," at grammarlyblog

3.23: Compose / Constitute / Include

To "compose" or "constitute" is "to form" or "to make up":

Smog is composed of smoke and fog.

Three parts constitute the whole.

"Include" indicates a selective, incomplete listing of constituents, implying the presence of other constituents as well:

The formation includes limestone and shale. (Other constituents are implied.)

3.24: Comprise

Literally, "to comprise" is "to include" or "contain." The earth comprises rocks (it includes them), but rocks do not comprise the earth (they do not include it). Therefore:

> *The Union comprises 50 states.*
>
> *The whole comprises the parts, but not vice versa.*

Strict writers say that using "comprise" in the passive ("One foot is comprised of 12 inches") is unacceptable; instead, use "is composed of" or "is made up of."

3.25: Continual / Continuous

"Continual" describes intermittent activity; "continuous" denotes unceasing, uninterrupted activity. Meals are continual; time is continuous:

> *The Vesuvius volcano in Italy has erupted continually over the past century.*
>
> *Seismometers, which constantly detect and record ground movement, are designed to receive seismic impulses continuously.*

3.26: Different than / Different from

Established usage dictates that “different than” is not correct; good writers use “different from”:

> *In relation to its accessibility, a private web client is different from a public web client.*

3.27: Due to the fact that / The reason is because

These two phrases are both too wordy and too colloquial for formal writing. They also fail to express a simple causal relationship with efficiency. Handily, these phrases can usually be replaced by the word "because":

> *Instead of: "The experiment was halted due to the fact that funding was withdrawn."*
>
> *Write: "The experiment was halted because funding was withdrawn."*

3.28: e.g. / i.e. / et al.

It is important to use these abbreviations literally and to punctuate them correctly. Many writers confuse "e.g." and "i.e.," and many type "et al." improperly or do not properly recognize what words it represents.

The abbreviation "e.g." is from the Latin *exempli gratia* and means, literally, "for example." Periods come after each letter and a comma normally follows unless the example is a single word and no pause is natural:

> *Any facial response (e.g., a surprised blink of both eyes) was recorded.*

The abbreviation "i.e." is from the Latin *id est*, meaning "that is." Loosely, "i.e." is used to mean "therefore" or "in other words." Periods come after each letter and a comma normally follows, depending on whether the wording following the abbreviation dictates a natural pause:

> *In every case Angle 1 was greater than Angle 2—i.e., every viewer perceived a circle.*

The phrase "et al."—from the Latin *et alii*, which literally means "and others"—must always be typed with a space between the two words and with a period after the "l" (since the "al." is an abbreviation). A comma does not follow the abbreviation unless the sentence's grammar requires it. Some journals italicize the phrase because it comes from the Latin, but most do not.

> *Schweiger et al. applied the neural network method.*

Never begin a sentence with any of these three abbreviations; if you want to begin a sentence with "for example" or "therefore," always write the words out.

Self-Study

For an entertaining look at how "et al." is used, visit this site:

Game of Thrones explains "et al." at grammarlyblog

3.29: etc.

This abbreviation means, literally, “and other things.” Many professors urge against using etc. in formal writing because it is, by definition, nonspecific, but it can be used effectively when you have responsibly chosen representative constituents in order to avoid a cumbersome list:

> *All prime numbers between 1 and 101 (2, 3, 5, 7, 11, etc.) were transmitted by the pulsing signal in the movie Contact.*

Tacking on “etc.” at the end of a list introduced by “for example” or “such as” is sloppy, because “for example” suggests that you have already carefully selected and presented the key constituents, which the “etc.” then undermines. Good alternatives to “etc.” are “for example,” or “such as” followed by just a few concrete representative examples that best demonstrate your point.

3.30: Fact / Factor

Use “fact” only in reference to matters capable of being proven; do not use it in matters of subjective judgment:

> *It is a fact that the output of many oil wells is a mixture of both oil and salt water.*

Use “factor” literally to describe a relationship in which one thing is an actual agent for another thing:

> *Porosity and permeability are factors in the level of groundwater pollution.*

Depending on the context, generally acceptable synonyms for factor are “element,” “ingredient,” “component,” and “constituent.”

3.31: Farther / Further

"Farther" is used literally to describe matters of measurable distance (I think of the imbedded word "far," suggesting distance); "further" is more figurative and is used for broader general comparison:

Long Island is farther away from Cape Charles than Cape May.

Antarctica must be explored further.

She is further along in her schooling than I.

Self-Study

For more on this particular usage challenge, visit this site:

"Farther" vs "Further," at grammarlyblog

3.32: Few / Less

Both these words are adjectives, but "few" is usually used to describe countable nouns while "less" is used to describe noncountable nouns. Countable nouns are often physical whereas noncountable ones are often abstract or nonphysical:

> *The industrial trend is in the direction of more machines and fewer people. ("People" are countable.)*
>
> *Less destruction was caused by the earthquake than one would have expected. ("Destruction" is noncountable.)*

If you memorize the phrase "few units = less quantity," you will remember the distinction—"few" is for countables occurring in units, while "less" is for noncountables occurring in quantity.

As often happens in English, exceptions do arise. Sentences involving periods of time, sums of money, or specific measurements usually require "less":

> *The sonde was lowered less than 50 feet.*
>
> *Excavation took less than two weeks.*

3.33: Former / Latter

These two words, sometimes used in combination, are often misused in technical writing. "Former" refers back to the first of two things mentioned; "latter" refers back to the second of two things mentioned:

> *The chief spices used in this dish are coriander and cumin, the former being less pungent.*
>
> *The two diseases studied were Hodgkin's disease and leukemia, with the latter resulting in more fatalities this year.*
>
> *Last year's tornadoes in Tracy, Minnesota, and Kansas City, Kansas—the former measuring F4 and the latter F5—were the two most destructive tornadoes of the summer.*

When more than two members of a list are involved, or when the sentence's context does not clearly indicate an antecedent (a word or phrase being referred back to), then strictly avoid using "former" and "latter."

3.34: Imply / Infer

These two words are too often used interchangeably, but they are completely different in meaning. "Imply" means to suggest or to indicate; "infer" involves a person actively applying deduction:

> *Water droplets accumulating on the outside of a cold glass of water can imply a hot humid day.*
>
> *We can infer that Stonehenge was an early calendar.*

Another way to look at it: We can substitute "suggest" for "imply" and "reason" for "infer," still retaining the correct meaning.

3.35: In terms of

This phrase is virtually meaningless, but we often hear it on the news and in bloated speeches. "In terms of" is really just a wordy and sloppy transition—usually an unoriginal disguise for a simple preposition, such as "in," or a more elegant phrasing, such as "in relation to." "In terms of the cost, it is high," is easily revised to "Its cost is high." Do not use "in terms of," or do so trembling.

3.36: Irregardless

“Irregardless” is just wrong—an invented word. Use “regardless”:

> *The department decided to purchase the geophone regardless of the cost.*

3.37: It's / Its

These two words probably represent the most common usage problem in papers, but the distinction between the words is painfully simple. "It’s" always means "it is." "Its" never does. At first glance, there seems to be an inherent inconsistency, because we usually use apostrophes to indicate possession, but certain words, for instance "its," "hers," and "yours," automatically show possession and need no apostrophes. When you write "it’s" be certain that you mean two words rather than one. Read it to yourself aloud if you have to, reading every "it’s" as "it is."

In war, a country must protect its borders.

It is understood that part of the area’s soil is of glacial origin.

3.38: Lay / Lie

"Lay" (present tense) implies an agent acting on something, and it means "to put, place, or prepare." Its other forms are "laying," "laid" (past tense), and "laid" (with "has," "have," or "had," usually implying a past event that continues into the present):

> *I lay the nugget in the empty pan. (Present tense—the nugget was put there by an agent.)*
>
> *They were laid there centuries ago. (Past tense—they were placed by an agent.)*

"Lie" (present tense) means "to recline" or "to be situated," and its other forms are "lying," "lay" (past tense), and "lain" (with "has," "have," or "had," usually implying a past event that continues into the present):

> *This tomb has lain undisturbed for thousands of years. (Used with the helper "has"—it has been situated.)*
>
> *During field camp in the Connecticut Valley last year, he lay down next to an eight-foot black rat snake. (Past tense—he reclined, albeit briefly, to be sure.)*

3.39: Lead / Led

“Lead” is a present tense verb meaning “to guide” or “to direct”. “Led” is the past tense of the same verb, and it must not be spelled with an “a”:

> *She led a discussion on how best to lead the group.*

3.40: May / Might

"May" expresses possibility, permission, or human interpretation. "Might" is used in the same way, but implies possibility over permission:

> *This outcrop may be studied. (Implies that permission has been given.)*
>
> *This outcrop might be studied. (Implies that the possibility merely exists.)*

Many writers puzzle between "may" and "can," and I always advise them to elect "may" when human permission or human interpretation (especially speculation) is involved, and "can" when the point is more factual or proven:

> *The calculated R2 value of 0.68 demonstrates that a relationship may exist between silica concentration and the presence of iron. (Human speculation is involved.)*
>
> *Tests show that dust particles produced by breakage can carry elementary electrostatic charges. (The statement is more factual and proven than interpretive.)*

3.41: One / You

It is a shame that many high school teachers continue to penalize students for each occurrence of "one" or "you" in an essay. You certainly are permitted to use these words in writing, but you must do so sparingly, appropriately, and for the reader's sake. "You" and "your" are somewhat informal but are nevertheless directed explicitly at the reader; thus they are especially appropriate for memos, letters, advice, or a set of instructions designed to apply to the reader in the act of reading:

> *I am responding to the memo you wrote to me on March 20.*
>
> *Your first task is to remove the nozzle.*

In more formal, technical documents, rely on the word "one" to refer to people generally, ideally as you present them as potential thinkers or doers:

> *One can assume that there is a threshold axis above which the eyes simply cannot detect the difference between a circle and an ellipse.*

Finally, be careful not to switch back and forth arbitrarily between "you" and "one"; be consistent and use your common sense.

3.42: Per

Literally, "per" means "for every" or "according to":

> *It costs 30 cents per gallon.*
>
> *Per your instructions, I completed the lab.*

The phrase "as per" is incorrect—a redundancy.

3.43: Percent / Percentage

These two terms are not interchangeable. “Percent” means “per hundred” and can either be written out or expressed by the symbol %. Ideally, “percent” is always associated with a specific number:

> *The maximum error that can be introduced by over-mixing is 10%.*

“Percentage” is used to refer to a general relationship rather than a specific measure:

> *A large percentage of the people voted, but only 20 percent of the votes counted.*

In published literature, many writers use “percent” as an adjective (“percent quartz”) for economy, especially in figures and tables. If this is done, the same phrasing should be used consistently to refer to the same thing.

3.44: Perfect / Unique

In *Geowriting: A Guide to Writing, Editing, and Printing in Earth Science*, Robert Bates amusingly notes that "unique, like pregnant and dead, is an absolute: it cannot be more or less." "Unique" means "being the only one of its kind"; "perfect" means "without flaw." Professors reading of "a unique insight" or "a perfect software package" could correctly challenge these absolutes—i.e., the insight would certainly parallel others, and the software package could certainly be improved. By definition, uniqueness and perfection are so rare in scientific contexts that the concepts are best avoided in formal writing. And if you dare to refer to something as "perfectly unique," keep an aspirin handy for your professor.

3.45: Perspective / Prospective

These two terms are frequently confused, but their meanings are highly different from each other. The most common use of "perspective" is to mean "point of view":

> *Pickett explained the problem of poverty from a socialist perspective.*

"Prospective" means "expected or likely to happen":

> *The National Agricultural Statistics Service publishes data projecting the prospective plantings for crops each year in the United States.*
>
> *The university requires prospective students to apply by February 1.*

3.46: Pretty / Quite / Rather / Very

In technical writing, avoid the words “pretty,” “quite,” “rather,” and “very” as adjectives. Some writers mistakenly use these words to create emphasis or lend the appearance of exactitude, but this backfires—“the pebble is round” is clearer than “the pebble is quite round.” By definition, these words are nonspecific, and many professors are highly sensitive to their use. Other terms such as “virtually,” “highly,” “essentially,” or “relatively,” may work in their place, but be certain to use these terms literally and sparingly. “Rather” as a comparative word is, of course, valid in an “a rather than b” construction.

3.47: Principal / Principle

These two terms are often confused, but the fact is they have no meanings in common. “Principal” means “first, primary, or main”:

> *The principal feldspar is orthoclase.*

“Principle” implies an abstraction, and it means “a doctrine,” “a truth”:

> *MAN01 teaches basic management principles.*

“Principal,” of course, also denotes the head of a school, and in some fields, “principal” has specialized meaning: in law, a principal empowers another to act as his or her representative; in finance, the principal is the capital of a financial holding as distinguished from the interest.

3.48: Precede / Proceed / Subsequent

Various forms of "precede" and "subsequent" are often confused with each other, but the two terms are opposites. To "precede" is "to come before"; "subsequent" means "following in time":

> *Record albums preceded compact discs.*
>
> *Decades can be devoted to the discovery and subsequent clinical development of a single drug.*

"Precede" is also sometimes confused with "proceed," which means to go forward:

> *When stuck on a particular exam question, proceed to the next question, then return to the difficult question if time allows.*

3.49: Respective / Respectively

“Respective” is an adjective, usually meaning “particular”:

> *On a References page, article titles appear after their respective authors.*

“Respectively” means “in the order mentioned,” and is usually preceded by a comma:

> *Aluminum and iron are evident in about 8 and 5 percent, respectively, of the earth’s crust.*

3.50: That / Which

The rules governing these two words are a bit flexible, but "which" is too often used where "that" should be. "That" is preferable when you are limiting or restricting a noun:

> *A law that does not have public support cannot be enforced. ("A law that" helps to limit the meaning to just one kind of law.)*
>
> *The air dry loss moisture factor appears to control the amount of airborne respirable dust that is liberated from the product. ("Airborne respirable dust that" restricts the dust just to that liberated from the product.)*

The following line from a nursery rhyme is instructive here, because all of the "thats" are correct:

> *This is the rat that ate the cat that lived in the house that Jack built.*

In contrast, "which" introduces a phrase that provides descriptive yet incidental information, and "which" often requires commas on one or both ends of the phrase it introduces:

> *The law, which was enacted in 1897, was soon challenged by the courts.*
>
> *Approximately 71 percent of the earth's surface is covered by a worldwide body of sea water, which is interconnected.*
>
> *The trawl consists of five net bags in a row which are collected on board one at a time as they become filled with oil.*

In short, you use "that" to complete a noun and "which" simply to describe a noun.

Self-Study

Want more on :"that" vs "which"? Check out these entertaining websites:

"Which vs That" article from the worldwidewords.org

James Thurber's advice on why we should "Never monkey with 'Which'"

3.51: Try and / Try to

"Try and" is often used incorrectly to introduce a verb that must be linked with "to." "Try to" is the correct choice:

> *They will try to perform a new survey.*

3.52: Will / Would

"Will" suggests strong probability or future likelihood. "Would" implies the same, but is typically used when the probability is more hypothetical.

> *Eventually these sediments will be deposited on a sea floor. ("Will" expresses strong probability and future likelihood.)*
>
> *At still higher temperatures, the radiation would probably become stronger. ("Would" suggests hypothetical probability.)*

Be especially careful not to overuse "will" and "would," in particular when affirming facts. Some writers habitually compose sentences such as "A comparison of MWD logs and wire line logs would be difficult because they will operate in different environments." In a revised version of this sentence, the writer should eliminate "will" and "would," simply affirming the fact that she knows to be true: "A comparison of MWD logs and wire line logs is difficult because they operate in different environments."

CHAPTER OVERVIEW

4: Equations, Figures, and Tables

4.1: Introduction

Data tortured long enough will almost always confess. —The Economist, May 16, 1998

To underscore the importance of good figure design and captioning, I like to use the following example. Consider this dubiously famous roughhewn figure, which includes no caption:

I wager that few viewers of this figure would be able to fathom what it is meant to represent, and those who guess correctly would probably do so only because they had seen the figure before, properly captioned.

Now consider the figure with the caption added:

Figure 1. Ship Arriving too Late to Save a Drowning Witch (Zappa, 1982).

Without the caption—even though we have all seen simple line drawings, ships, and witch hats—we're unlikely to grasp the figure's meaning. With the aid of the helpful, thoroughly worded caption, however, we can easily understand (and be delighted by) the figure's intended purpose. And with the citation at the end of the caption, we can turn to a References page to discover that this figure is cover art from a 1982 Frank Zappa album cover. This example provides a simple demonstration of how critical it is to write helpful figure captions, and shows how even the simplest graphic can be enigmatic to the reader (especially when not drawn to scale, as in the Zappa figure) when effective clues about its meaning are absent.

Figures, equations, and tables must be presented so that readers can rapidly understand their purpose in your work. They represent opportunities to present your ideas, explanations, and experimental results in a form that is professional, aesthetic, and—tell the truth—even fun. The computer has truly revolutionized the typing of equations and the presentation of graphics for us. However, some professors long for the days when figures had to be drawn laboriously by hand, because the cost and the labor made it inviting to keep figures and tables to a minimum. Now, graphic overkill is common, especially by advanced students; some professors call it the *USA Today* mentality. We must keep in mind that graphics are a means to an end, not an end in themselves.

Also, since readers might leap right to a table or figure while reading an article, it is vital that each table or figure is meaningfully presented and works both independently and as part of the text. Carefully study the tables and figures published in the best journals in your field, and apply the same conventions of presentation to your own work.

This chapter's aim is not to make it easier for you to create equations, figures, or tables—computer software has made their creation easy enough—but to teach you how to make your presentation of them professional. For much more on how to present tables and figures, and for a nifty review of the different types, I highly recommend Paul V. Anderson's *Technical Writing: A Reader-Centered Approach*. I have looked at over 40 textbooks that give space to the subject, and Anderson's chapters are the best I have seen.

Self-Study

Browse these two websites for advice on presenting data in research papers:

The aptly named "resources for the ambitious undergraduate or beginning graduate researcher in astronomy and astrophysics"

"The Data Analysis BriefBook" on statistics, computing, analysis, and related fields

4.2: Style for Equations

This section offers concrete advice about some of the mechanics of style for presenting equations. For specific rules about such details as punctuation, spacing, or the flushing of elements, the best idea is to check out a journal or textbook in your field and learn by example.

Self-Study

To review basic principles of equations, study these sites:

"How to Set Up Algebraic Equations to Match Word Problems" page from homeschoolmath.net

"Fundamental Principles of Algebra" page from ibiblio.org

In the absence of any rules about how equations are presented in a particular class, follow these best practices when using equations:

- Set off and center equations on their own separate lines of text if the equations are long, contain more than one or two symbols that must be identified, or contain expressions with numerators and denominators that fall on different lines.
- When you center an equation, skip a line above and below it, and skip an extra line or two if the equation includes any symbols of more than letter height. Make the equation easy to find and easy to read.
- When appropriate, define any symbols that you use.
- If possible, do not let an equation spill from one page to another.
- Equations are not always numbered, especially if only a handful occur in a paper. However, if you need to refer back to equations already introduced in the text, you should number all equations in sequence. Do this by identifying the number of the equation in parentheses at the right-hand margin of the line on which the equation appears. Then you can readily refer back to it with a phrase such as "Equation 3 describes a contrasting relationship."
- When numbering an equation, be sure the number is set far enough away from it that it does not seem to be a member of the equation.

4.3: Equations as Sentence Parts

The following advice will help you to integrate equations into your sentences and understand them as grammatical units.

- Grammatically, you can think of an equation as a single noun and generally treat it as such. Usually an equation is followed by a comma after it is presented (especially when followed by descriptions of its individual members) or by a period if the sentence has ended. Some journals do not follow the equation with any punctuation marks, relying on the wording of the sentence alone to carry the meaning.
- Short and uncomplicated equations can simply be included as part of a sentence without any special spacing. However, be sure that the equation flows as a readable unit of the sentence. Example:

  The equation $2H_2+1O_2 \rightarrow 2H_2O$ *represents how hydrogen and oxygen react to form water.*

- It is common to use the word "we" to introduce equations to enhance efficiency, foster readability, and promote the active voice. Handy phrases with which to introduce equations include "we can express," "we can approximate," and "we can describe." Example:

  We can express the distance of this transition region by the equation . . .

- If an equation is too long for a single line, break it just before a "verb" (such as the = sign) or a "conjunction" (such as the + sign) and make the following symbol the first member of the next line, then continue the equation.
- When appropriate, define members of the equation just after you present it, usually by introducing them with the word "where." For example, if you wanted to define "t" and "n" just after they appeared in an equation, a phrase such as this would appear: "where t is the film thickness and n is a constant equal to 0.4."
- Unlike a figure or table, an equation does not "stand alone" in a paper. Always use the wording that precedes an equation to introduce it, thus making it a distinct member of a particular sentence.

4.4: Sample Equation

In the simple sample equation that follows, note how the equation is followed by a comma and is presented as a grammatical member of a smooth, simple, fluid sentence. Note also the use of semicolons and commas to separate members of the equation as each is described.

> *The duration of the heating cycle can be approximated by the equation*
>
> $t = 2R_tC_t$,
>
> *where t = cycle time, s;* R_t*= resistance,* Ω *and* C_t *= capacitance, F.*

4.5: Writing Equations with LaTeX

If your field requires you to use equations regularly, and especially if you plan to write a paper or publish an article or book that includes multiple and complex equations, the computer language that you are likely to have to use is called LaTeX. LaTeX, originally developed in the 1980s by Leslie Lamport, allows you to generate camera-ready format and equations using predefined macros rather than all manual text. If you need to publish your material on the web, LaTeX is especially valuable, since you can easily convert an equation to a pdf and post it on the web in a format that will be readable no matter what browser your reader is using.

Writers unfamiliar with using LaTeX tend to start with a tutorial, such as this basic "quick and dirty" LaTeX tutorial, this one from Drexel University, or with Leslie Lamport's definitive book LaTeX: A Document Preparation System.

Self-Study

Free tips and tricks for using LaTeX abound on the web. Here are two recommended sites:

Basic LaTeX tips from the University of Illinois Department of Mathematics

"LaTeX: Tips and Tricks" from wikibooks.org

4.6: Figures and Tables Overview

Because figures and tables can now be created by just a few keystrokes, it is tempting to swamp the reader with them or get caught up so much in bells and whistles that fundamentals are ignored. Some papers include oversized three-dimensional objects to display one-dimensional data, the illogical use of a different color to represent each data point, or fancy fonts and special effects that dazzle the eye but confuse the mind. Just as commonly, there is a lack of elemental detail or care: Xeroxed figures or tables from a textbook with the original (and therefore inaccurate) page numbers not even whited out; a figure whose caption is simply "Costs"; undefined terms, unlabeled axes, uncited data. The list could go on for too long.

Yet these errors are just as easily avoided as committed, especially if you only use figures and tables when it is appropriate to do so. Tables and figures are supposed to be designed to simplify and condense the presentation of what is otherwise complex information. Their function is to save the reader time, enhance comprehension, and allow rapid comparison and interpretation of relationships or trends. Remember this as you prepare figures and tables, and present them accordingly. Further, understand the inherent problems associated with data sets that are either too large or too small, the need for proper scale, both the pitfalls and value of color, and that good graphics are purposed to make sense of data, not vice versa.

Self-Study

Excellent discussions of figure and table basics await you at these sites:

Advice on creating tables and figures from Bates College

"Using Figures, Tables, and Graphs" page from Monash University

4.7: Using Statistics in Figures and Tables

As you prepare figures and tables, remember how *not* to lie with statistics. One could accurately report that the real income of United States households was nearly the same in 1969 and 1992. However, according to an April 24, 1995, article in *Forbes* magazine, the real income per person grew by almost 40 percent in that span of time, because average family size and average household size declined. As this example demonstrates, effective data presentation and description often require you to set proper context.

For an excellent review of how to achieve graphical excellence, chase down and study Edward R. Tufte's *The Visual Display of Quantitative Information*. To gain insight into how to avoid choosing statistics merely for the occasion, track down a copy of Darrell Huff's ironically titled classic, *How to Lie with Statistics*.

Self-Study

Entertaining webpages written by scientists on typical errors of data analysis reside at:

"Popular Pitfalls of Data Analysis" page from a Research Fellow at the Norwegian University of Science and Technology

"Pitfalls of Data Analysis" article from Clay Helberg

4.8: Fundamentals for Figures

Whether they be pie charts or digital stills, figures are fundamentally defined as drawn or photographed pictures. Basics about how they are used follow:

- Be sure to name figures properly; do not accidentally call them tables, even if they include words and numbers.
- As a general rule, orient figures from left to right, in that readers are used to following that path with their eyes.
- Use line graphs to plot *continuous variables*, such as time or temperature. Line graphs are especially handy to show relationships among measured variables.
- Use pie charts or bar graphs to depict *discontinuous variables*, such as percentages or sampling that occurred in intervals. Pie charts are especially useful when you wish to show the relation of parts to a whole.
- Use photographs or drawings for material that is large in scale, such as a cloud or an office building, or very small in scale, such as the grain boundaries of a sample.
- Use flowcharts to represent pathways of activities and outcomes. Most flowcharts use simple geometric shapes (circles, rectangles) to represent activities and arrows to indicate change from one event to the next.
- If possible, label the axes of graphs with full words: "Temperature versus time" rather than "T versus t."
- Be certain that your legend—that part of the figure where you define any symbols or other visual markers that appear—is readable, clear, and meaningfully placed. As long as it does not overwhelm the rest of the figure, do not be afraid to make the legend large to enhance its readability.
- Use footnotes (a simple asterisk to indicate them will do) for explanatory material such as the number of respondents to a survey or the fact that certain values were estimated.

4.9: Fundamentals for Tables

By definition, tables are lists of words or numbers arranged in columns and rows. Follow these practices when creating them:

- Be sure to name tables properly; do not accidentally call them figures. The basic difference between them is that tables do not involve pictures.
- Make certain that each entry in the left-most column (called the stub) applies across its entire row, and that each column heading pertains to all entries beneath it.
- Arrange stub items by a logic suited to the context—largest to smallest, alphabetically, by category, or for emphasis.
- Straight lines are often used to separate the table's title from the column heads, the column heads from the body of the table, and the bottom of the table from the paper's text or the table's footnotes. Boxes around and within the table are also appropriate, especially if they aid the eye in vertical movement.
- If possible, construct a table so that the reader's eye can primarily travel down a column rather than have to read along a row.
- Use footnotes (a simple asterisk to indicate them will do) for important explanatory material such as the provider of testing equipment or the fact that a particular sample became contaminated.

4.10: Aesthetics for Figures and Tables

Making figures and tables look good requires you to consider elements such as color, organization, readability, and visual clarity. To be certain your figures and tables have aesthetic appeal, heed these practices:

- Do not crowd a table or figure, neither within itself nor within your text; give it room to breathe. When it appears amidst your body text, skip at least one line above and below it.
- Always beware of creating a 3-D or special effects monster. Do not clutter any visual information with needless items or parts. Every item in the table or figure should have a function—therefore do not do things such as number items unless the numbers actually carry meaning.
- Organize information so that it is prioritized and easily seen. It is acceptable to highlight a part of a picture or boldface a column of a table to emphasize it, but be certain to explain such emphasis in the caption.
- As a general rule, place figures and tables right in the text as soon as possible after they are mentioned. If the figure or table cannot be imbedded into the body text, it is common to put it on a separate numbered page that appears on the page immediately following the first body text reference. It is also generally acceptable to include all tables and figures, in order, on separate pages at the end of the document just after the references page, especially in a lengthy paper or thesis.
- Give each table and figure its own separate page unless it is logical to group them together.
- If it can be avoided, no single figure or table should spill over to a second page. To keep this from happening, you may orient the table or figure horizontally or break it into parts.
- Rule of thumb: Try to present the table or figure so that it would make sense even if ripped from the paper.

4.11: Textual References to Figures and Tables

When integrating references to figures and tables within your text, follow these guidelines:

- Number figures and tables consecutively in the text, beginning with the number 1. Be sure to number figures and tables separately from each other.
- Capitalize the "t" in "table" and the "f" in "figure" when you refer to a specific table or figure created in your text. (Some journals do not follow this convention, but most do.)
- "Table 3 and 4" is incorrect because each table is a separate entity. If you refer to more than one table or figure at a time, pluralize the reference. "Tables 3 and 4" is correct.
- Introduce figures and tables in your text in logical places and in logical ways. In some cases, it may simply be appropriate to write "see Figure 7" in parentheses at the end of a paragraph that prepared the reader to view the figure; in other cases, it is appropriate to introduce a figure or table at the beginning of the paragraph and build the entire paragraph around it.
- In your body text, always spell out the point that you want your reader to get from your figure or table. Example:

  As Figure 8 indicates, the modulus of the transverse direction was always equal to or greater than the modulus of the machine direction.

- Use some of your body text to interpret a table or figure, but only to a sensible degree, and after it is introduced rather than before. When interpreting, avoid needless redundancy. If your pie chart shows percentages for the market distribution of platinum, say, there is no point in your repeating all these percentages in your body text unless you have something meaningful to say about them.
- When a reference to a table or a figure is a sentence subject, match it with an interpretive verb to describe the work that the table or figure performs. Examples:

  Figure 2 illustrates the predominant orientation of acicular particles in magnetic storage material.

  Figure 5 compares two magnetization curves for hard and soft magnetic materials.

- "Show" is generally a safe verb to use to describe a table or figure, but beware of overusing it or using it too loosely. Good alternatives to "show" include "display," "demonstrate," "illustrate," "depict" (for figures), and "list" (for tables). As always, search for the *best* verb to describe your figure or table. For ideas on active verbs you can use to refer to figures and tables, see the handy table on the "Using Active Verbs" page in chapter 1 of this manual.

4.12: Captions for Figures and Tables

In papers written for classes and submitted to journals, every table and figure should include a caption, honoring these common practices:

- The caption for a figure appears below the graphic; for a table, above. It is easy to get this wrong accidentally.
- Typically, boldface or underscore the word "Figure" or "Table" and the associated number in the caption, then present the caption in plain text with only the initial letter of the caption and any proper names in the caption capitalized (see example below).
- Always concentrate on completeness and concreteness as you caption figures and tables. "**Figure 3**: Air flow" is far less illuminating and accurate than the following:

Figure 3. *The motion of a parcel of air as it flows across a mountain.*

- Do not be afraid to use lengthy figure and table captions—better that than confusing or incomplete ones.
- If your figure or table is essentially the same as or based on another author's, but you recreated or adapted it, it is standard to include the words "Adapted from" or "After" followed by the author's name and a citation at the end of the caption.
- Always cite the figure or table if it—or its data—came from a source, using the same citation style that you have used throughout the paper. The most logical place for the citation to appear is at the end of the caption. See chapter 5 of this manual for a thorough discussion of rules for source citation.

4.13: Sample Figures

Artful figure presentation takes some practice to master, but two basic categories—a simple figure and a complex figure—provide for a useful starting point.

Simple Figure

The purpose of a simple figure, often in the form of a picture or a map, is typically to give the reader basic visual context. The simple figure that follows is in the form of a cartoon cutaway, with its purpose to give the viewer an idea of how a fan from a heater can stir up dust at a worker's feet in an enclosed cab.

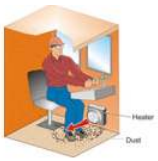


Figure 1. Floor heater stirring up dust in an enclosed cab.

Complex Figure

Complex figures are handy when we want readers to compare multiple pieces of information or to establish analytical relationships among parts. The complex figure and corresponding text that follow were published in the proceedings of the year 2000 Conference of The International Emergency Management Society. I chose this figure because, as often occurs in papers, it is effectively introduced at the end of a paragraph describing its function, and because it includes a thorough, descriptive caption.

This figure is especially useful because it visually aids us in understanding the possible relationships among various players in a rescue operation—something that would not easily be described by text alone. Given that the viewers of the figure are intended to understand human movement and interactions within two different field areas (an "area of operation" and a "command post"), depiction of these interactions greatly simplifies our understanding and connects us to the place of activity better than text alone could.

> *To analyze command and control in rescue operations, we need to capture the temporal aspects of the interaction between the command post and the units in the area of operation. Figure 1 illustrates the data collection needs and the applicability of the corresponding support tools.*

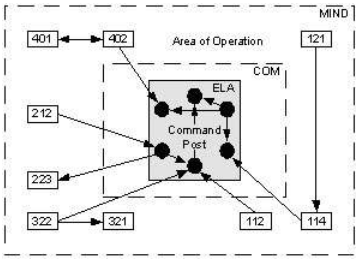


Figure 1. A graphical description of different possible tools for registering the course of events in different areas. ELA is effective inside the command post. The communication between the command post (gray box) and other units (boxes with 3 digit numbers) is identified in the communication layer. A model of the dynamic course of events in the area of operation is created using an instrumentation system, for example MIND.

As this sample figure demonstrates, the caption to a figure, especially a complex one, can do far more work than just identify the nature of the picture. The caption can describe the trend being demonstrated, can explain to the reader how to view the figure, and can build on the text within the paper beyond the figure caption (thus the references in the example to ELA and MIND).

4.14: Sample Tables

Tables used in papers can be so simple that they are "informal" enough to be a sentence member and not require a caption, or they can be complex enough that they require spreadsheets spanning several pages. A table's fundamental purpose should always be to visually simplify complex material, in particular when the table is designed to help the reader identify trends. Here, a simple table and a complex table are used to demonstrate how tables help writers to record and "visualize" information and data.

Simple Table

The simple table that follows, from a student's progress report to his advisor, represents how tables need not always be about data presentation. Here the rows and columns simply make it easy for the writer to present the necessary information with efficiency. This unnumbered and informal table, in effect, explains itself.

Plan for Weekly Process for the Remainder of the Semester

Week of 11/28	Contact Dr. Berinni for relevant literature suggestions. Read lit reviews from *Vibrational Spectroscopy*. Research experimental methods used to test polyurethanes, including infrared (IR) spectroscopy and nuclear magnetic resonance (NMR).
Week of 12/5	Define specific ways that polyurethanes can be improved. Develop experimental plan.
Week of 12/12	Create visual aids, depicting chemical reactions and experimental setups. Prepare draft of analytical report.
Week of 12/18	Turn in copy of preliminary analytical report, to be expanded upon next semester.

Complex Table

The following sample table is excerpted from a student's senior thesis about tests conducted on Pennsylvania coal. Note the specificity of the table's caption. Also note the level of discussion following the table, and how the writer uses the data from the table to move toward an explanation of the trends that the table reveals.

Table 1 summarizes the results of borehole dilution testing and slug testing on wells B2, B3, and B4. The hydraulic conductivities computed from the borehole dilution test velocities for these wells range over an order of magnitude—a reasonable spread for hydraulic properties of close, but varying, test sites.

Table 1. Water velocities and hydraulic conductivities of the Lower Kittanning coal at the Kaufmann site in Clearfield County, Pennsylvania, from slug tests, November 1991, and borehole dilution (BD) tests, November 1992.

Well #	Velocity: BD tests	Hydraulic Conductivity: BD tests (p_e = 0.01)	Hydraulic Conductivity: BD tests (p_e = 0.05)	Hydraulic Conductivity: slug tests
B2	0.054 ft/d	1.1 x 10^{-2} ft/d	0.054 ft/d	0.19 ft/d
B3	0.32 ft/d	0.07 ft/d	0.32 ft/d	8.9 x 10^{-3} ft/d
B4	0.06 ft/d	1.2 x 10^{-2} ft/d	6.0 x 10^{-2} ft/d	2.8 x 10^{-2} ft/d

The hydraulic conductivities computed from the borehole dilution test velocities are significantly lower than those predicted by Huang and Sheltons' core analysis of Middle Kittanning coal. As shown in Table 1, the borehole dilution hydraulic

> conductivity values for wells B2 and B4 agree reasonably well with their corresponding slug test values, assuming an effective porosity between 0.01 and 0.05. This effective porosity seems high, but the dip of bedding in the study area is opposite the regional dip. This implies slumping, which could increase the effective porosity significantly.

Above, we see how the table caption and supporting text are tightly intertwined, with the aim of describing a trend. In this case, the writer compares her table data to the work of other authors and extracts key test results and quantities from the table to discuss in the paper's text. Here, we learn that "wells B2 and B4 agree reasonably well with their corresponding slug test values," and we can retreat to the table for verification if we wish. Put simply, the table records the facts; the writer selects from the facts to interpret the trend.

4.15: Discipline-Specific Advice on Equations, Figures, and Tables

The material in this chapter is intended as a broad and fundamental look at how to manage equations, figures, and tables in your writing. Style manuals within your field will offer much more detailed advice, possibly devoting a chapter or more to the subject. For instance, an excellent book by Dr. David Schultz, chief editor for Monthly Weather Review, offers about 30 pages of advice on equations, figures, and tables. Schutz's chapter covers specialized forms such as the Cartesian grid, thermodynamic diagrams, and the use of GEMPAK software in meteorology, while also discussing nuances of legibility during rescaling, the use of nonlinear axes, shading and color, and line graphs vs. scatterplots. Schultz's book is titled *Eloquent Science: A Practical Guide to Becoming a Better Writer, Speaker & Atmospheric Scientist*.

If you intend to be taken seriously as a published writer within your field, shelling out the cash for handbooks within your field will pay handsome dividends. For some additional recommended titles of style manuals and handbooks—where you will find discipline-specific advice that goes well beyond equations, figures, and tables—see the page "Some Recommended Print Resources" in chapter 5 of this manual.

CHAPTER OVERVIEW

5: Using Sources

5.1: Introduction to Using Sources

> Thank you for sending me a copy of your book. I'll waste no time reading it. —Moses Hadas

This chapter is an especially important one. With the explosion of available online information that has emerged since Al Gore invented the internet, many students enter college with the attitude that they will never set a single toe in any library that has a hard-surface floor and stacks of shelved books. Indeed, it is possible to write many college papers using only internet resources, and many professors embrace the internet by assigning papers that promote or demand its use. Modern libraries must and do scramble to keep up as well, subscribing to online journals and CD-ROMs so that students can work in virtual space and download to their desktops with a single click of the mouse.

So how do you address this issue of effectively using and documenting sources, whether internet or print resources? The answer lies in applying professional standards to your work, recognizing how your research and writing process inform the product you produce, understanding how the modern library is best used, and mastering the mechanics of citation. The issue of mechanics—citing your sources properly, especially on your references page—remains a challenge for many writers, and the question of exactly how to cite web sources makes things even murkier. With various citation styles available and URLs that are longer than the alphabet, what is a writer to do?

The material in this chapter will help you to address these issues and provide you with resources where you can track down more information. Whatever your writing process, even if you are in the habit of resorting to the "patch and pray" method, my aim is to help you approach the writing process professionally, begin to understand how to assess the quality of all of your sources, whether print- or web-based, and clarify the mechanics of citation. So press on, and recognize that your facility at using resources highly influences your reader's perception of your work.

Self-Study

For tips on how to integrate sources into your papers and an excellent overview of some of the most common options for the mechanics of citation, I recommend the pages at the following sites:

- "Using Introductory Tags in Research Writing," from LEO: Literacy Education OnLine
- "Style Guide Resources: MLA, APA, CSE, Chicago," from informED

5.2: How Plagiarism Occurs

To discuss professionalism and writing, we should begin with the most obvious problem: **plagiarism**. Outright plagiarism is always a serious offense, and, when professors forgive it, it is usually because they see it as a terribly dumb and desperate act. In a composition class that I taught, I once had a foolish student plagiarize from someone in the same section (then he was surprised that I noticed—duh), and in the hallways I have heard students talk about "getting away with" blatant plagiarism on papers. Further, there are ample websites (I will not supply their URLs here, natch) where lazy students can download ready-made papers and turn them in for their classes. (Savvy professors can track down these papers readily, of course, perhaps by submitting a suspicious paper to http://turnitin.com/,a website devoted to helping teachers check submitted papers for originality.)

However, as a writing tutor for 20 years I discussed this issue almost daily with students, and I am convinced that many students plagiarize "accidentally"—that is, they fail to cite information they took from a source because they quickly, if tentatively, assess that the information they chose resides in a "gray area," and thus it might not need to be cited. They reason, "Why bother if I'm unsure?", or "Why risk doing it poorly?" Further, students frequently oversimplify this issue by rationalizing that the information appeared in an encyclopedia or in several books and therefore it need not be cited. In one case, I had a student say to me, "If it's on the internet, by definition, it's common knowledge, and therefore I don't have to cite it." Such thinking causes me pain.

What such writers must realize is that one's use and citation of sources has to be both reflective and discerning. The quality and context of your sources matter just as much as their content, and you are obliged always to assess that quality and consider whether and how best to establish that context. Your readers—especially your professors—will naturally be assessing quality and context in the act of reading, and they will expect you to have done the same. When using web-based sources, the responsibility to cite your material conscientiously remains, and in fact your responsibility to assess the credibility of the information increases simply because the material did in fact appear on the web. Further, if you see in-text citation of sources as a final, merely trivial step to writing rather than as an integral part, you are bound to slip up somewhere in your citation practice or lose track of the relationship between your own ideas and those of your sources. I am always surprised at the number of students who sit down with me to review a "complete" paper draft, yet with no sources cited. "Oh, I do that last," they say, then during our tutorials we invariably encounter problems that can only be reconciled by a better handling of source material. Stated simply, using sources well in your paper is not a matter of mere mechanics; it is the art of blending source material within the context of a focused argument as you write.

Unfortunately, the norm for many students is that they spend hours unreflectively surfing the web with an overly broad research focus, or they quickly Xerox anything that looks relevant in the library, then, 24 or 12 hours before the deadline, they sit down and start tapping madly into the word processor, sometimes simply lifting whole paragraphs from their sources and hoping that it looks like their own work, loudly assuring themselves and their friends that they "work best under pressure." If this is your technique, you will find that it fails you miserably when it comes to writing a thesis or working on a lengthy writing project on the job. Writing a long research paper in a day is a bit like pulling an all-nighter on Christmas Eve to crochet a quilt—the end product looks hurried and flimsy, and you can be sure that you have left many loose ends and produced a lousy Christmas gift.

Self-Study

An excellent guide, along with examples, about different types of plagiarism and how to avoid them resides here:

"Grammar Guides" at australianhelp.com

5.3: Assessing Source Quality

Especially if you are surfing the web, your research process should commence with a quality check of any sources you plan to use. Many writers begin badly in this area, simply typing, say, "genetics" into a search engine and getting a return of over 90,000 hits. The likely result is an arbitrary research process, yielding sources vastly varying in quality. The first step when writing a research paper should always be narrowing your focus and choosing quality sources to fit the circumstances.

To run a quality check on your sources, follow these guidelines:

- Begin by discerning the expected quality of resources in relation to the paper you are writing. Read carefully any material supplied by the professor regarding the assignment. Typically, you will be told if your paper should favor primary sources (original evidence provided by participants) or secondary sources (interpretations of primary sources by authors). Specific sources might be suggested to you, and parameters for using internet resources might also be discussed.
- Assess the author's credibility and bias. This could be established by your finding out and providing efficient biographical information on the author, and interpreting the author's agenda through the tone of the text, the kinds of examples provided, and the level of audience to whom the author is writing.
- Note whether the author has any professional affiliation, and how this affiliation connects to the author's work. Especially with websites, where an organization might be considered the author, the question of affiliation and professional status becomes especially important. The most credible resources often have ties to professional organizations with standards for membership, for instance. The most credible web pages are often affiliated with a professional sponsoring organization. And we should expect different commentary on the same incident by, say, a chemical plant representative as opposed to a spokesperson from the Environmental Protection Agency.
- Assess the level of information and interpretation the source provides. Encyclopedias, dictionaries, and other information-based resources are perfectly good for attaining or verifying dates and facts, but keep in mind that the information provided may be viewed as elementary by your readers, and typically little if any authorial interpretation is provided in such sources.
- Carefully consider the sources cited by *your* sources. This not only gives you a potential reading list, it helps you determine the quality of your sources' research. Are the cited sources primary or secondary? encyclopedia or journal articles? biased or objective?
- For both print and web resources, look for clear indicators of quality in both form and content. Are you using a cheaply produced brochure by an organization interested in self-promotion and fundraising, or a book published by a government agency or established press? Is the material written with grace and clarity, organized effectively, and professional in appearance, or is the writing style embarrassing, the organization haphazard, the text awash in typos?
- Note how current the information is, especially if the material comes from the web. In this regard, the internet is sometimes superior to the print medium, in that information might be published either exclusively or first on the web. However, also assess whether the source of information is outdated, or should be compared to information from a different time or a different medium.

Self-Study

For more information on assessing source quality, especially of internet resources, turn to these sites:

- "Evaluating Information Found on the Internet" article from Johns Hopkins University
- "Research Using the Internet" advice from the University of Toronto

5.4: Why We Cite Sources

A colleague of mine once told me a story that proves how small the academic world can be while underscoring the best reason to document sources: Doing so is likely to make you friends; failing to do so can only make you enemies. This colleague was asked to review a proposal submitted to the National Science Foundation, and was irate when he realized that an author of the proposal did not acknowledge my colleague's work when he clearly should have. An investigation confirmed my colleague's suspicions, which stung all the more because he had once actually nominated the author for an award. For my colleague, the author, and the National Science Foundation, this became an unpleasant situation all around, breeding distrust and embarrassment. A lot of time was wasted. All of this could have been avoided if the author had merely put his research into the appropriate context by properly acknowledging his sources. Instead, the author—whether intentionally or not—plagiarized, thus hurting other members of his proposal team as well.

When you write papers, you might be tempted to plagiarize to try to cover up the fact that almost all of your paper came directly from sources or that you relied heavily on the internet for your research. Your well-read professors will not be fooled by this tactic, though, and part of your job as a researcher and writer is to organize, assimilate, and recast your information in your own form. If you find yourself doing such things as using the same source for several paragraphs in a row or failing even to provide your own topic sentences for paragraphs, you are obviously not doing your job as a thinking writer. Do not fall back on the flimsy excuse that you might as well just copy it exactly as it appeared because you "like the way it was written." The context for your writing is different from the context of the original. The reason you use sources in the first place is to simplify and summarize information and weave it into the pattern of your own ideas, and your pattern of ideas will develop as you write and do your research.

5.5: When Sources Must Be Cited (Checklist)

Information that always must be cited—whether web-based or print-based—includes:

- Quotations, opinions, and predictions, whether directly quoted or paraphrased.
- Statistics derived by the original author.
- Visuals in the original.
- Another author's theories.
- Case studies.
- Another author's direct experimental methods or results.
- Another author's specialized research procedures or findings.

If you use specific information of the type just mentioned, document it; otherwise you could be plagiarizing. Better safe than lazy. By citing the source of your information you point to an authority rather than ask your reader to trust your memory or what might appear to be your own idea. Even though you can recall a statistic or a description of a process, for example, citation of such information—if it came directly from a source—gives more credibility to your writing and underscores the accuracy, timeliness, and even the potential bias of your information. In short, be honest, smart, and safe.

5.6: Integrating Source Material

In technical writing, integrating source material is a process of selection, extraction, and recontextualizing. Technical writing rarely relies on direct quotations, because the author's exact wording is usually not as relevant as the data or information reported. Suppose you are writing a technical paper on mine safety, for example, and you encounter this material:

> *Since 1870, 121,000 mining deaths have occurred; 1.7 million lost-time injuries have been recorded since 1930. Historically, all of this has contributed to the public's negative perception of mining safety and even helped to fuel the NIMBY mentality.*

It is highly unlikely that you would quote these sentences directly, especially because some of the material is data and some is interpretation. The exact wording does not matter, but some of the material does, so your job is to extract only the relevant information, use it, and cite the source.

Similarly, there is no good reason to quote this sentence directly:

> *Acid mine drainage has been and continues to be a major problem generated by the mining of coal in Pennsylvania and elsewhere in the world.*

In this instance, the information is so general that it need not even be cited, but neither should the sentence itself just be plucked out and plopped into your paper. Ideally, the information from the above sentence would simply end up as part of a sentence of your own creation such as this one:

> *This paper explores the three chief reasons why acid mine drainage continues to be a major environmental problem in Pennsylvania.*

In this example, note how the relevant information is extracted from the source, without the need for citation, and note how the writer creates new context for the information.

5.7: Blending Source Material with Your Own Work

When working with sources, many students worry they are simply regurgitating ideas that others formulated. That is why it is important for you to develop your own assertions, organize your findings so that your own ideas are still the thrust of the paper, and take care not to rely too much on any one source, or your paper's content might be controlled too heavily by that source.

In practical terms, some ways to develop and back up your assertions include:

- *Blend sources with your assertions*. Organize your sources before and as you write so that they blend, even within paragraphs. Your paper—both globally and at the paragraph level—should reveal relationships among your sources, and should also reveal the relationships between your own ideas and those of your sources.
- *Write an original introduction and conclusion*. As much as is practical, make the paper's introduction and conclusion your own ideas or your own synthesis of the ideas inherent in your research. Use sources minimally in your introduction and conclusion.
- *Open and close paragraphs with originality*. In general, use the openings and closing of your paragraphs to reveal your work —"enclose" your sources among your assertions. At a minimum, create your own topic sentences and wrap-up sentences for paragraphs.
- *Use transparent rhetorical strategies*. When appropriate, outwardly practice such rhetorical strategies as analysis, synthesis, comparison, contrast, summary, description, definition, hierarchical structure, evaluation, hypothesis, generalization, classification, and even narration. Prove to your reader that you are *thinking* as you write.

Also, you must clarify where your own ideas end and the cited information begins. Part of your job is to help your reader draw the line between these two things, often by the way you create context for the cited information. A phrase such as "A 1979 study revealed that . . ." is an obvious announcement of citation to come. Another recommended technique is the insertion of the author's name into the text to announce the beginning of your cited information. You may worry that you are not allowed to give the actual names of sources you have studied in the paper's text, but just the opposite is true. In fact, the more respectable a source you cite, the more impressed your reader is likely to be with your material while reading. If you note that the source is the NASA Science website or an article by Stephen Jay Gould or a recent edition of *The Wall Street Journal* right in your text, you offer your readers immediate context without their having to guess or flip to the references page to look up the source.

What follows is an excerpt from a political science paper that clearly and admirably draws the line between writer and cited information:

> *The above political upheaval illuminates the reasons behind the growing Iranian hatred of foreign interference; as a result of this hatred, three enduring geopolitical patterns have evolved in Iran, as noted by John Limbert. First . . .*

Note how the writer begins by redefining her previous paragraph's topic (political upheaval), then connects this to Iran's hatred of foreign interference, then suggests a causal relationship and ties her ideas into John Limbert's analysis—thereby announcing that a synthesis of Limbert's work is coming. This writer's work also becomes more credible and meaningful because, right in the text, she announces the name of a person who is a recognized authority in the field. Even in this short excerpt, it is obvious that this writer is using proper citation and backing up her own assertions with confidence and style.

5.8: Anatomy of a Well-Cited Paragraph

Writing a paragraph with the sources properly cited can seem a tricky task at first, but the process is straightforward enough, especially when we analyze an example. Writing a sound paragraph is really just a matter of thinking clearly about a topic you have researched and transferring that thinking to the page. To illustrate, a tidy sample paragraph follows, with the sources properly documented in the author-year system. Next, the genesis of the paragraph is analyzed.

> *The millions of species of plants and animals on the earth have a phenomenal influence on the human species. Not only do they provide a substantial amount of our food, they are of great value in medicine and science. Over 60 percent of the purchases we make at the pharmacy contain substances that are derived from wild organisms (Myers 2008). Studies of plants and animals have led to discoveries in virtually all of the sciences, from biology and chemistry to psychology and astronomy (Wilson 2001). Furthermore, plants and animals are vital to the maintenance of our ecosystem. Their diversity and balance directly control food webs, nutrient diversity, supplies of fresh water, climate consistency, and waste disposal (Eberly 1988). Finally, many species act as barometers of our environment. The salmon, for example, is extremely sensitive to changes in the condition of the water in which it lives. Any abnormality in population or behavior of fish usually indicates some type of chemical imbalance in the water. The same is true of butterflies and their responses to the environment within prominent agricultural areas. Clearly, the millions of species of plants and animals in the world are vital to the continued thriving of the human population.*

Now let's walk through the paragraph and its use of sources. The first two sentences assert the author's personal view about the value of the world's species (a view shaped by his research, no doubt), which he is about to back up by using three recent sources. Next, the author cites a journal article (Myers) from which he extracted a statistic ("over 60 percent of the purchases we make at the pharmacy"). Without this source cited, the reader might believe that the author estimated loosely or simply relied on his memory for the statistic. The next source (Wilson) is cited because the paper author borrowed a general claim from a textbook by Wilson. The author was at first not sure whether to cite the source, but he wisely decided that he should because he realized that he had in fact had Wilson's book open to a particular page and referred to it as he wrote the sentence. The next source (Eberly) is cited because the author had browsed through a whole chapter of Eberly's book in order to compose the list in the sentence, usually using Eberly's exact section headings from the chapter as the list members. The final examples of the salmon and the butterfly were based directly on the author's personal experience of working at a fish hatchery for a summer, so documenting sources was not an issue. The fact that the author finds a way to tie this experiential knowledge in with his research is testimony to the fact that he is *thinking* as he writes the paragraph. He blends his sources, but he does not allow them to do the thinking for him. More evidence of the author's control over his material resides in his transparent mid-paragraph transition sentence (beginning with "Furthermore"), his labeling of species as "barometers" of the environment a few sentences later, and his closing sentence, which wraps up the paragraph's ideas neatly by making an affirmative and confident statement that backs up his topic sentence and examples.

Not every paragraph should look exactly like this, of course, but every paragraph should be written with the same kind of conscientiousness about how, when, and why the sources are cited.

5.9: Best Practices in the Modern Library

In the modern library, whose shelves could be wooden, metal, or electronic, we need to school ourselves in the best practices to ensure that we efficiently access the best material from these shelves. We do this by overcoming the attitude that the library is a foreign country, by rapidly understanding distinctions among resources, and by using search engines effectively.

Getting to Know Your Library

My colleagues and I lament a growing problem with the modern university library, which now houses both books and computer terminals: Students use the library computer to track down a perfect resource, find all the bibliographic information they need about it online, then have no idea how to find it on a particular shelf, and give up without actually ever tracking it down. The problem here is not in the electronic cataloguing system, which must be comprehensive to be useful, but in the individual user's initiative. Put simply, to become a good researcher, there is no substitute for being physically present in the library and learning its layout.

To work in the modern library, follow these basic practices:

- *Take a tour.* Whether self-guided, human-led, or virtual, a tour curbs the fundamental confusion about where you are within a library, which can make all the difference when you are chasing down a particular source in a hurry. A simple tour will also expose you to the different forms and locations of library resources, such as help desks, shelves for current periodicals, reference shelves, stacks for less recent resources, and microfilm.
- *Plan ahead*. Especially when working on a sizeable project, it is unrealistic to expect that all the resources you need will be immediately available. You must give yourself time to physically track down resources, recall material that is checked out, request archived material, or deal with the inevitable limitations of resources that you find.
- *Recognize how libraries work together*. Especially at a large university, you encounter multiple, specialized libraries within one system, and you have access to interlibrary loan (allowing you to borrow books from other libraries). No library is or even tries to be a "one-stop shop."
- *View the library webpages as a time-saving device.* Beyond their obvious aid as a research tool, library webpages are typically set up to save you time. You can usually do such things as reserve books online, renew books online, and even suggest books for purchase or e-mail specific questions to a librarian.
- *When you find a hard copy of a resource, browse the nearby shelves*. Frequently, while standing among the library shelves, I have discovered some of the best resources simply by looking through the related books near the one I was originally seeking. Such serendipitous, productive discovery is a lot more likely to happen at the library shelves than online.
- *Do not fear the human*. When in doubt, ask a real person who is paid to help you.

Discerning Distinctions Among Resources

When choosing the best resources for a particular task, you improve and narrow your search by assessing source quality and establishing a good fit between the level of source information required and the circumstances for which you are writing. A good starting point is determining whether a resource is scholarly or popular, whether its material is more anecdotal or research-based, and whether the author's tone is subjective or factual. When discerning which sources best fit the task at hand, keep in mind these guidelines:

- You can rapidly determine the quality and usefulness of a source without fully reading it. Consider such issues as its level of language use, its context (whether published as a single work or as part of a collection), and the sources that it cites. Popular material is often short, not technically oriented, and topical. Scholarly work tends to be longer and more structured, more technical, and concerned with adding to a body of academic work rather than just standing alone.
- The best academic resources are usually journals that are "peer-reviewed" or "refereed" (the two terms are used almost interchangeably). This means that the journal editor has had other authorities critique and approve articles that the journal publishes. Practices vary about how this review takes place, but such review affords a level of quality that other resources might not possess. If the journal is online, you can try to determine if it is peer-reviewed by reading its root pages, but the surest way is to find a print version of the journal and look at its "Information for Authors" page, typically appearing in the back or front of the journal.

- When seeking print journal articles, narrow your search by using abstracts and indexes available on your library shelves. This helps you find resources across disciplines, and abstracts and indexes provide a form of quality control by listing established journals.
- If a source is online, see if it is also available in print, and favor the print version.

Understanding Search Engines

Happily, the web is a good teacher of itself, so rather than provide lengthy material here on search engines, I offer just a few tips and some URLs for further information. A few oft overlooked fundamentals of search engines are worth special highlighting here:

- For a comprehensive search, do not rely on a single search engine, and understand that different search engines work differently. Some, for instance, first yield sites that are attempting to sell books, while others first yield sites of academic journals online.
- Learn to do advanced searches by clicking on a link such as "Search Tips" near the search box within a particular engine. Such tips tend to be transferable among search engines.
- Most search engines employ "Boolean logic" (for an excellent primer on Boolean logic, see "Basic Search Tips and Advanced Boolean Explained" from Berkeley University) which means that you can use operators (such as "or," "not," "and," and the "+" and "-" sign) to narrow your search. Further, you can usually use quotation marks around a key phrase to indicate that you wish to view pages that include those words in that order.

Self-Study

Here are two excellent online tutorials on using search engines from Purdue University and Grossmont College:

"Searching the World Wide Web" article from Purdue's Online Writing Lab (OWL)

5.10: Some Recommended Print Resources

Amidst the spinning electrons that we exploit nearly every time we do research, let us not forget the value of print resources available in most any college library. From style manuals that go well beyond the scope of this one to guidebooks published by professional organizations, an amazing number of print resources are available in libraries to help us track down definitive answers to questions and narrow our research focus. Below I list just a few of the best print resources available by category, along with their call numbers so you can easily track them down. Many of these resources are updated every few years, and most will reside on the references shelves in your library.

STYLE MANUALS provide stylistic guidelines and answers to matters of grammar and format.

PN171.D37L5 1993	Electronic Style: A Guide to Citing Electronic Information.
PN147.A28 1985	The MLA Style Manual.
BF76.7.A46	Publication Manual of the American Psychological Association.
Z253.C5701	The Chicago Manual of Style.
PN147.M47 1983	The McGraw-Hill Style Manual.
LB2369.D8 1962	A Manual of Form for Theses and Term Reports.
PE1475.S25 1994	Helping Researchers Write—So Managers Can Understand.
PE1408.S772 1959	The Elements of Style.
T11.M56	Writing for Technical and Professional Journals.
T11.K34 1985	Elements of the Scientific Paper.
T11.M418 1982	How to Write and Publish Engineering Papers and Reports.
T11.E35	The Art of Technical Writing.
T11.D33 1988	How to Write and Publish a Scientific Paper.
T11.S65 1977	Technical Report Writing.
QD85.A25 1986	The ACS Style Guide: A Manual for Authors and Editors.

DICTIONARIES define words and describe how to use them.

PE1693.G3 1990	Acronyms, Initialisms, & Abbreviations Dictionary.
PE1680.M59	Harper Dictionary of Contemporary Usage.
PE1591.M37 1962	Roget's International Thesaurus.
PE1680.R63 1957	The Word Finder.
Q123.M15 1983	McGraw-Hill Dictionary of Scientific and Technical Terms.
QA5.J32 1976	Mathematics Dictionary.

ENCYCLOPEDIAS provide general and specialized background information.

Q121.M3 1982	McGraw-Hill Encyclopedia of Science and Technology.
QH540.4.M3 1980	McGraw-Hill Encyclopedia of Environmental Science.
AE5.E363 1990	Encyclopedia Britannica.

HANDBOOKS guide you to preliminary information and serve as reference tools.

TJ151.M371	Standard Handbook for Mechanical Engineers.
TK151.S8	Standard Handbook for Electrical Engineers.
QA47.M315 27th	CRC Standard Mathematical Tables.
QD65.H301	CRC Handbook of Chemistry and Physics.
T56 1971	Industrial Engineering Handbook.
TA151.S8	Standard Handbook for Civil Engineers.

ABSTRACTS AND INDEXES lead you to specific journal articles.

QD1.A51	Chemical Abstracts.
QA75.5.A25	ACM Guide to Computing Literature.
QA76.C5854	Computing Reviews.
G1.G36	Geo Abstracts.
TD180.P6	Pollution Abstracts.
HD9540.5.E55	Energy Index.
Z5322.E2E53	Environmental Index.
QA1.M76	Mathematical Reviews.
QA276.A1 C87	Current Index to Statistics.
TN1.A58	Metallurgical Abstracts.

BUSINESS SOURCES describe industries, corporations, and products.

T12.T6Q	Thomas Register of American Manufacturers.
HC107.P4A282	Harris Pennsylvania Industrial Directory.

CONFERENCE PROCEEDINGS lead you to papers given at conferences.

Z7401.I54	Index to Scientific and Technical Proceedings.
Z7409.D56	Directory of Published Proceedings.

BIOGRAPHICAL SOURCES give general information about scientists.

Q141.A47	American Men and Women of Science.
Q141.D5 1981	Dictionary of Scientific Biography.
T39.W5	Who’s Who in Technology Today.

GUIDES TO THE LITERATURE list some of the best resources in the field.

QA41.7.S3	Using the Mathematical Literature, a Practical Guide.
Z7551.B86	How to Find Out About Statistics.
QA76.C6501	Computing Information Directory.

TECHNICAL REPORTS give results of ongoing governmental research.

Z7913.U2	Government Reports Announcement and Index.
Z1223.A18	Monthly Catalog of U.S. Government Publications.

5.11: Author-Year System- In-Text Citation

The author-year system of documentation is used more on the undergraduate level than the graduate. Fields that have ties to the liberal arts, such as geography, human development, and political science, tend to favor the author-year system.

Your basic job when using this system is to indicate right in the text—in parentheses—the author(s) and year of publication of the reference you are citing. Since the citation becomes part of your sentence, you delay the appropriate punctuation until after the parentheses:

> *In recent decades, anthropogenic activities such as deforestation, desertification, and urbanization have significantly altered the land surface (Nicholson 2007).*

Many writers identify the source as soon as they begin the reference, including the author's name directly in the text and supplying only the year in parentheses:

> *Furlong et al. (2001) estimate that the first Mt. Erebus eruption . . .*

If you use two or more articles written by the same author(s) in the same year, you distinguish between the documents in your text and on your references page by using an "a,b,c" system, providing an identifying letter after the year:

> *Toon (1989a) found evidence of . . .*

When citing web-based sources in your text, you will often encounter sources with no author listed. Handle these cases just as you would when citing print sources—that is, if no author's name is given in the original, offer the title of the web page, or the publication's title, or the publisher's name. If such a title is lengthy enough to be awkward, offer a clear shortened form of the title, with the goal of making it easy for us to find the source on the references page. In the following example, a document authored by a governmental agency is identified by a shortened form of its name:

> *Coordinated measurements planned in the framework of the original program should help to explain the apparent discrepancies in the data (PRIMO document, 1989).*

Other In-Text Citation Practices

Slight but important mechanical differences exist among in-text citation practices, in particular when you are trying to conform to a specific style, such as MLA (Modern Language Association) or APA (American Psychological Association). For example, MLA style requires you to provide the page number of your citation in-text, but not the year, while APA style asks you to place a comma between author and year. Please feel welcome to explore all of these nuances for yourself if you wish, and recognize that some professors will insist that you conform to a particular style. When professors do not dictate a particular style, they will usually simply expect you to use the author-year or number system with consistency throughout the paper.

Remember, too, that journals within your field have already made informed decisions about which in-text citation practices they use. To settle on citation particulars, many writers model a journal in their field—mandatory, of course, if you submit material to a journal hoping for publication.

Self-Study

Read up on the specifics of various citation styles, in particular MLA and APA, at the following pages:

"Research and Citation Resources" article from Purdue's Online Writing Lab (OWL)

"Citation Style for Research Papers" article from Long Island University

5.12: Number System- In-Text Citation

Generally, the number system is favored in fields where you typically report experimental field or lab work. Technical fields such as materials science, aerospace engineering, and chemistry tend to favor the number system.

When you use the number system, your responsibility is to indicate in your text—either in parentheses or brackets—a number that corresponds to a source on your references page. The first source you cite in your text receives the number 1, the second number 2, and so on. If you repeat a reference to a source later in the text, it retains its original number—thus, all references to source number 4 receive a 4 after them in parentheses or brackets. You delay the appropriate punctuation until after the parentheses or brackets:

> *If the load on the thrust bearing can be decreased by some means, the life of the turbodrill can be significantly increased (1).*

Many authors prefer to identify the source at the beginning of the reference, perhaps including the author's name directly in the text:

> *Gould et al. (5) found a clear relation between. . .*

The number system is especially handy for citing equations, because you can simply insert the citation number logically as you introduce the equation to avoid confusion with any other numbers:

> *The line's slope is used in the following equation (7) to calculate. . .*

Other In-Text Citation Practices

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"Citation Style for Research Papers" article from Long Island University

5.13: Author-Year System- References Pages

Following in-text citation of sources, of course, you are obliged to provide bibliographic information about your sources on a references page. Composing a references page is, for many writers, a painful process, particularly if they handled their references sloppily at the research stage. You simplify your task greatly by recording complete bibliographic information of your cited sources as you research, thus building your references page as you go. Some students wisely use notecards to keep track of their references, while others have a less formal system. As I cite sources in-text, I simply keep adding the complete bibliographic information to my references page right in my Word file for the paper; thus my references page is finished as soon as the last paragraph is.

As with in-text citation, reference page styles vary from one publication to another, but the fundamentals can still be expressed by the two simple categories of the author-year system and the number system. You could, of course, choose any respected magazine or journal in your field as a model for your references page and use it consistently, and this is often the easiest and most logical path to take.

Self-Study

Read up on the specifics of various citation styles, in particular MLA and APA, at the following pages:

"Research and Citation Resources" article from Purdue's Online Writing Lab (OWL)

"Citation Style for Research Papers" article from Long Island University

Mechanics of the Author-Year System References Page

Using the author-year system, on your references page you typically provide the following information in the following order:

- *The names and initials of all authors*, beginning with the last name of the first author listed, followed by a comma.
- *Year of publication*, followed by a colon.
- *Title of the document or article being cited*, with the key words capitalized. Quotation marks could be used around article titles.
- *Title of book, magazine, or journal*, underlined or italicized, with journal titles abbreviated, followed by a period.
- *Publication information*—for a book or privately published document, provide the publisher's name and location, then the total number of pages, separated by commas; for a journal or magazine, provide the volume number in boldface, then a comma, then the page numbers of the article being cited.
- *The entire URL* (if the source is a website), usually enclosed in brackets, followed by a period. Then provide either the last date the page was updated or the date that you accessed it, followed by a period. When citing a web document, typical bibliographic details, such as the page's author, will often be unavailable. Therefore, skip the steps above as needed, but always provide the URL.

At times, some of the above information will be unavailable or sketchy, especially in relation to company brochures, maps, non-professional publications, and web sources. It is acceptable to omit unavailable information, of course, but when less information is available you might provide a short narrative description of a particular source.

5.14: Sample Author-Year System References Page

In the author-year system, your references are listed on a separate references page in alphabetical order, using the last names of the authors, article title (if no author), or publisher name. The type should be double-spaced, lines should not be skipped between each reference, and a hanging indent of five spaces should be used after the first line of each reference. Always include the word "References," boldfaced, in the center at the top of the page.

Click here to download a pdf of a sample References page using the author-year system.

Click here to open a sample References page using the author-year syste within this page.

Sample Author-Year System References Page

REFERENCES

Charlock, T.P., and V. Ramanathan, 1985: "The Albedo Field and Cloud Radiative Forcing Produced by a General Circulation Model with Internally Generated Cloud Optics." *J. Atmos. Sci.*, **42**, 1408-1429.

"Drilling Probes Mediterranean Climate and Oceanography," originally published in *Earth in Space* **8**, May 1996. accessed May 22, 2001.

Ozick, B., 1987: The Physical Oceanography of the Mediterranean Sea. Bell Publishing Co. Austin, TX. 176 pp.

PRIMO document, 1989: Preparatory document on the development of PRIMO, an international research program in the western Mediterranean. Published by PRIMO, Inc., Paris. 29 pp.

5.15: Number System- References Pages

Following in-text citation of sources, of course, you are obliged to provide bibliographic information about your sources on a references page. Composing a references page is, for many writers, a painful process, particularly if they handled their references sloppily at the research stage. You simplify your task greatly by recording complete bibliographic information of your cited sources as you research, thus building your references page as you go. Some students wisely use notecards to keep track of their references, while others have a less formal system. As I cite sources in-text, I simply keep adding the complete bibliographic information to my references page right in my Word file for the paper; thus my references page is finished as soon as the last paragraph is.

As with in-text citation, reference page styles vary from one publication to another, but the fundamentals can still be expressed by the two simple categories of the author-year system and the number system. You could, of course, choose any respected magazine or journal in your field as a model for your references page and use it consistently, and this is often the easiest and most logical path to take.

Self-Study

Read up on the specifics of various citation styles, in particular MLA and APA, at the following pages:

"Research and Citation Resources" article from Purdue's Online Writing Lab (OWL)

"Citation Style for Research Papers" article from Long Island University

Mechanics of the Number System References Page

Using the number system, on your references page you typically provide the following information in the following order:

- *The number of the reference*, followed by a period.
- *The first initials and last names of all authors*, followed by a comma.
- *Title of the article* enclosed in quotation marks, followed by a comma.
- *Title of book, magazine, or journal*, underlined or italicized, with journal titles typically abbreviated, followed by a period.
- *Volume numbers or editors*—if citing a journal or magazine, provide the volume number in boldface, followed by the issue number in brackets; if citing a book with editors or volume numbers, provide the names of the editors or the volume numbers.
- *Publication information*—for a book or privately published document, provide the relevant page numbers, then the publisher's name and location (all separated by commas), then the year in parentheses, followed by a period; for a journal or magazine, provide the relevant page numbers of the article being cited, then the year in parentheses, followed by a period.
- *The entire URL* (if the source is a website), usually enclosed in brackets, followed by a period. Then provide either the last date the page was updated or the date that you accessed it, followed by a period. When citing a web document, typical bibliographic details, such as the page's author, will often be unavailable. Therefore, skip the steps above as needed, but always provide the URL.

At times, some of the above information will be unavailable or sketchy, especially in relation to company brochures, maps, non-professional publications, and web sources. It is acceptable to omit unavailable information, of course, but when less information is available you might provide a short narrative description of a source for clarity.

5.16: FAQs about Citing Sources

Q: Suppose I can't determine the author of a source, should I just cite "Anonymous"?
A: This is an outmoded practice. If no author is listed but an affiliated organization is given, consider the name of that organization to be the source, both in-text and on the references page.

Q: What if I can't find either author or year? May I cite the source in-text just by its title?
A: Typically, yes. Supply the title (or a shortened form of it) in-text in quotation marks, then give fuller bibliographic information on the references page.

Q: When citing web sources, should I give the URL within the text itself?
A: No—this is non-standard and, frankly, comes off as pretty lame. Provide the URL on the references page, but handle the in-text citation as you would any other, providing author-year or source number. Unless the nature of the source as being web-based is highly relevant to context, the reader in the act of reading should be virtually unaware (no pun intended) that you are using a web source. Never attempt an in-text citation with something as informal and downright silly as "According to the internet . . ."

Q: Suppose a web page has nothing but a title on it, and I have no idea who authored it?
A: Then you would provide only that information available, in particular the URL and the date accessed, on your references page. As always, be sure to carefully assess the page's quality and credibility too.

Q: What about information obtained verbally from a credible source?
A: In-text, handle the citation as you normally would, giving author-year or source number; on the references page, follow the person's name with his or her title or affiliation (you could even supply the party's mailing address), then the words "personal communication."

Q: What if I'm citing e-mail, or a newsgroup, or a gopher site, or a CD-ROM? How do I handle this on the references page?
A: For such specialized concerns, you need to consult a more specific style guide. Online, I can recommend *online! a reference guide to using internet sources.*

Q: I'm trying to return to a page I visited last week, and I get error messages. How do I find it?
A: After rechecking your typing, try truncating a portion of the URL. Cutting off the end of the address frequently takes you back to the page's author and you can try relocating from there. Of course, the page might indeed be gone, entirely eliminated from cyberspace.

Q: How important is a small detail such as punctuation on my references page?
A: Consistency within your document is what matters. Professors rarely deduct points over such small issues, but they do expect you to pay close attention to them and be consistent in your practices.

Q: Suppose I'm citing an author who cited someone else? Do I cite the original author or just the one I read?
A: You should only formally cite the author that you actually read, although a narrative mention of the other source within an in-text sentence is often appropriate. For example: "Kunkle (2001) reports that a 1998 study by Edmund Eberly revealed . . ." Of course, if time permits and the circumstances suggest you should, you might try to track down the original source and interpret it for yourself.

Q: Are footnotes "in" or "out"?
A: They're definitely "out." Try to avoid them. Journals rarely use them, preferring an endnotes page with explanatory notes at the end of the text. Even this practice is rare except in scholarly works, where the author chooses to offer explanatory side discussions.

Q: What's the difference between a references page and a bibliography?
A: A references page contains only those references that were directly cited in the text. A bibliography page is more of a reading list—it contains references referred to in the text plus the chief publications that you consulted in a general way. Some people—even some professors—use the two terms loosely and interchangeably, but journals tend to follow the distinction I just provided.

Q: What if I can't find a source in the library, but the computer tells me it's on the shelves?
A: Ask a librarian (this answer applies to questions I haven't listed here as well). My experience is that most librarians are terribly helpful and kind to serious, respectful students.

Q: I'm old-fashioned and I still believe in books, so can you recommend some print resources to answer specific questions about citing web sources?

A: Good for you. I highly recommend *Electronic Style: A Guide to Citing Electronic Information*, by Xia Li and Nancy B. Crane. Also, the most modern library editions of major style guides (*The MLA Style Manual and Guide to Scholarly Publishing*; *The Chicago Manual of Style*) have thorough information and discussion on citing web sources.

CHAPTER OVERVIEW

6: Writing Documents for Classes

6.1: Introduction

> ***I never let schooling interfere with my education. - Mark Twain***

At some point during college, you will probably be enrolled in a writing-intensive course (also called w-courses or writing-across-the-curriculum courses). In a nutshell, the aim of these courses is to help you learn about a subject by researching and writing about it, and in some courses you actually produce the kinds of documents that are common to your discipline beyond graduation, thus helping you to get ready for the workplace. Some writing-intensive courses require a series of short assignments culminating in a longer report, while others require both oral and written presentation and are akin to a senior thesis. Many w-courses also involve substantial e-mail correspondence between you and a professor or you and other members of a project team, and they may require oral presentation or an online portfolio. In any case, all writing-intensive courses provide you with ample opportunity to receive concrete feedback on your writing from your professor.

All that said, it must be noted that, from both the professor's and student's point of view, writing-intensive courses often mean extra work and higher standards. Yet many professors are happy to teach them, because it becomes clear from the course's very definition that good communication skills are key to good performance. While you may groan at the prospect of both the workload and standards of a writing-intensive course, they do serve to underscore the fact that writing will matter greatly in any profession you choose.

Simply put, this chapter is designed to help you survive writing-intensive courses. Individual sections in this chapter are devoted to the types of forms you will probably be using in any course involving technical writing, whether it is designated as writing-intensive or not. By reviewing the stylistic tips and the models herein, and following any advice your professor gives to the letter, you should be able not just to breathe a little easier in any writing-intensive course that you take, but to thrive.

Self-Study

For those who wish to polish their skills, some good (and free) extensive writing advice awaits you in cyberspace, courtesy of university professors. Here are two such sites:

"Advice on Academic Writing" from the University of Toronto

"Advice on Research and Writing" from Carnegie Mellon University

6.2: Outlines

Most students see outlines as a royal pain. But not only are they often central to writing-intensive courses, they are frequently required on the job; for example, a project manager may require each individual team member to outline and compose different portions of a joint report. Do not be seduced by the belief that an outline is totally useless or simply mechanical; this will only be true if you make it so.

Self-Study

Plenty of tips on writing outlines are available on the web on university webpages. Here are two recommended sites:

"Types of Outlines and Samples" article from Purdue's Online Writing Lab (OWL)

"Using Outlines" article from Indiana University, Bloomington

he Value of Outlining

Outlines foster coherence by helping the writer to:

- plan both the sequence and hierarchy of information.
- make decisions about organization and content without the distraction of all the details of composition.
- avoid repetition, digression, poor emphasis, and poor flow.
- improve general organizational skills.

Considered in the light of the above ideal, outlines can be as fundamental to the writer as a flowchart is to the computer programmer. Good writers use outlines to flesh out their ideas, organize their thoughts, and discover their gaps.

Outlines can be writer-centered, of course, to aid you in expressing your ideas, but the material presented here assumes a reader-centered outline—i.e., one written for the eyes of a professor who will use the outline to provide you with some written feedback. As long as the mechanics of the outline are correct and the details concrete, most professors will not be too finicky about the quality of your outlining skills, and will simply take the opportunity to give you quick feedback on your ideas and organization.

Style for Outlines

When drafting an outline, keep the following stylistic tips in mind:

- Compose a thorough working title for your paper, with the title offering a window into the paper's purpose and content.
- Double-space your type to allow room for comments.
- Present headings as scientific categories and assertions rather than as informal speculations (i.e., "How Manganese Oxides Trap Heavy Metals" rather than "Just How Do Manganese Oxides Trap Heavy Metals?").
- Avoid presenting section headings as questions unless the questions themselves are especially compelling.
- Be certain that headings work in relation to one another.
- Avoid the use of acronyms in headings—write the material out.

When writing an outline for a class, even if you are unsure of what material to provide under each heading, include a draft of each major heading to demonstrate your overall plan and to encourage professor feedback.

Mechanics of Outlining

The mechanics of outlining are simple when stripped down to their essential elements. The two most common forms used are the Arabic System and the Decimal System. Indentations of a tab (1/2-inch or five spaces) are used to designate hierarchy of material, and order is indicated by sequential numbers, letters, or Roman numerals. Headings at the left margin are typically referred to as first-level headings, those indented one tab as second-level headings, and so on. The Decimal System requires a period between numbers, and note that, for both systems, the rising sequence of the numbers, letters, or Roman numerals is determined by the level of the heading under which a character falls.

Click here to download a pdf of a simple depiction of two outline systems, without the outline text.

Click here to view a simple depiction of two outline systems within this page, without the outline text.

```
DECIMAL SYSTEM
1.0 _____

        1.1 _____

        1.2 _____

2.0 _____

        2.1 _____

                2.1.1 _____

                2.1.2 _____

                        2.1.1.1 _____

                        2.1.1.2 _____

        2.2 _____

        etc.
```

```
ARABIC SYSTEM

I. _____

        A. _____

        B. _____

II. _____

        A. _____

                1. _____

                2. _____

                        a. _____

                        b. _____

        B. _____

        etc.
```

6.3: Sample Outline

The sample outline that follows comes from the field of geology, and its first-level headings reflect a common approach writers take when organizing their original research into a senior thesis. As often happens, the writer's first-level headings are somewhat generic, while the second- and third-level headings are more specialized to the subject matter of the essay. Note also the specificity of the title, of each section heading, and the relationships of the headings to each other. Such a detailed and professional outline helps the writer to keep organized during the writing process as well as gives the advisor an opportunity to give concrete feedback.

Click here to download a pdf of a sample outline.

Click here to open a sample outline within this page.

"The Petrographic Characteristics of the Elk Basin Sandstones and Their Correlation with Joint Spacing"

by John Lerner

Abstract

```
I. Introduction
     A. Distribution of Joints about Folds
     B. Joint Spacing and Fracture Porosity in the Petroleum Industry
     C. Effect of Lithology on Joint Development
     D. Objective
          1. Perform Petrographic Analysis of Elk Basin Sandstones
          2. Establish Correlation between Joint Spacing and
Petrography
II. Background Literature
     A. Definition of Fracture Spacing Ration
     B. Past Work on Fracture Spacing Ration in Sedimentary Rocks
          1. Fracture Spacing Ration in Various Geological Localities
          2. Fracture Spacing Ration as a Function of Rock Properties
     C. Possible objective of interpreting the record of the Eemain
interglacial.
III. Geologic Setting of Big Horn Basin
     A. Stratigraphy of Big Horn Basin
     B. Structural Geology of Big Horn Basin
     C. Description of Elk Basin
IV. Experimental Technique
     A. Sampling of Fracture Spacing Ration
     B. Sampling and Preparation of Thin Sections
     C. Point Counting Technique
V. Results
     A. Formation versus Composition
     B. Formation versus Porosity
     C. Bed Thickness versus Porosity and Composition
VI. Discussion of Correlation between Point Counting Data and
Fracture Spacing Ration
     A. Composition versus Fracture Spacing Ration
     B. Porosity versus Fracture Spacing Ration
VII. Conclusions
VIII. References
```

6.4: Proposals

In the working world, you will often be in the position of writing a proposal, usually to try to solve a problem or receive approval or funding for a project. Such proposals must be prepared to exact specifications and must strike an artful balance between your own needs and those of your audience. Recently, I worked closely with a professor as she prepared a proposal for some vital funding for her research, and her revisions during our discussion were effective because they were completely audience-centered and goal-oriented, even to the point that she revised tentative-sounding phrases into positive affirmations, shortened paragraphs and provided more transitions so that her sentences were easier to read and reread, and changed certain past-tense verbs to present tense to establish a stronger sense of immediate relevance.

In your courses, your professor may simply ask you to write a short topic proposal for his or her approval, or you may be asked to write an extensive proposal as a warm-up for a term paper or lengthy writing project. The advice that follows will help you prepare an extensive proposal.

Self-Study

For more ideas on writing research paper proposals, try out these URLs:

"Research Paper Proposal" article from George Mason University

"Steps to Writing a Research Paper" article from Rio Salado College Online

Pitfalls of Proposals

When you are faced with the task of preparing a proposal for a paper, consider your audience's position first. Believe me, when a professor asks you to write a proposal, what he or she wants to do is read and understand it rapidly, give some feedback, and then grant speedy approval to someone who is clearly prepared to begin writing a paper. Empty phrases, vague detail, apparent self-absorption, cockiness, or a lack of confidence on your part just get in the way of all that. I once reviewed a batch of paper proposals in which the following sentences appeared verbatim:

> *Another aspect in which I will ultimately show there is some importance here is . . .*
>
> *Currently I am working hard at gathering more information and reviewing all my present information, maps, and resources that I have etc., etc., etc.*
>
> *At this point in time my proposed topic that I have chosen is . . .*
>
> *By the deadline of this paper I will have expected myself to have gone far more into depth about this interesting topic and would have all of the required information.*

In the nearly 90 words above, there is nothing of use to the reader of the proposal, who wants specifics, not fluff. Empty phrases merely waste the reader's time and even breed suspicion that the writer has no real specifics to report. If you complicate what should be simple with such bloated, undigestible, and unswallowable phrases, your poor professor only winds up with a headache and heartburn.

Style for Proposals

As you compose your proposal, follow these stylistic tips:

- Try out a title, seeing it as a window into your introduction.
- Include an immediately relevant introduction that briefly and professionally sets the context. Do not bother with such silliness as "Hi!!! Happy to be in your class. My name is Joseph. My social security number is . . . ."
- Have a premise, objective, or rationale clearly stated. Label it as such.
- Use brief, logical, concrete section headings to orient yourself and your reader.
- Take advantage of enumeration or formatting so that your important points stand out. Consider some sort of outline form where appropriate, even if only for one section of the proposal. Make it easy to scan.
- Do not waste any time at all. No verbal drumrolls.

- In general, do not hesitate to use "I," but do not overuse it. Sound like a person, even if it means taking a tiny stab at something that feels creative or bold. You may strike just the right humanizing chord and be invited to do so in your paper as well.
- Pose questions. Actively speculate. Be thinking on the page.
- Remember that a proposal is not an unbreakable covenant, but a thoughtful plan. Be specific about the work that you have not yet done as well as the work that you have. For example: "I am still speculating about how best to define the general characteristics of particle systems, and I know that I need to find more information on particle interactions, mechanics, and processing." Such a comment might inspire a helpful professor to jot you a concrete note about where to find the needed information.
- Cite sources in your proposal, using the same citation style that you will use in the paper. You may be expected to give an annotated bibliography, but even if not, consider giving a sentence or so of description about your sources to establish your credibility, show the relevance of your initial research, and begin to spark the thoughts that the sources will help you to generate.
- Proofread the proposal with care, just as you should the final product.

6.5: Sample Proposal

What follows is a short proposal for a paper on the rapid growth of convenience store chains in America. Note how admirably the proposal takes advantage of the stylistic tips noted in the list on the previous page. Also note that because the proposal author took the initiative to go to a convenience store chain's business office, she found out that the chain had an historian, who provided her with abundant and excellent data, such as that generated by exit polls, to supplement her library research. This proposal was submitted by an earth science student and received enthusiastic approval and concrete feedback from the professor.

Click here to download a pdf of a sample proposal.

Click here to open a sample proposal within this page.

Sample Proposal

"The Burgeoning of Convenience Stores Across the American Landscape"
by Janet Lerner

INTRODUCTION
In a little over two decades we have witnessed the emergence of a new concept in retail buying for the American consumer—the convenience store. The United States government defines convenience stores as "food retailer(s) of limited lines in a freestanding sales area of 3,000 square feet, concentrating on selected fast-moving products" (Directory of Supermarkets, Grocery, and Convenience Store Chains, 1990). To this definition I would add that typically the products on the shelves of convenience stores are priced higher than those carried by their competitors.

RATIONALE FOR MY INVESTIGATION
While spreading across the country like politicians on a campaign trail, convenience stores appear to have maintained a fairly distinctive regional character. Uni-Mart and Sheetz are common names for these stores in central Pennsylvania, but in Iowa we find Casey's, in Massachusetts Cumberland Farms, and hundreds of other names specific to a state or region. I am intrigued by the rapid growth of convenience stores, which, from my early research, seem to retain a local flavor for such a widespread national phenomenon.

PROCEDURE
Through my library research, I will examine the burgeoning of convenience stores by exploring the answers to questions such as the following:

—How does the rapid growth of convenience stores reflect demographic trends?
—What determines the location of convenience stores? (macro-geography?)
—How have the unrelated markets of food retail and gasoline sales evolved into a common store?

I also plan to interview several key executives at Uni-Mart, including Charles R. Markham, who is the executive vice-president.

REFERENCES
Directory of Supermarkets, Grocery, and Convenience Store Chains. CGS, 1990. This is a comprehensive guide to all major and many minor stores and their data (number of stores, size, brief history, top personnel). It also includes maps that illustrate regional concentrations of stores, and provides an overview of the industry today.

Curtis, C.E. "Mobil Wants To Be Your Milkman." Forbes. February 13, 1984, pp. 44-45. This article provides a concise but informative discussion of the combining of the food retail and gas industries.

6.6: Annotated Bibliographies

Many professors ask you to write annotated bibliographies—bibliographic information about your primary sources and a short description of each—as preparation for writing a paper. Often, these bibliographies are no more than a page or two in length, but they are important because they force you to get your teeth into the source material and they give your professor the opportunity to comment on your use of sources and suggest some that you may have overlooked.

Style for Annotated Bibliographies

When you write an annotated bibliography for a course or in preparation for a thesis advisor, consider that the professionalism of the product is a direct reflection of the quality of the paper that will result. Therefore, be stylistically conscientious, following these tips:

- Begin by listing complete bibliographic information (author, year, source name, publisher, etc.) just as you would on the References page at the end of a paper.
- Provide a sentence or two describing the contents of the source.
- Summarize the various relevant topic areas that the source discusses.
- Avoid vague phrasing and empty sentences. Weed out any generic sentences such as "This source is very useful because it has tons of really good information."
- Use present tense and future tense verbs to facilitate the immediacy of the information and the actual future use of sources.
- Discuss the exact way that you will use the source (e.g., for background information, data, graphics, as a bibliographic tool).
- Carefully judge the value of the source, considering, for example, its level of detail, bias, or the timeliness of its data.
- Note if the source's text or bibliography will lead you to other sources.
- Comment on anything that you find especially noteworthy about a source—is it controversial? definitive? political? new?
- Format the annotated bibliography so that each description is clearly associated with the proper source.

6.7: Sample Annotated Bibliography

An excellent annotated bibliography by a geography student follows. Note how he takes advantage of all of the stylistic advice offered on the previous page, and how the paper's sections begin to take shape even in the source descriptions. Note also that the writer's tone is upbeat and informed. We get a strong sense that the writer cares about the topic and will make it interesting to read about.

Click here to download a pdf of a sample annotated bibliography.

Click here to open a sample annotated bibliography within this page.

SAMPLE ANNOTATED BIBLIOGRAPHY

"The Geography of American Graveyards"
by John Lerner

1) Jordan, Terry G. (1982). Texas Graveyards, A Cultural Legacy. Austin: University of Texas Press.

Jordan offers an in-depth look at the hows and whys of Texas graveyards. He divides vernacular burial sites into three categories: Mexican, German, and "Southern folk cemeteries." His physical descriptions of cemetery layout, inscriptions, grave markers, and the like are very detailed.

2) Meyer, Richard E., ed. (1989). Cemeteries and Gravemarkers, Voices of American Culture. Ann Arbor

Meyer's book is a compilation of works concerning such topics as regional epitaphs, origins of Southern cemeteries, the Afro-American section of a Rhode Island burial ground, and the use of bronze in memorials.

3) Sloane, David Charles (1991). The Last Great Necessity, Cemeteries in American History. Baltimore: Johns Hopkins University Press.

Sloane's work will serve as my primary source of information. He has written a history of American cemeteries in a cultural context concentrating on significant trends in their development. Sloane's "Notes" section will allow for easy access to other sources.

4) Weed, Howard Evarts (1912). Modern Park Cemeteries. Chicago: R.J. Haight.

Weed was a landscape architect and his work concentrates on how a cemetery should look. Weed offers detailed descriptions of the physical layout of pre-20th century cemeteries.

5) Zelinsky, Wilbur (1994). "Gathering Places for America's Dead," The Professional Geographer. 46:1, 29-38.

Zelinsky's article is an intriguing analysis of the spatial patterns of American cemeteries. He calculates and maps the number of cemeteries by county across the country. He then seeks answers as to why there is such a fluctuation in the number per square mile from one place to the next. Zelinsky's bibliography led me to Sloane's work.

6.8: Descriptive Abstracts

A descriptive abstract—a summary of someone else's paper or book—is often required by professors to give you practice in summarizing and responding to sources. Writing a descriptive abstract can be especially trying if you feel as though you are reading material over your head; however, if you understand the goals of a descriptive abstract correctly you can read and write in such a way that the author's ideas are simplified while being represented fairly.

Style for Descriptive Abstracts

In many courses, a professor will set forth specific guidelines for both form and content of a descriptive abstract. In the absence of such guidelines or to supplement them, follow this advice:

- Include a title and the word "Abstract" as a heading. Include basic bibliographic information about the source after the title (author's name, title of work, etc.).
- Frequently, a list of key words that will be used appears just underneath the title of the abstract. Consider listing your key words in this way.
- Many professors will expect you to limit a descriptive abstract to a single page, so be certain to write with efficiency in mind—no filler.
- Begin the abstract by providing some condensed background information and a statement of overview or purpose, much like the kind of material an author provides in an introduction and a thesis statement.
- Decide on topics by selecting key information from your source. Use the chapter headings, section headings, conclusions, topic sentences, and key terms from your source to determine the topics.
- Point out relationships among topics, especially via transition words.
- Consider working from an outline to organize and write the abstract.
- Use paragraphing generously to discuss different facets of the topic; do not fear short paragraphs.
- Consider techniques such as enumeration or bulleting of key points for emphasis. However, unless the document becomes very long, you typically do not use section headings in an abstract.
- Use present tense verbs generously, both to describe ideas or events and to present the author's goals.
- Use the author's name or the names of other key authors, especially those who represent particular theories, directly in the text. However, you typically do not cite sources in the abstract itself; the reader understands that all of the ideas in a descriptive abstract come from a particular source unless you note otherwise.
- Do not skimp on the conclusion; assert the source's "bottom line" information, even if that means repeating some of the author's words.
- Some professors will expect you or allow you to close the descriptive abstract with your own views on the subject or on the author's treatment of the subject. Explore this option as concretely you can.
- Do not use the abstract as a vehicle of apology for ideas you do not understand; stick to those key ideas that you can represent well.

6.9: Sample Descriptive Abstract

The sample abstract that follows is a solid model written for a class in mineral policy analysis. Given the pre-determined rhetorical context, no time is wasted, and paragraphs are kept both short and detailed. Note that, in accordance with her professor's guidelines, the writer gives her particular views on the author's treatment of the subject at the end of her descriptive abstract. She gives a full paragraph to her commentary, even noting how the author might have calculated costs differently to achieve a different outcome. Such detail and commentary show us that the writer both understands her material and can think effectively about it.

Click here to download a pdf of a sample descriptive abstract.

Click here to open a sample descriptive abstract within this page.

SAMPLE DESCRIPTIVE ABSTRACT

"Oil and National Security," by Darwin C. Hall, in *Energy Policy* (1992) v. 20, no. 11
submitted by Janet Lerner

Keywords: National Energy Security (NES), Strategic Petroleum Reserve (SPR), energy security, oil.

In February 1992, President Bush presented the National Energy Strategy (NES), which is based upon the ideals of a free market. Included in the NES are policies that remove restrictions on oil production and restrictions on the construction of nuclear power. This paper attempts to quantify the costs associated with spending on oil imports as related to national security and the Strategic Petroleum Reserve (SPR).

Energy security is measured by the size of U.S. imports because the Middle East holds the majority of reserves and oil reserves are being depleted. The consequence of this is that oil prices can be manipulated to harm the U.S. and its allies. Oil price shocks or supply disruptions instigated by OPEC cause recessions by lowering output, raising prices, and lowering real wages. These effects are determined by applying the Granger causality tests.

A benefit of a market-driven price determination system is that prices rise as depletable resources fall, implying increased scarcity. This rise in price gives an incentive to produce substitutes as well as reduce consumption of oil.

There is a large divergence between the social cost of energy and the price because of environmental externalities associated with conventional energy sources. The philosophy of the administration is to rely on market prices to determine 20% of the economy's investment. However, misplaced investments based on such a policy have implications for many years. Hall concludes that the policies reflected in the NES will result in gross economic inefficiency.

I agree with Hall's conclusion that misplaced investment in such a large part of our economy is dangerous. I believe that there should be more of an analysis concerning how varying oil prices can affect the costs associated with oil import spending. This would show how vulnerable oil import spending is relative to price changes. Although Hall mentions the opportunity cost of interest that could have been earned had the amount spent been invested, he does not attempt to quantify what that amount is. I would attempt to calculate these costs using various interest rates. I also feel that he should calculate the inventory holding cost, and I am also curious to know what the cost of oil deterioration is and if there are transportation costs involved. These additional costs could be very significant in adding to the costs that Hall has already predicted.

6.10: Progress Reports

Progress reports are common and critical documents in science and engineering, typically when you are part of a research team reporting to a funding agency about your progress on work you are doing for that agency. The basic point of a progress report is to summarize the status, progress, and likely future for a particular project. In a progress report you are often expected to commit to an exact schedule for the project completion, discuss the status of the materials being used and account for the money spent, and summarize concretely both the current findings and the predicted results. The professionalism of the progress report is often vital to the future of the project.

In classes and projects involving writing, progress reports are used as a way for you to summarize your progress to your teacher or advisor, who will typically give feedback on whether he or she is satisfied with your progress. These reports could feel like a mere formality or a waste of time to you, but they are an excellent opportunity to articulate some of the key sentences of your final report and even pose questions in writing to your audience. The rules for writing progress reports are a lot more flexible in a classroom or lab than they are on the job, with a lot less at stake, so you should take full advantage of the opportunity for practice.

Self-Study

For more ideas on writing progress reports, I recommend that you visit:

"Progress Reports" article from the Department of Engineering at Penn State

"Guidelines for Writing Reports" from networklearning.org

Style for Progress Reports

The following stylistic advice can be applied to most progress reports you write:

- Include a working title and the words "Progress Report" at the top of the page.
- Use section headings in the report to simplify both the writing and reading process.
- Open the report with a "Scope and Purpose" section, where you give a condensed version of your future report's introduction and objective.
- Always include a section entitled, for example, "Progress," which summarizes the work's pace and progress and explains any snafus, dilemmas, or setbacks.
- Always include a section entitled, for example, "Remaining Work," which honestly assesses the work that must still be completed. Think right on the page in this section, posing questions, speculating meaningfully, exploring your options.
- Always include a section that projects the expected results. Commit to a schedule for obtaining those results if possible.
- If necessary, include a section in which you directly solicit advice from your teacher or advisor. Be forthright and professional about the nature of the advice you need.
- Keep your paragraphs short and focused—just a few paragraphs per section, typically.
- Your tone can often be straightforward and familiar—therefore, as a rule, you can use "I" and "you" freely—but do not lapse into informality.
- Avoid being overly optimistic, pessimistic, apologetic, cocky, or self-deprecating.

6.11: Sample Progress Report

The following short progress report, written by a student in geology, provides an excellent example of how concrete and affirmative a progress report can be. Note the specificity even in the title, and how sections such as "Remaining Questions" and "Expected Results" demonstrate that the writer, even though he is two months away from the completion of his thesis, is thinking about the work in a professional manner.

Click here to download a pdf of a sample progress report.

Click here to open a sample progress report within this page.

Progress Report

"Stratigraphic Architecture of Deep-Ramp Carbonates: Implications for Deposition of Volcanic Ashes, Salona and Coburn Formations, Central Pennsylvania"
by John Lerner

SCOPE AND PURPOSE

The Late Middle Ordovician-age Salona and Coburn formations of central Pennsylvania show cyclic patterns on a scale of tens of meters. Little research has been done on sequence stratigraphy of deep-water mixed carbonate/siliciclastic systems, and a depositional model for this environment is necessary to understand the timing and processes of deposition. The stratigraphic position of the bentonites at the base of the larger cycles is significant because it indicates that they accumulated during a time of non-deposition in a deep water environment.

PROGRESS

To date, I have described five lithofacies present in the Salona and Coburn formations. Two lithofacies are interpreted as storm deposits and make up the limestone component of the thinly-bedded couplets. Some trends were observed in the raw data; however, because of the "noisy" nature of the data, a plot of the five-point moving average of bed thickness was created to define the cycles better.

ADDITIONAL WORK

Two key tasks are to be completed in the coming weeks. With the results of these tests and the field observations, I will create a model for deposition of a deep-ramp mixed carbonate/siliciclastic system in a foreland basin environment. The model will include depositional processes, stratigraphic architecture, and tectonic setting.

REMAINING QUESTIONS

Questions remain regarding the depositional processes responsible for the featureless micrite at the base of the Salona Formation. . . . How rapid was the transition? What record (if any?) remains of the transition? Were bentonites not deposited, or were they selectively removed at certain locations by erosive storm processes?

EXPECTED RESULTS

I expect to find that the large-scale cycles represent parasequences. Flooding surfaces are marked by bentonites and shales, with bentonites removed in some locations. If the cycles are true parasequences, the implication is that eustatic sea level changes and not tectonic influences controlled the depositional changes over the interval.

6.12: Memos

In many courses, you are asked to submit your writing in memo form, and in some cases your assignments are given to you as memos. This not only gives you practice in writing a professional document, it invites you to see your writing as purposeful and aimed at a particular audience. A detailed instructional memo about memo writing—a "metamemo," if you will—follows.

Click here to download a pdf version of an instructional memo about memo writing.

To open an instructional memo about memo writing within this page, click here.

Memo

MYTHIC UNIVERSITY ONLINE
memo

DATE : August 9, 2008
TO : Users of Style for Students Online
FROM : Joe Schall
SUBJECT : Writing Memos for your Classes

This memo provides you with tips on writing memos for your classes, with special attention to a memo's audience, format, organization, content, tone, and style. Because my advice comes in the form of a memo, you can use this document as a model for writing your own memos.

The Audience for a Memo
It is useful to begin by considering that a memo is essentially a one-on-one communication between writer and reader. Although a memo may be written to a group of people or with various audiences in mind, usually it is a highly goal-oriented communication between two people who need to share information. When you write a memo to a professor in the classroom setting, you are much like the employee who has been assigned to investigate a problem and report back to a supervisor. Therefore, you are expected to provide concrete information, even information that the supervisor might already know, in a form that clarifies ideas and puts them into context. Finally, a memo enjoys a broader context than an essay; hence, you might refer to other related memos as you write, or you might respond to specific requests made by the audience in your text, in effect, carrying on a professional conversation.

Typical Memo Format
The overall format of a memo can be broken down into the heading, the body, and the closing notations. What follows is a brief description of each component.

The Heading
The heading has two parts: part one includes two centered lines at the top of page 1, identifying the name of the company or institution on the first line, with the word "memorandum" on the second line; part two includes the "DATE," "TO," "FROM," and "SUBJECT" lines at the left margin, filled in appropriately.

The Body
The body of the memo follows the Introduction, and it is usually presented in single-spaced paragraphs with a line skipped between each paragraph. The first lines of new paragraphs can appear at the left margin or they can be indented five spaces.

The Closing Notations
The closing notations, used to identify such things as attachments, appear at the left margin two lines below the text of the final paragraph. By simply typing the word "Attachment" as a closing notation, you automatically refer the reader to any attachment, such as a map, a set of calculations, spreadsheets, or a References page.

How Memos are Organized
The general organization of a memo mirrors that of an essay: an introduction, followed by body paragraphs, followed by a conclusion. However, the first paragraph of a memo is typically used as a forecasting device. Note how the opening paragraph of this memo defines the memo's function and reflects its organization. It is sensible to open memos for your classes in the same way, first directly stating the memo's purpose, then setting forth the organization and noting how the memo can be used.

Organization in the body of a memo is typically characterized by the use of section headings and short paragraphs. Paragraphs should not be too bulky—five or six per page is usually ideal. On the sentence level, you should take full advantage of the same organizational tools that you employ when you write an essay: meaningful topic sentences; carefully selected transition words; focused section headings; indented blocks of cited text; a bulleted series of examples; powerful punctuation marks such as the colon, semicolon, and dash.

Selection and Citation of Content

A memo's content, of course, is guided by the assignment and the research required. It is important to remember as you present the content that selectivity and relevance matter greatly. Your job is to select and present the most pertinent, most current information available to you. Do not hesitate, of course, to let your memo's content be heavily informed by your research, but also provide your own interpretation and organization of this research.

As in any essay, you must document the sources of your information so that your reader could find the original source of the information if desired. If your memo uses sources, provide the bibliographic information related to your sources on a References page as an attachment at the end of the memo—just as I have in this memo.

A Memo's Tone and Style

Memos for your classes require a highly informative and straightforward tone, but allow for a slightly informal style compared to essays. As in this memo, "I" and "you" are handy because they provide a straightforward way of communicating, but you must be careful not to overuse these terms. Stylish prose is key to good memo writing, and you should not hesitate to use active, interpretive adverbs and verbs and concrete, carefully chosen adjectives and nouns.

A memo need not be written in a dry, dull fashion; rather, it should emulate the same stylistic standards that good prose has always embraced. These standards are summed up neatly in the popular style guide, The Elements Of Style, as follows:

A sentence should contain no unnecessary words, a paragraph no unnecessary
sentences, for the same reason that a drawing should have no unnecessary lines
and a machine no unnecessary parts (Strunk and White 1979).

As this quote suggests, good prose can achieve elegance by its clarity, efficiency, and sense of purpose.

Conclusion

The conclusion of a memo should not simply provide a summary of the memo's entire contents, but it should be a true conclusion—that is, an articulated conviction arrived at on the basis of the evidence presented. The closing paragraph is the place to spell out the bottom line to the reader. Therefore, I close with my bottom line about writing memos for your classes:

- Study and use standard memo format to present your text;
- Use internal organizational tools such as section headings, topic sentences, transition words, and powerful punctuation marks to enhance the flow of ideas; Write with the same clarity, grace, and efficiency expected of you in any essay.
- Strunk, William Jr and White, E.B., 1979: *The Elements of Style.* Macmillan Publishing Company, Inc., New York, 92 pp.

Attachment

ATTACHMENT

References

Strunk, William Jr and White, E.B., 1979: The Elements of Style. Macmillan Publishing Company, Inc., New York, 92 pp.

Self-Study

For more information on memo writing, chase down these two websites:

Advice on writing memos from the Writing Center at Rennselaer Polytechnic Institute

Advice on memo writing from The Ohio University College of Business

6.13: Essays and Term Papers

When you are first faced with the task of writing a long essay or term paper it can be intimidating, but you make your job and the reader's job much easier by following some basic rules of thumb. Of course, if your professors offer you any specific guidelines about writing be sure to follow those first. Otherwise, incorporate the advice that follows into your papers wherever appropriate.

Self-Study

Here are some excellent websites for further advice about writing term papers:

"Term Paper Guidelines" article from Lock Haven University

"How to Write Academic Term Papers" article from theuniversitypapers.com

Mechanics

Of course, papers should always be typed, double-spaced on 8-1/2 x 11 paper on one side of the page only, and letter-quality print or better is always expected. Often you are expected to supply a cover sheet giving the date, your name, the title of the paper, the class, and the professor's name. Tables and figures should be numbered consecutively throughout the text, and if there are a good number of them, then separate lists of tables and figures at the beginning of the paper may be expected. Tables and figures should always have descriptive captions, and if they come directly from sources, the sources must be specifically credited in the captions with the same citation style that you use throughout the paper.

Title

A paper's title should be succinct and definitive, individual and informational. Clearly, the title "An Overview of the Hydraulic Fracturing of Methane-Bearing Coal Formations" is more complete, satisfying, and informative than "Hydraulic Fracturing." The title is important because it announces the paper's specific content and typically serves as a pathway to the paper's thesis.

Introduction

Your introduction is your opportunity to be at your most individual. You should get your reader's attention immediately by announcing the paper's subject or by launching into a relevant scenario or narrative that informs or illustrates your overall argument. A paper illustrating the costly effects of poor mine design, for instance, might open with the scenario of how a poorly designed pillar at a salt mine in Louisiana once collapsed, fracturing the surface above and draining an entire lake into the mine. A paper on the supply and demand of nickel might begin by straightforwardly announcing that the paper will explain the uses of nickel, detail its market structure, and use data to forecast the future supply and demand of the metal.

In brief, a paper's introduction should define and limit the paper's scope and purpose, indicate some sense of organization, and, whenever possible, suggest an overall argument. Another important principle in technical writing is that the introduction should be problem-focused, giving the reader enough background so that the paper's importance and relationship to key ideas are clear. A rule of thumb about the introduction's length: about 5-10% of the entire paper.

As examples of how creative an introduction can be, here are the opening lines from a geography paper and a paper on optics, both of which use narrative technique to arouse our interest. Note how the first excerpt uses an "I" narrator comfortably while the second excerpt does not use "I" even though the writer is clearly reflective about the subject matter. The first excerpt is from a paper on the generic nature of America's highway exit ramp services; the second is from a paper on shape constancy.

> *The observation struck me slowly, a growing sense of déjà vu. I was driving the endless miles of Interstate 70 crossing Kansas when I began to notice that the exits all looked the same. . . .*
>
> *Our eyes often receive pictures of the world that are contrary to physical reality. A pencil in a glass of water miraculously bends; railroad tracks converge in the distance. . . .*

Thesis Statement / Objective

Most papers have outright thesis statements or objectives. Normally you will not devote a separate section of the paper to this; in fact, often the thesis or objective is conveniently located either right at the beginning or right at the end of the Introduction. A good

thesis statement fits only the paper in which it appears. Thesis statements usually forecast the paper's content, present the paper's fundamental hypothesis, or even suggest that the paper is an argument for a particular way of thinking about a topic. Avoid the purely mechanical act of writing statements like "The first topic covered in this paper is x. The second topic covered is y. The third topic is . . ." Instead, concretely announce the most important elements of your topic and suggest your fundamental approach—even point us toward the paper's conclusion if you can.

Here are two carefully focused and thoughtfully worded thesis statements, both of which appeared at the ends of introductory paragraphs:

> *This paper reviews the problem of Pennsylvania's dwindling landfill space, evaluates the success of recycling as a solution to this problem, and challenges the assumption that Pennsylvania will run out of landfill space by the year 2020.*
>
> *As this paper will show, the fundamental problem behind the Arab-Israeli conflict is the lack of a workable solution to the third stage of partition, which greatly hinders the current negotiations for peace.*

Self-Study

From the flat state of Indiana, here are two pages on how to write sound thesis statements:

"How to Write a Thesis Statement" article from Indiana University, Bloomington

"Tips and Examples for Writing a Thesis Statement" article from Purdue's Online Writing Lab (OWL)

Body Paragraphs / Section Headings

Never simply label the middle bulk of the paper as "Body" and then lump a bunch of information into one big section. Instead, organize the body of your paper into sections by using an overarching principle that supports your thesis, even if that simply means presenting four different methods for solving some problem one method at a time. Normally you are allowed and encouraged to use section headings to help both yourself and the reader follow the flow of the paper. Always word your section headings clearly, and do not stray from the subject that you have identified within a section.

As examples, I offer two sets of section headings taken from essays. The first is from Dr. Craig Bohren's "Understanding Colors in Nature" (1), which appeared in a 1990 edition of *Earth & Mineral Sciences*; the second is from a student's paper on the supply and demand of asbestos.

Section Headings From "Understanding Colors In Nature"

- Color By Scattering: The Role of Particle Size
- Color By Scattering: The Positions of Source and Observer
- The Blue Sky: The Role of Multiple Scattering
- Color By Absorption in Multiple-Scattering Media
- Color by Absorption: Microscopic Mechanisms are Sometimes Elusive

Section Headings From "Asbestos: Supply and Demand"

- Industry Structure
- The Mining and Properties of Asbestos
- World Resources and Reserves
- Byproducts and Co-products
- Economic Factors and Supply and Demand Problems
- Uses of and Substitutes for Asbestos
- The Issue of Health on Supply and Demand

Just by considering the section headings in the above examples, we can begin to see the fundamental structures and directions of the essays, because both sets of headings break the paper topic into its natural parts and suggest some sort of a movement forward through a topic. Note how these headings—as all section headings should—tell us the story of the paper and are worded just as carefully as any title should be.

Most importantly, then, you must use your section headings in the same way that you use topic sentences or thesis statements: to control, limit, and organize your thinking for your reader's sake.

Conclusion

Most papers use "Conclusion" as a heading for the final section of the text, although there are times when headings such as "Future Trends" will serve equally well for a paper's closing section. When you are stuck for a conclusion, look back at your introduction; see if you can freshly reemphasize your objectives by outlining how they were met, or even revisit an opening scenario from the introduction in a new light to illustrate how the paper has brought about change. Your conclusion should not be a summary of the paper or a simple tacked-on ending, but a significant and logical realization of the paper's goals.

Beware of the temptation to open your final paragraph with "In conclusion," or "In summary," and then summarize the paper. Instead, let your entire conclusion stand as a graceful termination of an argument. As you write your conclusion, concentrate on presenting the bottom line, and think of the word's definition: a conclusion is an articulated conviction arrived at on the basis of the evidence you have presented.

What follows is an excerpt from a conclusion to a paper entitled "Exercise in the Prevention and Treatment of Osteoporosis in Women." Note how the conclusion reflects directly on the paper's hypothesis and spells out the bottom line, gracefully bringing closure to the paper's argument:

> *The majority of evidence presented in this paper supports the hypothesis that exercise positively affects bone mineral density in both premenopausal and postmenopausal women. Significantly, exercise has been shown to increase bone mineral density in premenopausal women even after the teenage years, and it helps preserve the bone mass achieved in the following decades. There is also evidence that exercise adds a modest, yet significant amount of bone mass to the postmenopausal skeleton. As these findings demonstrate, women of all ages can benefit by regular weight-bearing exercise, an increased intake of calcium-rich foods, and—for postmenopausal women—the maintenance of adequate estrogen levels. For all women, it is never too late to prevent osteoporosis or lessen its severity by making appropriate lifestyle choices.*

References

Any sources cited must be correctly listed on a References page using the Author-Year or Number system (see Chapter 5 of this handbook).

6.14: Technical Reports

Particularly for those of you in engineering fields, you might find the reading of journal articles none too stimulating (other than the occasional exciting references to hot presses, cool gels, quickened pulses, or body melds). Nevertheless, at their best, the journal articles you must read are certainly important and carefully crafted. The rigid-seeming format and objective style of scientific reports lend them a universal utility so that readers from various disciplines can readily access and use the complex information. Your professors will confirm that busy scientists (who can actually sometimes be characterized as "reader-hostile") rarely read these reports linearly—many readers cut right to "Results and Discussion" or look over the tables and figures before reading anything, then jump around to those bits of the report that are most relevant to their particular needs. Often, their goals are to rapidly exclude information they do not want (or do not trust).

In light of the above realities, it is especially important for you to write reports in a fashion acceptable to a journal in your field. As you prepare technical reports for your classes, you have built-in slots in which to put your information, and you plug in to a tried and proven recipe that has evolved over many years. Understanding this recipe and conforming to it will help you to organize your complex information as well as meet your reader's specific and sophisticated needs.

Self-Study

Two excellent online resource for writing technical reports reside at:

"Stages of Report Preparation" article from technocritical.com

"Writing a Technical Paper" article from a University of Washington professor

Mechanics

Of course, reports should always be typed, double-spaced on 8-1/2 x 11 paper on one side of the page only, and letter-quality print or better is expected. Unless you are instructed otherwise, it is usually standard to include a cover sheet giving the date, your name, the title of the report, the course, and the professor's name. Tables and figures should be numbered consecutively throughout the text, and, in a thesis or long report, separate lists of tables and figures are normally included at the beginning. Tables and figures should always have descriptive captions, and if they come directly from sources then the sources must be properly credited in the captions. Never present tables and figures without some useful interpretation of them in the text.

Title

It is always necessary to have a highly concrete title consisting only of words that contribute directly to the report subject. Be sure that the title contains no filler and includes few abbreviations or acronyms, yet also be certain that it is complete. "Sol Gel Method" is clearly incomplete compared to "The Synthesis of NZP by the Sol Gel Method." Of course, it is possible to overdo specificity as well: "The Role of Solid Oxide Fuel Cells in the Important Scientific Search For Energy Alternatives as Necessitated by the Recent Middle East Crisis and America's Energy Consumption" is painfully excessive and should be reduced to its essential elements.

Abstract

Most reports require an abstract—a condensed summary of the report's contents. In a journal article, more people will read the abstract than any other part of the paper, so its succinctness and accuracy are vital. The abstract is always self-contained, and is sometimes presented as a separate page. The best abstracts do these things, usually in this order:

- summarize the specific nature of the investigation;
- identify the rationale behind the investigation;
- present the important findings and most significant overall data;
- briefly interpret the pertinent findings.

By necessity, abstracts are often written last, and a good rule of thumb is that the abstract is less than 5 percent of the paper's total length. In a thesis, an abstract should fit on one page if possible. Passive voice and past tense verbs are usually appropriate for the purposes of summary, although many journals now print abstracts in the present tense with active voice.

What follows is a short excerpt from the opening of an abstract. Note how the first sentence summarizes the nature of the investigation, while the second identifies the rationale:

> *This study determines the locus of rifting at the southern end of the Eastern Branch of the East African Rift System within northern Tanzania. Here, the Eastern Branch diverges into a 300-km-wide area of block faulting, and consequently it is uncertain whether the rifting extends seawards across the Tanzania continental shelf or directly southwards into central Tanzania. In this study, the locus of rifting is investigated by . . .*

Introduction

The introduction should offer immediate context for the reader by establishing why the problem being studied is important and by describing the nature and scope of the problem. You should describe your specific approach to the problem and establish how your investigative work meshes with the needs of the field or with other work that has been done. The so called "funnel system" of organization—moving from a broad approach to a gradually narrowed scope—is highly recommended here. Present tense is also highly favored, especially as you present accepted scientific truths and the objectives of the report. Introductions range from one to several pages in length, and must always include a clearly worded account of the report's objective, usually at the end of the introduction (Some writers even include a short separate subsection labeled "Objective"). Most journals allow "we" or "our" to be used in the introduction, especially as you outline your objectives or summarize the common goals of researchers.

Here is an ideal opening sentence from a report introduction. Note how it launches the reader directly into the science:

> *To produce highly reliable metal-ceramic joints, we must fully understand the joining mechanisms. Therefore, today's ceramic scientists aim to . . .*

Literature Review

When articles appear in journals, the most noteworthy literature will usually be reviewed only briefly in the introduction or as it becomes relevant. In technical reports and theses for your classes, however, an entire section of your paper may well be devoted to a literature review. Literature reviews range from exhaustive searches to summaries of only the most germane articles, but the fundamental objective is always the same: to establish the history of the problem being investigated by summarizing the WHAT, HOW, and WHY of the work that has already been done. Writing a literature review requires you to establish relationships among findings from other researchers and to condense many pages of published material into shorter segments. Therefore, your ability to assimilate material and, in effect, tell your own story, becomes critical.

Stylistically, literature reviews are often written in the past tense, but many authors favor the present tense when the research being summarized was completed recently. Passive voice may seem tempting to use, but active voice will serve you well here, because you can smoothly place the names of authors into the subject slot of the sentence:

> *Yoldas and Lloyd (1999) propose a chemical polymerization technique for the preparation of NASICON gels.*

Experimental / Methods / Procedures

Any of the above titles will usually do for this section. The goal is to summarize the WHAT, HOW, and WHY behind your specific experiment, with particular emphasis on the WHAT and HOW so that other researchers can repeat your procedures if they so desire. As necessary, this section includes a description of the relevant apparatus and materials used, and photographs and diagrams could be used, sparingly, to help clarify the procedures.

Stylistically, passive voice and past tense verbs are essential in this section, but be sure that your sentences are written efficiently and contain simple subjects and verbs when possible. The basic form of directly saying "what was done; why it was done that way" should be used over and over in the "Experimental" section.

Here is an ideal sentence from the "Experimental" section of an engineering report:

> *After the dispersion thickened it was poured into molds coated with Vaseline to prevent sticking.*

Finally, subsections, perhaps numbered, are often used to aid in the organization of the material. For example:

```
2.0 EXPERIMENTAL
    2.1 Apparatus
        2.1.1 Heat treatment furnace
        2.1.2 Tensile testing device
    2.2 Materials
```

Results

For most readers, this is the most important section of the report—your readers must easily find your results in order to interpret them. Here you straightforwardly present the results of your experiment, usually with minimal discussion. Naturally, the use of tables, graphs, and figures is especially enlightening here, as are explanations of how data were derived:

> *The conductivities of the top and bottom values for each measurement were averaged and the results are listed in Table 3.*

Take care not to include your experimental methods here—that is the job of the previous section.

Discussion

Often this section is combined with "Results" into one "Results and Discussion" section; this allows you to interpret your results as you summarize them. Logical deductions must be made, errors of or ambiguities in the data should be discussed, and even simple causal relationships must be confirmed. It is important here not to rely on a table or figure to do the work for you—you must outrightly and concisely interpret. Beware of making sweeping generalizations or unfounded statements. Again, passive voice may seem tempting here, but active voice can be highly valuable, especially as you make a logical assertion:

> *Obviously, the formation of the protective layer prevented rapid oxidation.*

As a rule, use past tense to summarize your actual results; use present tense to present established facts or present your interpretations ("The helium sintering data show . . .").

Finally, consider referring back to the key literature of your introduction or literature review in this section. Enlighten your readers (and perhaps even elevate your work) by discussing your results in relation to the published results of others.

Conclusions

In "Discussion" you supplied your reasoning; now you present the exact conclusions you have arrived at as they relate to your experimental objectives. Conclusions may be listed and numbered, and it should be made clear how they contribute to the understanding of the overall problem. In a sense, you are going back to the big picture provided by your introduction now, incorporating your conclusions into that picture, even suggesting where more work is needed. This section may be short—often about the same length as the abstract.

The following is an excerpt from the "Conclusions" section of a report:

> *These results confirm the hypothesis posed in the Introduction: that the shock sensitivity of this explosive is probably not due to the weakening of the phenyl ring by the substituents. It is possible, however, that mechanical properties such as the coefficient of friction, uniaxial yield stress, and hardness greatly influence the explosive's shock sensitivity. Further work is needed in this area to determine . . .*

Acknowledgments

If appropriate, briefly recognize any individual or institution that contributed directly to the completion of the research through financial support, technical assistance, or critique. In a thesis, this section may appear just before the introduction.

References

List cited sources on a References page using the Author–Year or Number system (see Chapter 5 of this handbook).

Appendices

If necessary, use an "Appendices" section to present supplementary material that was not included in the main body of the report because it would have detracted from the efficient or logical presentation of the text, usually either by sheer bulk or level of relevance. A typical appendix would be a list of organizations relevant to the material of the report, or a list of symbols used in the

text, or the derivation of an equation that was used in the text but could not be referenced because it did not originally appear in a standard text. As with figures and tables, appendices should be numbered or lettered in sequence; i.e., "Appendix A, Appendix B," and so on.

6.15: Internship and Co-op Reports

Typically, you are required to write a report about your work at the completion of an internship or co-op. Although an internship or co-op might not be linked directly to a class, per se, the act of writing the report—which is often achieved in the final weeks of the experience or in the semester following the work—is certainly a writing-intensive experience. The document provides a simple means for you to report to your faculty supervisor on both the content and value of your work assignment, and, more importantly, it gives you a chance to reflect on the work you have done in both a personal and professional manner. You should think of your report, therefore, as both a formal academic assignment and as a personal opportunity to use and enhance your skills as a communicator. Just as successful people thrive by blending their formal education and experience with critical self-assessment, you can use your report to review what you have learned, detail what you have accomplished, and gauge your personal growth. Also, especially if you produce a professional product, you might offer your report as a writing sample to a potential employer.

Frequently, you will be given guidelines for writing your report from a faculty supervisor, and it is critical that you follow these guidelines to the letter. It is also important, though, that you treat these guidelines as starting points rather than ending ones. For instance, if you are posed with three questions to consider in a particular section of your report, your responses to these questions should be thoughtful and expansive rather than just simple one-sentence answers. Further, you should see these questions as starting points that will lead you to other related questions of your own design. The bottom line is this: Any report guidelines you are given should be viewed as a substantive framework that awaits your interpretation and elaboration, not as a simple Q-and-A or fill-in-the-blank exercise.

One important note about your report: Before being turned in to your faculty supervisor, it should first be reviewed by your employer. Your employer's role here is proprietary; i.e., the employer should be considered the "owner" of the report content. You must be certain that your employer will allow the content of your report to become public, and you should also view the employer's review of your report as standard practice—just as a project manager reviews and endorses the written work of his or her team members.

As a complement to whatever guidelines you are given, the following sections will aid you in generating detail, making your report stylish, and treating it as a personal and professional product. Keep in mind that internship and co-op reports are typically built around specific majors or programs. Therefore, advice you find on the web for one program might not be correct for another, even within the same school. Always check within your program or department office to ensure you are following the appropriate, most up-to-date guidelines.

Report Content and Style

The specifics of your report content will vary based on the guidelines provided by your faculty supervisor. However, all faculty supervisors will be interested in reading about three main subjects:

1. Your employer;

2. Your duties;

3. Your evaluation of the work experience.

Your Employer

You should describe the employer you worked for in thorough detail. As you do so, consider doing the following jobs, typically devoting at least one paragraph to each:

- Introduce the employer's connection to you by providing an overview of your position, including such details as where you worked, for how long, and how the position fit into your education.
- Describe the nature of the position you held in relation to the employer—what is the position's value to the company? Why does the company hire interns? Is the internship program new or long-standing?
- When appropriate, quote key company literature—e.g., a brochure, a mission statement, a web page—to summarize the company's values and culture.
- Give an overview of the employing organization's size, structure, and commitment to internship/co-op positions. Use the company literature or web page directly to help you generate detail, but avoid simple cut-and-paste composing—assimilate the

material.
- Detail how the position you held fit into the overall company organization.

Outline some of the employer's key goals and challenges, highlighting those problems or projects with which you were specifically charged.

Your Duties

In describing your work duties, outline your specific responsibilities and tie them into any larger projects with which you were involved. Detailed accounts should be given of such issues as the following:

- Your specific day-to-day responsibilities and activities. Turn here to your daily routine activities, record keeping methods, and any job description provided by the employer.
- Duties you took on or were assigned beyond the standard job description.
- Activities in coordination with project teams or co-workers.
- Specific technical functions of your position.
- The academic background necessary for any project you worked on.
- The goals of any project you were involved in.
- Key data, equations, or software that you generated or used.
- Names and functions of machinery or instruments that you operated.
- Analysis and application of data to your particular project.
- Documents, reports, or presentations that you were required to complete.

Your Evaluation of the Work Experience

An evaluation of your internship or co-op is important not just for your faculty supervisor, but for your academic department, your peers, and for you personally. As a way to evaluate your experience, elaborate on areas such as the following:

- The assessment others made of your work, especially if you were given a written evaluation.
- Contributions that the work experience made to your career development, goals, and growth.
- Contributions of the work experience to your selection of future coursework, either because you foresaw new needs due to the work or because a co-worker made recommendations.
- Assessment of which courses you completed that were the most or the least applicable to your internship/co-op. Note specific courses and principles studied in these courses.
- Noteworthy distinctions between your education and on-the-job experience.
- Whether the internship/co-op made good use of your technical background.
- Your level of personal satisfaction with the internship/co-op and whether or not you would recommend it to others.
- Your assessment of how the internship/co-op could be improved for others.

Stylistic Benchmarks

No one expects you to emulate Shakespeare as you write your report (in fact, you had better not do so—"Whether 'tis nobler in the mind to suffer the slings and arrows of outrageous fortune . . ."); instead, your readers will expect your information to be clear and your ideas to be fluid. Therefore, as you compose your report, employ the following stylistic benchmarks:

- Pay special attention to subject/verb agreement and verb tense, the two most common sentence-level problems in technical writing.
- Favor short paragraphs over long ones. Short paragraphs tend to be focused; long ones tend to be cumbersome. Aim at four-six paragraphs per page.
- Consciously build your paragraphs around topic sentences, even very simple sentences such as "My daily activities fell into three categories." Your readers will be thankful that you spelled your paragraph topics out clearly, and it will help keep you focused as well.
- Selectively use transition words at the beginnings of pivotal sentences and paragraphs, remembering that transition words provide simple ways for you to guide the reader's thinking. Opening a sentence with a word such as "Specifically" tells the reader that you are about to elaborate, while a transition such as "Clearly" implies writer contemplation.

- Rely on active voice more than passive. Write "WBRE-TV employs three interns" rather than "Three interns are employed by WBRE-TV."
- Exploit active verbs, especially as you describe your accomplishments. As with a resume, think in relation to things you demonstrated, performed, defined, improved, mapped, programmed, organized, presented, etc.
- Take advantage of the most powerful punctuation marks—the semicolon, colon, and dash—to present material efficiently.
- Use an honest, upbeat, sincere tone, especially in the conclusion of your report when you assess the internship or co-op's value to you personally.

Global Mechanics

Of course, reports should always be typed, using double-spaced type, one side of the page only, on 8-1/2 x 11 paper. Use a point size of 10-12 and a highly readable font such as Times. Include page numbers on all pages after page 1. Use a laser printer to print off the final version of your report.

Just as in a professional paper, any tables and figures should be numbered consecutively throughout the text, and if many figures and tables appear then separate lists of them at the beginning of the report would be wise. Tables and figures should always have descriptive captions, and if they come directly from sources, the sources must be specifically credited in the captions with the same citation style that you use throughout the report. Use an appendix to attach any important related materials, but only if these materials are highly illuminating or were used directly to write the report.

Cover Page

Typically, you are expected to supply a cover page giving such details as the title of your report, the type of report, your name, your major, and the complete name, address, website, and phone number of the employing organization. It is important that your cover page be thoroughly detailed, but that you do not let the presentation of detail be overwhelming to look at. Organize and balance your information on the cover page with aesthetics in mind, favoring centered text and skipped lines between each separate detail. Also, consider using a table of contents page, especially if your report includes many section headings or is more than, say, eight pages in length.

Title

It is important that your report include an appropriate title. Again, look to any report guidelines you have been given for particulars, but remember that your title should be logical, informational, and professional, and should reflect the type of document that your report represents. Even a generic title such as "Internship Report" is more appropriate than an idiosyncratic, cutesy one such as "My Headache with Bayer Corporation."

Abstract

Since most professional reports require an abstract—a condensed summary of the report's contents—it is logical for you to include one with your report as well. In published reports, more people will read the abstract than any other part of the paper, so its utility is critical. The abstract is always self-contained, and is normally presented as a separate page and in a single paragraph. By necessity, abstracts are often written last.

The best report abstracts do these things, typically in this order:

- briefly summarize the purpose of the report;
- summarize the specific nature of your work assignment;
- provide basic information about the employer;
- point the reader towards the conclusions of the report, which might in this case be your evaluation of the experience.

The style of abstracts is grounded in economy and information. Sentences should be kept short but detailed. You could use the pronoun "I" to refer to yourself in the abstract, but in general a straightforward and objective tone should be maintained.

A short excerpt from the opening of an internship report abstract follows:

> *This report outlines the duties of a summer intern at BMC Corporation in New Brunswick, NJ, and highly recommends the internship to other students. BMC Corporation includes over 50 manufacturing facilities in three states. I worked in the*

Peroxygen Chemicals Division . . .

Introduction

The content and length of the introduction vary based on your report guidelines, but as a rule introductions are meant to spark the reader's interest by providing basic background relevant to the report. As you write your introduction, remember that you should create immediate context, ideally with individual style. You have a story to tell, and the introduction is your chance to get the reader interested in that story. Note in the following excerpt from a report introduction how the writer even begins with a creative, personal tone to invite the reader's attention:

> *From the White House to the home of Steven Spielberg to elementary school classrooms, Lutron Electronics' lighting controls manage the visual environment of millions of buildings all over the globe. Lutron's products form one of the largest markets in the lighting industry throughout the world, ranging from a simple wall box dimmer to a complex computerized system controlling all the lights of a coliseum.*
>
> *From May to August 2008, I worked at Lutron as a summer intern. My responsibilities included . .*

Section Headings

In any report more than a few pages long, section headings are always a good idea. Just by considering the section headings in a report, the reader can determine the report's organization and content. For the writer, thoroughly worded section headings help you to control, limit, and organize your thinking within each section.

To generate your section headings in the body of your report, you can begin by turning to any report guidelines with which you have been provided. For instance, if you are asked in your report guidelines to consider whether the position truly utilizes your technical background, you might create a section heading such as "Technical Background Necessary for Position." Compose section headings that have a clear relationship to one another and tell the story of the entire report.

The following section headings from a co-op report demonstrate both the specificity and the narrative nature of good section headings:

- Introduction to My Co-op
- Overview of Bayer Corporation
- Overview of My New Martinsville Co-op Experience
- Computer-Simulated Process Control: the Camile Tg Software Package
- The Use of Mid-IR to Monitor Reaction Extent
- Conclusion and Personal Evaluation of Bayer

Conclusion

The content of your conclusion might be made up entirely of your personal evaluation of the internship/co-op. However, it is also appropriate to give an overview of the report or to highlight something that you learned in writing the report. For instance, some students use the conclusion to review the key terminology that was used throughout the report and note how this key terminology now has practical applications for them. In short, you can use the conclusion to show how the work experience changed you.

Remember too that a conclusion can be a substantial portion of a report—perhaps several pages long. This makes it even more important for you to rely on specifics, not generalities. Avoid generic unsupported conclusions such as "The internship was a positive experience for me and it was very beneficial too." Instead, present evidence to prove your claims—provide examples, scenarios, lists, names, dates, emotions, labels, terminology. Do not skimp on detail.

As you write your conclusion, concentrate on presenting the bottom line, and think of the word's definition: a conclusion is an articulated conviction arrived at on the basis of the evidence presented.

Acknowledgments

An acknowledgments section, normally on a separate page with the heading "Acknowledgments," could be included at the beginning or end of your report. The style for this section is often highly personal, and your job is to recognize briefly any

individuals or organizations that contributed directly to the completion of your internship or co-op through financial support, technical assistance, critique, or personal commitment.

References

Any sources cited in your report must be correctly listed on a references page using a citation style that is standard in your field, such as the number system or author-year system (see Chapter 5 of this handbook). If your professor does not recommend a specific citation style, model yours on a journal from your discipline or, better yet, on the citation style recommended by your employer.

CHAPTER OVERVIEW

7: Presenting Yourself in Person and Online

7.1: Introduction

Computers are useless. They can only give you answers. —Pablo Picasso

For more than a decade, Beloit College has been releasing an annual "Mind-Set List" to help define the common worldview of the incoming first-year undergraduate class. Though this popular list is somewhat tongue-in-cheek, its point is to provide "cultural touchstones" for university folk to help us understand what the new crop of students has and has not experienced in 18 years of life. For the class in question at the time of this writing—the class of 2020—the list is 60 items long and includes these entries:

- *West Nile has always been a virus found in the U.S.*
- *Catholics and Lutherans have always been in agreement on how to get to heaven.*
- *Books have always been read to you on audible.com.*
- *Snowboarding has always been an Olympic sport.*
- *Robots have always been surgical partners in the O.R.*
- *Michael J. Fox has always spoken publicly about having Parkinson's disease.*

As a veteran teacher, what I always appreciated about this list is that it really did make me think about the experiences of the incoming class as well as my own experiences, especially in regard to writing and technology. The above list excerpt reflects rapidly implemented and vast technological changes that visibly affect our daily lives, and both students and faculty benefit from grasping the scope of such changes.

As a modern student writer, you compose at the keyboard, and while writing a paper you might also be checking Facebook, sniping an e-Bay auction, texting friends, watching youtube, running a grammar checker, answering e-mails—all at the same time. Meanwhile, you may also be receiving peer feedback or e-mail commentary from your teacher before your paper is even graded, and the form of the paper might include a Powerpoint presentation or poster. In short, with high-speed technology and voluminous resources at your fingertips, you must be able to multitask, collaborate, use multimedia, and define yourself as a thinking writer who is "plugged-in" in every sense of the term.

This chapter is devoted to helping you become a better communicator within the context of the computer age. Sometimes this means schooling yourself in long-established fundamentals, while other times it means understanding technology as a communication toolkit. Whether you're writing an e-mail to a professor, giving a Powerpoint presentation, creating an online portfolio, or sitting down for an interview, you need to focus on how well you present yourself, both in the corporeal world and the virtual world.

Self-Study

For further study, here are two websites that demonstrate both the complexities and the possibilities for those writing in the computer age:

Microsoft Word Tips, Tricks, and Ideas page

"First Steps Toward Understanding the Net Generation" article, from educause.edu

7.2: E-Mail Etiquette

Every e-mail user has received at least one. You open your inbox to discover an offer from, say, the nephew or second cousin of a deceased king who is happy to give you a portion of millions of dollars if you will simply reply favorably to the request to help transfer funds to a bank account of your choice. The most creative and convincing one I've received expressed concern that I had recently passed away (I had not), and if this was not so then I needed to inform someone in Nigeria immediately so that my waiting inheritance didn't go to my undeserving relatives. Such scam e-mails range from being badly written to artfully manipulative, and they often make their way past spam blockers and include subject lines such as "An Invitation," "Humble Request," or "Please Help!!"

Ironically, I have received e-mails from students containing these same subject lines, and the requests made within those e-mails were often less persuasive than the type outlined above, for one simple reason—the writer failed to demonstrate any sense of e-mail etiquette. My concern in such a case isn't just that the writer has failed to communicate with me effectively; I speculate and worry that such bad practices will carry over into the student's workplace, where daily and effective e-mail communication is vital to good job performance. On the job, you will literally be communicating via e-mail with scores of others with a simple touch of the Enter key, and whatever you send becomes, in a sense, part of a permanent record. Also, your e-mail will be one of potentially hundreds that your target reader receives in a week or even a single day, so you'll want it to be read and noticed for the right reasons.

To ensure that you become an urbane and effective user of e-mail, some essential rules for e-mail etiquette follow.

First, Decide if E-Mail is the Best Form of Correspondence

Just because you received a request by e-mail doesn't mean it's the ideal medium for a response. Before initiating any e-mail correspondence, always consider whether a memo, letter, phone call, or face-to-face meeting is a better choice. Do not feel obliged to make trivial e-mail responses; in many cases there is no need to reply at all. In short, be certain to choose the best, most efficient mode of communication for the circumstances.

Use a Short, Definitive Subject Line

The value of a solid subject line is indisputable, especially since the subject line usually appears in the electronic mailbox right next to the sender's name. It is tempting to write cryptic little teasers in your subject line ("Wow! Check This Out!!") to get your reader's attention, but this is always a bad practice, leading to the potential for your e-mail to be blocked as spam or simply trashed by the user. A much more civilized practice is to make your subject line concrete, informative, and respectful ("Electrical Engineering Student Requests Your Input"). Remember too that the subject line is part of the message's permanent record, and it may be used by the receiver of your message to decide where to file your message for future use; choose the wording of your line accordingly.

Follow the Conventions for Effective Paragraph Writing

Even in electronic communication, the standards for good sentencing and paragraphing apply. Complete sentences grounded in subjects and verbs should be the rule, not the exception, and transition words should be placed at the beginnings of pivotal sentences and paragraphs. When you reply to direct questions that you copy into your text from an original file, quick, one-word replies might suffice just below the questions, but otherwise you should avoid fragmentary snippets of ideas in favor of complete sentences. Keep your paragraphs short to enhance readability, because scrolling is usually necessary to read even a short message, and the reader tends to race through the text hurriedly.

Write from the Top Down and Focus Your Content on a Single Subject

When writing e-mails, borrow the convention followed in newspaper articles of "writing from the top down," putting the most important information at the top of the message so that it can't be missed. Most users will decide whether or not to read your e-mail within seconds; therefore, the opening of your message must be designed to survive snap decisions. Use the opening statements as a quick summary of the most important content, and stick to a single subject throughout. If specific action is needed in response to the e-mail, note that such action is needed as part of purpose statement in the first paragraph, then use the rest of the e-mail to flesh

out your reasoning. If you need to discuss multiple subjects, consider the use of multiple mailings with individual subject lines, or use a helpful table of contents and section heads within the e-mail to facilitate effective browsing.

If Necessary, use a Narrative Greeting to Specify Your Identity and Affiliation

Do not rely on your e-mail address or signature at the bottom of the document to be the sole indicators of your identity and affiliation. Even readers within your same organization—especially at a large university or corporation—may not automatically recognize your name. Therefore, use a first short paragraph as a narrative greeting to specify your identity, affiliation, and even to echo your subject line.

When Replying to Messages, Retain Only What is Needed to Give Context to Your Response

All e-mail software includes a response feature, which typically copies the sender's message over into a new message box for you, fills out the "To," "From," and "Subject" lines, and precedes each line of the original message with a symbol such as ">." However, for the sake of efficiency and clarity, you should cut the unnecessary lines of the sender's original message and respond point-by-point to particular issues raised by the sender, positioning your new text just beneath the sender's specific text that you are replying to. If you are simply responding to a single question that was asked amidst a lengthy paragraph, you might delete everything but the question so that your message is efficient and the context clear.

Learn how to Handle Attachments and Text Files

Attachments are one of the most common problems people have with e-mail correspondence, especially with the potential for viruses to be transferred via an attachment. Attachments are often courteous to include with e-mail messages, in part because they can be used to retain the appearance of an original file, including special characters and formatting, and they can be transferred immediately and for free. Your e-mail software dictates precisely how attachments are sent, but typically, in order to send an attachment, you drag and drop a representative icon, or use a pull-down menu to choose a desktop file. Some users prefer to receive attachments as text files in the body of the e-mail message itself, because text files are compact and electronically universal. Also, the form the attachment takes—whether in Word or as a pdf—determines how readily it can be opened from one computer to the next. If there are any ambiguities, the best practice is to communicate with the e-mail's receiver about the nature of the attachment—the software used to create it, for instance—and if possible to include a text version of the attachment in the body of the e-mail message as well.

Be Sensitive to Who Might Read Your Message and How They Might Read It

Even more than letters or memos, e-mail is surprisingly portable. There are few laws specifically governing e-mail, and the mores of the workplace can easily lend themselves to electronic gossip. E-mail can be printed out, passed on electronically to other parties, saved on a disk, or readily altered by anyone who receives it. Therefore, it is unwise to discuss certain subjects by e-mail, especially those that are sensitive, confidential, or damaging. What was intended as a light-hearted editorial aside can lead to a chilly little war. Assume that any message you send could become part of a permanent record, and control the content of the message accordingly.

Cite Sources Accurately and Quote Individuals Faithfully

Even an e-mail message is worthy of accurate citation and quotation, especially if you are quoting an individual from whom you received a message. When doing so, copy and paste the person's actual words rather than paraphrase them. However, also remember that standards of etiquette and good sense dictate that you should not quote another party's words without that person's implied or express permission. If you need to cite a source formally, as in a paper, be sure to give enough bibliographic information in the e-mail so that the receiver could track down the original source if needed.

Fit Your Tone to the Circumstances, Always Favoring the Courteous

Most circumstances allow for a blend of a personal and professional tone to your e-mail messages. Just as when you write a cover letter for a job, you want to maintain both a personal, amiable voice (often enhanced by the use of contractions and the first-person pronoun "I") and professional content (characterized by examples and evidence that relate to the point you are making). However, be aware that some e-mail messages—say, those that may become part of a formal report or those likely to become part of some

permanent record—demand a completely formal tone. Finally, if tone is an issue, when you want to be certain that a sentence you just wrote expresses the emotion you want, consider following the sentence with an emoticon (often called a "smiley"). Obviously, use emoticons with restraint and selectivity; sparse use is best.

Assess the Rank and Stature of your E-mail Receiver, and Compose Accordingly

Computer mailboxes give social equality to all messages as they arrive, which can seem to crumble hierarchies. Just as you can send a message to a long-time pal with a few simple taps of the keys, you can readily write to the CEO of a company or a university president just by discovering that person's e-mail address. Nevertheless, always keep in mind the position of the person you are writing to, and be certain to honor the niceties and respect that should come with that position. Maintain this respect and a tactful tone in everything from the greeting you use to the connotations of the words you choose. Even if you are composing your message at 3:00 a.m. while barefoot and in your bathrobe, the tone of your message should suggest that you are seated in the recipient's office, dressed for daylight and well-shod.

Avoid Flaming

Flaming is responding to the e-mail of others in an opinionated, emotional manner, often in an inflammatory way. Even if you find the tone of another person's e-mail especially combustible, a good rule of thumb is to wait 24 hours before replying, and be certain that any emotional response you do give will not be misinterpreted. Flaming begets more flaming and makes for bad diplomacy and ineffective communication.

Carefully Discern the Tone of Messages Sent by Others

We all develop skills that we can apply to face-to-face meetings and telephone conversations, including body language and voice inflection, but e-mail, despite its similarities to conversation, does not allow us to employ these skills. Remember that messages you receive will include nuances of style and tone, yet the intentions of the writer may be different from what you expect. In e-mail correspondence, people are not only more likely to write in an informal, relaxed tone, they are also more likely to editorialize ("What a silly thing to say."), reply emotionally to individual phrases or sentences ("Are you damn sure this percentage is correct?"), and be curt or sarcastic ("Oh, right!"). Be certain to interpret the tone of others' messages with discretion and, if necessary, with a bit of latitude.

Learn Key Acronyms Commonly Used in E-Mail Messages

Many users of e-mail save time—and appear relaxed and hip, too—by using acronyms in their correspondence. A list of some of the common ones follows:

Acronyms and corresponding plain text

Acronym	Plain Text
BTW	by the way
F2F	face-to-face
FAQ	frequently asked question
FYI	for your information
JTYLTK	just thought you'd like to know
AFAIK	as far as I know
LOL	laughing out loud
OTOH	on the other hand
RFC	request for comments
TTYL	talk to you later

Even though the use of such acronyms is common, keep in mind that your readers—especially international readers or new e-mail users—may not know what they mean, and in messages that will become part of a formal document these acronyms should be avoided.

Be Extremely Cautious with Listservs

Listservs, where a user sends copies of a single message to multiple readers, are handy because of the volume of people they can reach at once. However, be cautious about responding to messages that you receive through listservs; you may unintentionally send a message to every member of the list, leading to accidental, often irritated, audience members and wasted time. Instead of automatically replying to the message with the "reply" function, which may send a message to every person who received the original one, copy out the address of the person you wish to reply to, and write an individual message in a new window just to that person.

Familiarize Yourself with the Rules of Your Particular Electronic Community

Any electronic community, especially one that makes use of a listserv, should have implied or written rules of etiquette, often in an FAQ page. Usually, these rules will specify appropriate behaviors and procedures in relation to flaming, e-mail distribution, replying to messages, and frequently asked questions. The most mannerly users make it a point to learn the rules of their electronic community and follow them.

Proofread and Spell Check Your Work Carefully

Beware of the strong temptation to let the seeming informality of e-mail cause you to be sloppy about punctuation, spelling, and proofreading. I once had a student seeking my help on a paper write an e-mail to me, simply stating, "I have a paper dude on Thursday. OK?" (Unable to resist the temptation, I shot him back my smart-aleck reply: "That's okay with me, dude.") Your readers, especially your professors or supervisors, will likely be irritated by such errors in e-mail messages, in particular if they reflect a general sloppiness. Proofread and spell check the message text before sending it.

Beware of Silly or Offensive Signature Lines and Enigmatic Aliases

Most people create signatures or an electronic alias that is automatically attached to the end of any message you send. The standard contents of signatures include the sender's name, affiliation, e-mail address, phone numbers, and the like. Many users also include their nicknames, favorite quirks, past-times, personal habits, quotations, thoughts for the day, and keyboard artwork. Signature lines and aliases by students tend to favor nicknames that smack of secret identities ("The Lurker," "King of Pain") or personal credos ("Long Live Luke Skywalker," "Dave Matthews Rules"). You should obviously deactivate such signature lines when communicating with a professor or potential employer. Otherwise, you run the risk of irritating someone or even embarrassing yourself: Imagine a potential employer to whom you once e-mailed your resume forever thinking of you as "The Bedbug."

Self-Study

Visit these websites for further e-mail writing tips:

"Writing Effective E-mails" from mindtools.com

"30 Email Etiquette Tips for Avoiding Sloppy E-mails" from getsidekick.com

7.3: Effective Grammar Checking

When asked about grammar checkers, some teachers of English will immediately darken their eyes and pronounce them evil. No, this is not because they worry about losing their jobs to computers (English teachers will always be needed, certainly), but because they recognize the limitations of grammar checkers and fear that they make writers lazy or unthinking. Because my paper passed the grammar checker's test, some think, it must be fine.

A simple demonstration will prove otherwise. Consider the following nonsense sentence:

> *Grammar checker tell this sentence just fine, even when longer made, even made more nonsense, full of grommets, so trust grammar checker little, worked harder instead, with eye for errors open, until grammar understood better, by you, who more politic than checker, which allow manifold mistake, all over place, indeed.*

My grammar checker has no problem with this silly sentence; though any thinking reader would, and even assigns it a 12th grade reading level. Conversely, when I test sentences from one of our most lyrical works on science and nature, Loren Eiseley's *The Immense Journey* the grammar checker frequently wags its finger unhappily at the author, befuddled by his comma use, syntax, and sentence length. To put it plainly then, "Grammar checkers is stupid"—another sentence my checker accepts readily. This should be no surprise of course, in that grammar checkers merely match patterns derived from mechanical computations and offer suggestions with no understanding of context. In other words, *they do not think*. Since we do, we must and can learn to outperform them.

With these concerns in mind, I certainly do use and recommend grammar checkers to thinking writers, following these guidelines:

- Grammar checkers come with default settings, which can be changed to suit your needs. For instance, in my version of Word, I can go to "Tools" in my menu, choose "Options," then choose "Spelling and Grammar," and elect which options I wish to employ as my grammar checker crawls through my writing. Writing styles the checker monitors include such options as gender-specific words and passive voice, and the choices you elect in your settings influence the nature and number of suggestions made. You can also, for instance, invite the grammar checker to always suggest corrections or always ignore internet addresses. Look at your settings carefully and make choices for them that suit you as a writer, tinkering with your spelling and grammar options as needed.
- Grammar checkers are best at catching subject/verb agreement problems and unintentional verb tense shifts. Be sure you agree with the checker's suggestions in these areas. You can brush up on these subjects in Chapter 1 of this manual.
- Grammar checkers are especially useful if you want to reduce your usage of passive voice, in that passive voice sentences are faithfully flagged. Keep in mind that passive voice is often acceptable (see "The Passive versus Active Voice Dilemma" in this manual), but use the grammar checker to help you favor the active voice.
- As you use your checker, always take a moment to note the explanation provided about the problem to be certain it fits the circumstances. For example, the grammar checker mislabels the following complete sentence as a fragment: "My papers, which I completed with my partners, Sue and James, received high marks." Obviously, consult a style handbook to help you address uncertainties.
- My experience and research suggest that grammar checkers are least effective at discerning punctuation errors, and they are also especially poor at recognizing the proper use or absence of "a" and "the" (as shown by my example nonsense sentence earlier).
- Grammar checkers are particularly good at detecting certain kinds of typing errors, such as a space before a comma, an unintentionally repeated word, or a sentence with no end punctuation. Use them to help you catch such errors, which you can scan for visually even without actually proofreading a document.
- Keep in mind that, in a particular document, once you have accepted a sentence as error-free even though the grammar checker flagged it, it might not be challenged by the checker again, even after you do a bit of tinkering. This makes your thoughtful consideration of any suggestions made by the checker even more important.

Self-Study

Academics love to study performance of both human beings and computer systems, and studies on grammar checkers offer both options. Here are two academic studies evaluating grammar checkers:

- Academic study "Relative Performance Evaluation on Automated Grammar Checkers as Knowledge Systems"

- Article entitled "Academic Study Evaluating Grammar Checkers: A Comparative Ten-Year Study"

7.4: Oral Presentation and Powerpoint

I once attended a talk where the speaker held everyone's attention for a key five minutes by pulling the Seinfeld trick—putting on "a show about nothing." An engineer at a small, struggling company, he was near the end of a slick Powerpoint presentation about whether the design for a critical machine should be modernized to speed up production, and he presented three options:

1. Retool the machine in-house, which would sacrifice a month of production time but result in faster output in the long run.
2. Buy a new machine from a known distributor, which would involve a hefty up-front expense but save labor costs and time;
3. Do nothing.

That's right—do nothing. Continue with production and learn to live with the sacrifices.

To dramatize this third point, the speaker filled the presentation screen—which up to then had held colorful Powerpoint slides employing slick transitions and graphics—with nothing. He simply left the screen blank, proposed the option of taking no action, and then shut off the projector. For the next five minutes, he engaged the audience members—which included the company president and the company accountant—by switching to a lecture format, moving around the room without so much as a pointer or note card, and arguing his case: that it was smarter for the company to maintain status quo, especially since it was struggling financially. Ultimately, he impressed his point on the audience not with the magic of presentation software, but with reasoning, creativity, common sense, and the bottom line. As the speaker hoped, the company bought into option number 3.

As this example demonstrates, effective oral presentation is more about creative thinking on your feet and basic skills than about wearing good shoes and knowing how to turn on the computer projector. Companies have long cried for graduates who can give dynamic talks, and they have long relied on talks as a key way to sway concerned parties towards a desired outcome. But many presenters make the mistake of trying to let the computer, bells and whistles blaring, do all the work for them. They forget the fundamentals of oral presentation, and thus whatever polish they have quickly loses its luster.

To become a modern speaker worth listening to, whether you're serving as a company representative or presenting at a conference, you must come fully prepared, engage your audience's attention and memory, attend to some visual design basics, and take stock of how you come across as a speaker.

Preparing for a Talk

There's a rule-of-thumb in carpentry: Measure twice, cut once. The tenets behind this principle should be obvious—once a mistake is made, it's difficult or impossible to undo. Though the carpenter can usually spackle or glue to repair, as a speaker you simply cannot get back those three minutes you just wasted in a fifteen-minute presentation. The following preparation principles will keep you right on plumb.

- Practice your talk straight through, and as you go jot quick notes to yourself about how to improve it. If you cannot manage to practice your talk straight through, perhaps you are not yet ready to offer it.
- Ideally, practice your talk under conditions similar to those in which you will give it, considering such factors as acoustics, distance from the audience, lighting, and room size. Lighting becomes especially important when computer equipment is involved. Be mentally prepared to adapt to the environmental conditions.
- As a draft, present your talk to a friend or two first and have them critique it. If you're really gutsy and can tolerate the unforgiving lens of the camcorder, videotape your practice talk and critique it afterwards.
- View all of your visuals from your audience's perspective prior to your talk. Be sure that your audience can easily see all that you want them to see, especially material that appears in the lower half of the screen.
- When you give a talk professionally, always request presentation guidelines from any relevant organizations and conform to them explicitly. It would be embarrassing for you if you were expected to present units in metric, for example, and you did otherwise because you failed to request or follow the available guidelines.
- As part of your preparation, choose an appropriately snappy and helpful title. You are expected not to come off as stodgy. Which talk would you rather attend: "Specific Geometrical Objects with Fractional Dimensions and Their Various Applications to Nature in General and The Universe At Large as we Know it" or "And On The Eighth Day, God Created Fractals"?
- Become highly familiar with any technology you'll be using. Practice with the actual hardware or type of hardware you'll be working with, making sure that compatibility or speed issues don't get in your way. I've seen students go to present at a

conference with a zip disk of their talk confidently in hand, only to find that the computer they were using didn't have a zip drive. To facilitate faster computer speed, load your presentation onto the desktop if possible rather than run it from a CD or flash drive. If websites are needed as part of your presentation, check connection speeds and make sure all URLs are up and running.

Helping Your Audience Remember Your Key Points

Andy Warhol is known for the comment that everyone will be famous for 15 minutes. If your 15 minutes of fame is during your oral presentation, you want to be sure not to blow it. I'm amazed at how many times I've sat through a talk and come away with only a vague sense of what it was about. There are many reasons for this—some speakers view their talk as simply a format for reading a paper, while others fill the air with many words but little substance—but the most common reason is the simplest one: the *speaker* showed uncertainty about the talk's alleged subject. If you don't spell out your premise, highlight your key points, and make it easy for your audience to remember the thrust of your presentation, you can't expect your listeners to come away with understanding and investment.

To ensure an engaged audience for your talk, follow these practices:

- Introduce and Conclude. Use a formal introduction at the beginning of your talk and a summary afterwards to highlight your major points. Make sure your audience can remember your key points by keeping them simple and straightforward—even enumerated.
- Present in Sections. Give your talk "parts" —usually no more than three major parts for practical purposes—and let us know when we're transitioning from one part to the next. This will help your audience to remain interested and focused.
- Spell out the Objective. Give the talk's objective and even a hint of the conclusion right up front. Articulate the objective on its own slide so we can't miss it. Revisit the objective at the end if necessary to underscore how it was realized.
- Use Props. Consider the use of some simple, meaningful props—even pass them around. Props can generate audience interest and, especially if they represent the actual work you did, they make the nature of that work more concrete. I've been to great talks where an experimental sample or photographs representing production sites were passed around, and they often generated focused questions from the audience members afterwards.
- Use Handouts. If appropriate, give a handout. As long as it's well-designed, a concise written summary with bulleted points on a handout will ensure that your talk can be followed throughout. Such a handout should ideally be just one or two pages long, and be sure to time and manage its distribution so that it doesn't take away attention from you as you speak. One possibility for handouts is an actual printout of your slides through the "Handouts" option in Powerpoint, but be certain that your audience actually needs all of your slides before electing this option.
- Offer Q&A. If question and answer is involved as part of the end of the talk, don't let any questions deflect our interest. Some audience members might try to draw the attention to themselves, or focus on a mistake or uncertainty in your presentation, or even undermine your authority directly with an intimidating challenge. (I recall one speaker at a professional conference being tossed the strange question, "Your data is crap, isn't it?") Remember that the stage and agenda are yours, and it's your job to keep it that way and end your talk with a bang, not a whimper. If you don't know the answer to a question, admit it or offer to discuss it privately after the presentation, then move on. One savvy way to handle questions is to turn back to your presentation slides as you answer them—call up a slide that will help repeat or explain the relevant point—and this will remind your audience that your talk had substance.

Mastering the Basics of Slide Design

Powerpoint helps us to think of each projected page as a "slide" in a slideshow. But just as someone else's home movies can be thoroughly uninteresting if they're grainy, poor in quality, and irrelevant, Powerpoint slides that are too flashy, cluttered, meaningless, or poorly designed can quickly turn a darkened room full of smart people into a mere gathering of snoozers. As you design your slides, consider these factors:

- Templates. Even though Powerpoint helps you design your slides, don't assume that someone else's template will always match your needs. Take charge of slide design by considering first the most efficient way to transmit the necessary information.
- Simplicity. Keep slides as simple and uncluttered as possible, and if the information must be complex, prioritize it for your audience as you present it (e.g., if presenting a ten-column table, direct your audience to the most significant columns). Offer

only one major point per illustration. If you need to focus on more than one point, re-present the illustration in another form on a separate slide with the different point emphasized.

- Titles. Give most slides titles, with a font size of at least 36 points, and body text with a font size of at least 24 points. If you need to cite a source of information, include the citation in a smaller font size at the bottom of your slide.
- Rule of 8s. Apply the "rule of 8s": include no more than 8 words per line and 8 lines per slide.
- Bullets. When using bulleted lists in slides, present each bulleted line in parallel fashion—i.e., if the first line is a fragment, the others should be as well; if the first line opens with a verb, so should the others.
- Design. Design slides so that their longest dimension is horizontal rather than vertical. Use both uppercase and lowercase letters and orient pictures left to right. Avoid the overuse of animations and transitions, especially audio-based transitions, which can be distracting and downright silly.
- Color. Make sure the color for both the background and text are highly readable, especially under less than optimal lighting conditions. There's nothing wrong with basic dark lettering and white background for your slides, particularly if they're text-based. If you do choose a background theme or color, enhance continuity and viewability by keeping it consistent and subtle.
- Images. When possible, replace words with images. Use images in particular when presenting data, demonstrating trends, simplifying complex issues, and visualizing abstractions.
- Spelling. Spelling does count, and you can't rely on Powerpoint to be an effective proofreader. Be sure your slides are free of grammatical and spelling errors. As Will Rogers quipped, "Nothing you can't spell will ever work."

Maintaining the Look and Sound of a Professional Speaker

Public speaking is often cited by people as their number one fear (with death, ironically, as number two. Clearly, no one overcomes such fear overnight, and no one set of tips can transmogrify you into a polished speaker. However, you can work through that fear by learning from the successes of others. As Christopher Lasch once noted, "Nothing succeeds like the appearance of success." Good speakers attend first to their wardrobe, dressing as well as their "highest ranking" audience member is likely to dress. An equally important part of looking and sounding like a professional speaker is how you handle your body language and your voice. You must exude confidence if you want to be taken seriously, and remember that a high percentage of your audience's perception is not about what you say but about how you look when you say it. The following guidelines will help you to look good and sound good as you give a talk:

- Take care not to stand in the way of your own slides—many speakers do this without even realizing it. Especially when using an overhead projector, point to the projected image of your slide (ideally, use a stick pointer or laser pointer) rather than the original source. This helps you avoid covering up more of the image than you intended and keeps our focus on the projected image rather than your accidental hand shadow puppet.
- Ideally, use the mouse pointer, a stick pointer, or a laser pointer to draw our attention to a particular item on the screen. One simple circle drawn briefly around the selected information is enough to draw our attention. Beware of slapping a stick pointer loudly against a screen, or leaving a laser pointer on for so long that its bright dot shakes all over the screen as a blazing red mirror of your nervousness.
- When you are not using a slide directly, keep it out of sight or out of your audience's line of attention. Turn off the projector or create a dark screen when no visuals are relevant; literally invite your audience to turn its attention away from one thing to another.
- When working with computer projection, do not trust that hardware will always perform as you anticipate. Sometimes equipment fails midstream, or what worked fine for one speaker in a group doesn't work for the next. If necessary, take backup transparencies of your slides ready for use on an overhead projector. Be certain that an overhead projector is available beforehand as a fallback.
- Don't forget the value of a good old-fashioned easel or chalkboard. Not only do they offer variety, they are especially good for writing down basic information that you also want your audience to muse over or write down, or for presenting a picture as it evolves via its individual pieces (e.g., a flow chart, schematic, or simple experimental set-up).
- Maintain eye contact with at least a few people—especially those who are being the most responsive—in various parts of the room. Conversely, if you're especially nervous about one or two audience members or you note some audience members looking sour or uninterested, avoid eye contact with them.

- Refer to time as an organizational tool: "For the next two minutes, I will summarize the city's housing problem, then I will move on to . . . " This keeps both you and your audience anchored.
- Use the "point, turn, talk" technique. Pause when you have to turn or point to something, then turn back towards the audience, then talk. This gives emphasis to the material and keeps you connected with audience members. Strictly avoid talking sideways or backwards at your audience.
- Use physical gestures sparingly and with intention. For instance, raise three fingers and say "thirdly" as you make your third point; pull your hands toward your chest slightly as you advocate the acceptance of an idea. Beware, though, of overusing your body, especially to the point of distraction. Some speakers habitually flip their hair, fiddle with their keys, or talk with their hands. I've heard some people recommend that speakers keep one hand in a pocket to avoid overusing physical gestures.
- Minimize the amount of walking necessary during your talk, but do stand rather than sit because it commands more authority. As you speak, keep your feet firmly rooted and avoid continual shuffling of your weight. Intentionally leaning slightly on one leg most of the time can help keep you comfortable and relaxed.
- Take care to pronounce all words correctly, especially those key to the discipline. Check pronunciation of ambiguous words beforehand to be certain. It would be embarrassing to mispronounce "Euclidian" or "Möbius strip" in front of a group of people that you want to impress. I once mispronounced the word "banal" during a speech to English professors and one of the audience members actually interrupted to correct me. Most of that speech was—as you might guess—banal.
- Dead air is much better than air filled with repeated "ums," "likes," and "you knows." Get to know your personal "dead air" fillers and eliminate them. Out of utter boredom during a rotten speech a few years ago, I counted the number of times the speaker (a professor) used the word "basically" as an empty transition—44 times in just five minutes. Don't be afraid to pause occasionally to give your listeners time to digest your information and give yourself a moment for reorientation. To quote Martin Fraquhar, "Well-timed silence hath more eloquence than speech."
- If you know that you have a mannerism that you can't easily avoid—such as stuttering or a heavy accent—and it distracts you from making a good speech, consider getting past it by just pointing it out to the audience and moving on. I've been to several talks where the speaker opened by saying "Please accept the fact, as I have, that I'm a stutterer, and I'm likely to stutter a bit throughout my speech." One such speaker even injected humor by noting that James Earl Jones, one of his heroes, was also once a stutterer, so he felt in good company. As you might guess, the following speeches were confidently and effectively delivered, and when the mannerism arose it was easy to overlook.
- Avoid clichés, slang, and colloquialisms, but don't be so formal that you're afraid to speak in contractions or straightforward, simple terms. Use visual language, concrete nouns, active single-word verbs. When using specialized or broad terms that might be new or controversial to some audience members, be sure to define them clearly, and be prepared to defend your definition.
- Be animated and enthusiastic, but carefully so—many notches above the "just-the facts" Joe Friday, but many notches below the over-the-top Chris Rock.

Self-Study

For more advice on giving oral presentations and the use of Powerpoint, visit these websites:

"Powerpoint Presentations That are Not so Pretty" from about.com

"Rethinking the Design of Presentation Slides" Powerpoint by author Michael Alley

7.5: Online Portfolios

When an artist is asked about her work, she can dig into an oversized folder and slap down photographs or sketches that she feels best represent her artistic prowess. When a teacher is seeking a job, he can trot out, in paper form, his evaluations from student teaching, his lesson plans, and his written philosophy about education.

By comparison, how can a scientist or engineer, equipped with an armload of skills and bucketfuls of experience, effectively present this background to a potential employer, in a way that is personal, relevant, interesting, and cohesive? Answer: an online portfolio.

Fields such as fine arts and education enjoy a long-standing tradition of portable portfolios as vehicles to showcase a student's best work. Now, thanks to the lightning-fast information age, where details can be zipped across virtual space and both text and graphics can be rendered in neat, downloadable packages, all students can readily create online portfolios that they feel best represent their work and their lives. Essentially, an online portfolio is a series of linked webpages uploaded and maintained by the student—pages that represent the student both personally and professionally. An online portfolio is your chance to work with cache—a storage buffer in a computer's CPU—and to create cachet—a personal insignia representing your individuality and quality.

Publishing an online portfolio isn't just fun and creative—it's quickly becoming common practice for the best students in a program. Schools are now coaxing students to start creating portfolios as early as their first year of study, and they're hiring support staff and posting pages to be sure students have the tools they need to publish their work online. As described in most literature on the subject, preparing an online portfolio boils down to a three-step process: Collect, Select, and Reflect. Collection involves amassing your evidence and beginning to launch it into cyberspace; selection means culling the best pieces from your evidence; reflection is your opportunity to ponder and explain the choices you made about your portfolio pieces and even your life choices. And as you publish your portfolio online, following some basic principles of design will help ensure that your work makes an effective splash. The result is an organized virtual space where friends, family, and employers can gaze through a public window to catch intriguing glimpses of your online world.

Collect: Gathering the Parts of Your Portfolio

Think of your college experiences as a living mosaic. You've spent years completing diverse tasks or creating "snapshots" of your work: fine-tuning a project design, performing research, writing papers or memos, composing a resume, participating in group work, writing co-op reports, learning graphics packages, and earning grades. All of these experiences make for worthy candidates for your portfolio. You've also spent years gathering more personal "snapshots": IM sports participation, photographs of friends and pets, bookmarks of favorite websites, personal accomplishments, inspiring quotations, journal writings, society membership, awards, and hobbies. These are equally worthy candidates for a portfolio. Your collection process begins with you mentally cataloging each piece of the mosaic and deciding how to use it.

Most students begin to collect material for their portfolios by thinking of the work they've done as a printed product. With the professional resume being the most common and efficient standard of printable evidence available, almost all portfolios include an updated resume, perhaps downloadable as a pdf file. In fact, you might begin your portfolio simply by uploading your resume just to get you started, since the resume tends to be a critical cornerstone to the whole package. Portfolio writers also typically upload sample essays or reports they've written—again these are common standards by which all students are judged. However, more creative students think about additional pieces of "printable" evidence for their portfolios—pieces that stress the student's skills as a communicator, a consultant, an engineer, a designer. Among the online portfolios I've seen, students have presented their Excel-based designs for everything from a coffee mug to a Battlebot; a copy of a Powerpoint presentation or an effective letter they wrote to the campus newspaper editor; the daily construction site logs they kept while completing an internship; scanned copies of handwritten evaluations they received from their co-op supervisor; even a sample family newsletter that they edited. Such pieces of evidence are usually presented essentially as they would look in a hard copy, thus inviting the viewer to print them off or read them right in the browser.

For those willing to think even further outside the box, portfolio contents can reflect such personal attributes as oral communication skills, reliability and aptitude for planning, creativity and innovation, level of community service, willingness to travel, quality of judgment, and even social responsibility. Some students create videos of themselves giving a speech or participating in a debate; others present tables that chart their course selection for each school year as a kind of "planning matrix," listing the competencies

they achieved as part of those particular courses. Still others offer pictures of themselves that they think will demonstrate those more personal assets that all employers are interested in, using photograph captions to define how they have developed intercultural awareness ("Here I am in a village in France, chatting with locals about. . ."), or why they believe in volunteerism ("This Habitat for Humanity project helped three families . . ."), or showing they have a sense of humor ("This is me, last Halloween, as Austin Powers.") In one portfolio I found online, the student included the gutsy invitation, "Click here if you dare to experience my singing voice," linked to an mp3 of him crooning away in his dorm room. (He had a pretty good voice, actually.)

Select: Choosing the Best Evidence

When selecting material to include in your portfolio, the first principle you should consider is privacy and suitability. You should only upload material that you would like to be directly associated with your name, and you must carefully consider whether you want to give out personal information such as a mailing address or phone number (giving out your e-mail address is, of course, pretty standard). Some portfolio writers are even hesitant to put photos of themselves online (though others bravely display their prom pictures, no matter how cheesy the tux or how high the hair-do). If you're especially concerned about privacy, you could cloak your portfolio contents by keeping the material password protected, and you must always be careful not to give out highly private information that others could use, such as your social security number. A final point about privacy is that it works both ways—you must respect the privacy of others as well. This means that you shouldn't link to the pages of other individuals you know without their permission, and you also must attribute credit to any sources that you use, especially when borrowing material from someone else's website or posting copyrighted images.

Secondly, to give your portfolio coherence and continuity, try to think of all the material you select as pieces of unified evidence arguing the case that you're worth taking an interest in. Essentially, select material that inspires people to read and browse through your work, and choose artifacts that will demonstrate your growth over time (e.g., a paper from an introductory class as well as a senior thesis). Adopt an upbeat, welcoming tone ("In these pages, you'll discover exactly what makes me tick"), but also maintain enough professionalism to keep an employer's critical eye locked on your pages. Among the many portfolios I've browsed through, I've seen students take foolish risks such as publishing potentially embarrassing photographs (here I am, mooning my roommates), letting serious typos slip by ("Bachelor of Sciwence in Engginerring"), or revealing information that is too personal or leaves them open to judgment ("I've tried every beer on this list of 50 at least once, and some of them way too many times."). To emphasize the point of suitability, I've heard one instructor comment that you should only post something online if you'd be willing to show it to your grandmother. Though most students wouldn't go this far (and presumably most grandmothers would be pretty forgiving anyway), perhaps a good benchmark is that you only post material that you can be proud of a year from now, especially if you intend to advertise the URL to employers.

Finally, when selecting material, recognize the value of piggybacking. In addition to posting pages such as your home page, your resume, essays and reports, project designs, and photos, keep in mind that you can readily link your pages to those that others have created. Where logical, provide relevant links to your program or course descriptions, personal organizations with which you're affiliated, or pages that reflect your hobbies and personal interests.

Reflect: Being True to Yourself while Considering How You Come Across to Others

Good reflective writing is about reviewing what you've accomplished (or even what you'd like to accomplish someday) and projecting value. Students in technical fields often shy away from the concept of reflective writing, either out of unfamiliarity or because they hesitate to make private reflections public; yet reflective writing is standard and natural to most online portfolios. In fact, smart students realize that the portfolio is the safest place for reflective writing, in that it's inappropriate to make subjective, personal comments in a technical paper, resume, or cover letter, while it makes perfect sense in a portfolio. In an online portfolio, you have the space and opportunity to share your thoughts on everything from your personal passions to discussing how you performed in a particular course. The rules for such reflection are flexible, but there are some rules nevertheless.

The first rule I recommend is being selective about where the reflection occurs, and how much of it you use. Reflecting about coursework right on your downloadable resume is neither conventional nor efficient, while trying to reflect on every single course you've taken as a student would be overwhelming both for you and your reader. However, creating a page that summarizes your experience and reflecting briefly on the value of each experience as you describe it makes perfect sense. ("I valued this job because

it taught me how to analyze the network configuration needs of a small business." "This class taught me to use cascading style sheets—something I will apply to my future web designs.")

A second rule for good reflective writing is that it has a purpose both for you and your audience. Both you and your audience should be interested in commentary about why you chose your particular major, relationships (or the lack of them) that you see between your coursework and experience, and what sets you apart from others in terms of both training and life choices. In giving examples, especially related to your education, offer those that will demonstrate learning, change, empowerment, self-development, problem-solving, and results. Good examples are concrete, providing names, lists, scenarios, dates, definitions, etc. In the portfolios that I've reviewed, one student wrote an essay reflecting on how her intercultural understanding had been shaped by a year abroad, while another student wrote a few short poems defining his interest in engineering, and even created a sketch to accompany each poem. Still another student took an even bolder stroke—writing about lessons she'd learned about teamwork after being reprimanded by a co-op supervisor for working too independently. What these students are doing in the process of reflection is not only taking stock of their personal assessment of their growth, they're also preparing themselves for the toughest of interview questions. ("Tell me about the greatest challenge you've faced in life." "Argue to me how your education prepared you to work at our company.") Ultimately, effective reflection online is about learning to speak well in the company of others.

Finally, look for opportunities to write reflective comments on any major portion of your portfolio, including the resume, papers and projects, photography, etc. The bottom line: If it's worth a menu-based category in your e-portfolio, it's probably worth reflective commentary.

Principles of Portfolio Design

Although the design of online portfolios can vary greatly, especially depending on the computer skills of the creator, I've found that the best portfolios share three traits: unity, navigability, and simplicity.

The more unified the pages of your portfolio are, the more likely we are to dwell there. Come up with a basic design and background for each page that is repeated on other pages, and keep associated items parallel with each other from one page to the next. Use headings for short blocks of text, and when you do need to use long blocks of text such as in a complete essay, provide a ready means for us to return to the root pages of your portfolio. If you're handy with Dreamweaver or Frontpage, you can set up your portfolio so that when we exit to visit outside pages that you've linked to, these pages will open in a separate new window—thus when we click them closed we automatically return to your portfolio.

With these principles in mind, a unified design for one set of pages might go something like this: The page is entitled "My Design Projects," and it describes four projects you were involved in as part of your classwork and work experience. Each project has a short heading, written in boldfaced red text, followed by a short project description (just 3-4 lines long, in black text), and at the end of each description is the clickable line, "Click here to visit the project page." Between each description is a solid black line to enhance separation, and the background is white so that all text readily stands out. Also, at the left of each of these descriptions is a small screenshot (also clickable) of the page we'd visit to find out more about the associated project. Once we click to go into a specific project page, we see a "Click here to return to My Design Projects page" and a "Click here to return to my homepage" link at the top of the page. This basic form is repeated on other associated pages, and thus we have a strong sense of unity to your portfolio no matter what pages we are visiting.

Assuming a unified portfolio, one of the best ways to aid users in navigation is also the simplest—use icons and menus. We're used to thinking of icons as clickable, and we intuitively use menus—whether they appear at the top of the page or on the left side—to help us quickly drive through cyberspace. Many portfolio writers make sure the same clickable menu appears at the top of each portfolio page, with typical menu contents including simple, rapidly identifiable terms such as "Home," "Resume," "Major," "Projects," "Coursework," Computer Skills," "Work Experience," "Interests."

Beyond a menu or icon-driven strategy, you make your pages easier to navigate by creating a clear visual hierarchy on each page, by avoiding root pages that require a large amount of scrolling, and making sure that we have clickable links readily available on every page. Most portfolio designers also avoid using frames, in that they create multiple scrollbars on the same page, and you run the risk of having your viewer miss one of the scrollbars or becoming confused about how the frames are related. Also, if your portfolio is optimized for a particular version of Netscape, Explorer, or Firefox, you should make your reader aware of that fact right on your homepage, and perhaps even provide a clickable link where the appropriate software can be downloaded.

Finally, you've probably come across Thoreau's edict to "simplify, simplify," and we're all familiar with the KISS principle. Many portfolio creators violate that basic principle to "keep it simple, stupid." Too many are tempted by the trappings of the web, filling their pages with cute but tiresome animations, too many different blaring colors (called an "angry fruit salad" by web designers), and slow-loading, distracting backgrounds. Such tactics merely increase the odds that we'll turn away from your pages. Ultimately, the best portfolios are those most artfully simple in design, welcoming us at a glance to sit back, relax, click, and spend some virtual time with you.

Self-Study

In creating and designing an online portfolio, you are never alone. Visit these websites for design ideas and samples:

Resources for creating e-portfolios from Penn State

7.6: Tips for Interviews

Tips for Interviews

Few people relish interviews, and it is easy to respond to them by being either overly nervous or even overly cocky. It is important, then, to prepare for an interview as you prepare for any test. Incredible resources are available to you, including websites where you can "practice" by choosing among various responses to tricky interview questions, your school's Career Services staff, and technology that allows you to videotape yourself doing a mock interview. With all these resources, I'll keep my advice here brief, focusing on oft-overlooked fundamentals.

Basic Tips for Interviews

- Carefully review your resume and cover letter to prepare for the interview, and anticipate the kinds of questions that these documents might inspire from a stranger. It's surprising how many candidates forget that the resume and letter they sent might be right there in front of the interviewer.
- Read company literature and review any personal correspondence you're received from the company. Of course, research the company's web presence heavily, and go beyond the company's webpage—read publications by company members or search a newspaper local to the company for its mention.
- Be prompt, neat, and courteous, dressing appropriately for the occasion even if it's simply a career fair at your school. Believe it or not, I've had recent graduates who came back to the school on recruiting trips cite this issue to me as their number 1 concern. I recall one recent graduate turned recruiter saying after a long day of career fair interviewing, "I wish to god they'd just be on time, cover their tattoos, and remove their piercings."
- Listen attentively and speak thoughtfully—do not rush yourself, and don't be afraid of a bit of dead air if it helps you to think before speaking. Try to sense when you have fully answered a question and then distinctly stop rather than trail off into mumbled uncertainty.
- Be prepared to *ask* relevant questions. You will likely be expected to do so, showing that you have an inquisitive mind and a genuine interest.
- Express enthusiasm, but be realistic about your expectations of the job.

Common Mistakes Made During Interviews

- Criticizing yourself, partly to show humility even when it isn't expected.
- Interrupting the interviewer's questions or speaking out of turn.
- Overselling your case, trying to be too funny or too personal, or intentionally acting cocky to make an impression.
- Making uninvited or elaborate promises that are inappropriate for the circumstances.
- Drawing out the interview beyond its scheduled time frame or otherwise trying to control its pace.
- Lingering over questions that can better be addressed later, such as fringe benefits or starting salary.
- Speaking either too colloquially or too formally.

Qualities That You Can and Should Enhance in an Interview:

- Communication and technical skills.
- Motivation and willingness to accept responsibility.
- Self-confidence, decisiveness, stability, maturity, amiability, and loyalty.
- Perseverance, energy, common sense, and tact.

The Top Reasons Why Job Seekers Are Rejected:

- Lack of enthusiasm and interest; no evidence of initiative; no goals; lack of maturity.
- Poor personal appearance; extreme or careless dress.
- Poor scholastic record or few extra-curricular activities without reasonable explanation.
- Excessive interest in salary, benefits, or promotion.
- Lack of interest in or knowledge of the company.
- Poor presentation of self; therefore, lack of poise, awkward personality, abrasive manner, lack of confidence, timid approach, arrogant or conceited attitude, poor speech habits.

Self-Study

Advice on handling yourself in interviews abounds on the web. Here are four recommended sites:

Learn How to Become's "How To Nail your Next Interview"

"Typical Interview Questions" article from the Career Services website at Virginia Tech

"Ten Tough Interview Questions and Ten Great Answers" article from collegegrad.com

"15 Common Interview Questions and Answers (for New Grads)" from careermatch.com

CHAPTER OVERVIEW

8: Resumes

8.1: Introduction

Diamonds are nothing more than chunks of coal that stuck to their jobs. —Malcolm Forbes

Around campus, folklore abounds about unorthodox methods for landing jobs. Students swap stories about how one woman got her job with a major pizza franchise by having her resume delivered in a pizza box, while another guy fresh out of college took the George Costanza approach—lying his way through the interview, even faking his age. Another one I've heard is that a software company had hired a skilled hacker, impressed by his ability to access the company's confidential files.

Whether these tales are fact or fiction, I attribute them partly to wishful thinking—we want the hiring process to happen easily, almost magically, without having to do research or traverse hoops. We want the task of landing a job to be as simple as calling in a favor from Aunt Julie, or exchanging a chatty e-mail with an alum who knows of an opening. Mostly, we want to avoid having to *write* in order to get a job. But the fact remains that a perfect resume is usually essential for getting your foot in the door. Happily, lots of advice is available to guide you as you tread.

No one expects you to invent your resume from thin air; in fact, employers reading your resume expect you to know and follow the accepted conventions. Remember, you are often competing with hundreds of similar documents at a time, so you want yours to fit in yet stand out for the right reasons. Further, you must treat your resume as a living document that you will revise for the rest of your life. Most professionals change jobs five or more times, so their resumes are always in flux. So begin well by studying the conventions and basing your resume on a good model. And recognize that plenty of options and variations are available within the conventions. This chapter will help you to study the conventions, work within them, and write a winning resume.

Helping Yourself

Clearly, as a user of this handbook, you understand the value of using online resources to educate yourself. To educate yourself further about finding a job or an internship, I highly recommend the sites below.

- Learn How to Become's "15 Best Job Search Sites," which compares popular job search sites ranging from LinkedIn to Monster to Glassdoor.
- Learn How to Become's "How to Personalize your Hunt for Jobs Online," with questions and recommended websites to help job seekers whether they are recent graduates, vets looking for civilian work, or executives.
- Learn How to Become's "A Guide to Internships," which educates website visitors about the value and types of internships and provides resources about how to find them, both in the U.S. and abroad.
- Edumed.org's "The Healthcare Student's Guide to Internships," which helps you to find the best opportunities, acquire the needed skills, and understand the key differences between internships, externships, and clinicals.

Self-Study

There is no shortage of resume writing advice on the web. Here are four recommended sites:

"How to Write a CV and Cover Letter" article from themarketinghelpline.com

"How to Write a Masterpiece of a Resume" article from the Rockport Institute

Sample resumes and advice from greatsampleresume.com

Guidance and sample resumes from careermatch.com

8.2: Writing the Conventional Resume

I learned about resume writing from my students. The students with the best resumes, I found, were those who understood that a resume is principally an objective summary of your skills and achievements, secondly a subtly clever argument that you are worth hiring, and finally a reflection of your individuality. The key is to work within the conventions while building a resume that only you could have written. The best way to begin is to study the conventions, then mimic the qualities of a good model, with an eye for places where your individuality can emerge. With the help of your peers, I have provided you with excellent advice and resume models in the following pages. Finally, I should note here that employers sometimes use the terms "resume" and "curriculum vitae" (or CV) interchangeably, and both terms loosely mean "life summary."

The conventional resume is organized according to the sections that follow, moving from the top of the resume to the bottom.

The Heading

There is no title for this section; it's simply your name and contact information at the top of the page. This section is always presented at the top of the resume, taking up anywhere from two to five lines. Think of this section as highly readable data about yourself, and format and efficiently word accordingly, following these principles:

- Do not title this section; simply provide your legal name, addresses, and phone numbers as shown in the examples. No matter how attached you are to it, do not use your nickname—use the formal name under which you will be cashing your paychecks.
- Either beneath your name or address, provide relevant e-mail addresses.
- Boldfacing and capitalizing your name is reasonably standard, though not required, and making your name stand out with a larger or fancier font is acceptable, but beware of graphic overkill.
- Never use titles such as "Resume" or "Personal Data Sheet" on the top of the page—redundant and silly; your name centered at the top automatically tells readers that the document is a resume.
- If the phone number you provide for contact information is a cell phone, note that information efficiently as you present the number. It's useful for readers to know whether or not they're calling a cell phone, because that fact can change their expectations slightly.
- If you've created a personal webpage or online portfolio, you might offer the URL so that readers can visit it for further information. The material at that URL should go beyond the resume and be professionally presented, of course.

Objective

Some resume writers do not include an objective, either for reasons of space, personal taste, or because they want to hand out a lot of resumes at a career fair and think that an objective might not allow them to cast as wide a net. But most undergraduate resumes do include an objective, embracing these principles:

- As a rule of thumb, include a job objective on an undergraduate resume. Keep it as short as is practical, with the goal of taking up no more than two lines of text.
- If possible, use an actual job title ("forecaster," "engineering intern") and provide the specific type of employer or type of position that you are seeking ("internship at a research facility," "entry-level position with a consulting firm").
- Avoid the overuse of phrases such as "a challenging position," "a progressive company," "an established firm"—you need not preach to the employer about its status or sound too picky. Your aim here is to categorize the role that you can fulfill.
- Your job objective can be tailored a bit to the position that you are applying for, but avoid mentioning a company's actual name in your job objective—the objective is intended to define a role, not a specific job at a specific place.

Education

In this section, be at your most objective on the resume—simply report the facts. The order of information is up to you, but most writers begin by providing the title and address of their school. On the next line, provide your exact degree title, including a minor or program emphasis if relevant. Include your projected graduation date even if it is years away. Other material that might be included under "Education":

- GPA. Generally, include if it is a 3.0 or better; include GPA in major if impressive. Recognize that opinions vary about whether or not your GPA should be included on the resume, and that even if it is excluded you may be expected to reveal it at some

point to a potential employer anyway.

- Dean's List. Provide actual semesters or years.
- Relevant Coursework. List actual course titles or offer appropriately worded categories. You could combine courses for efficiency (i.e., Statistical Analysis I and II). Typically, you only include courses that you've actually completed or are currently enrolled in, although you might include projected courses followed by their target semester of completion in parentheses.
- Curriculum Description. This could be included to describe your background concretely. Turn to your school's descriptions of course curricula to help you with wording.
- Study Abroad. Always include it and provide the college's name and location. Most writers include the dates or semesters of attendance as well.
- Honor's Program. Always include it as a representation of academic accomplishment.
- Thesis. Always include it and list it by title. In place of or in addition to the actual title, even a working title or a summary of the thesis contents or objective is useful.
- Certifications / Training. Consider a subheading under "Education" to reflect formal education that resulted in specialized knowledge or skills. Typical examples include CPR certification, OSHA HAZWOPER training, scuba diving instruction, and the completion of short courses.
- ROTC / Military Training. Especially if military training involved short courses and took place on college campuses, include it and give vital details such as course names, number of hours involved, times of completion, and certifications earned.

Experience / Work Experience / Employment

This section is the heart of the resume—the place where readers are likely to spend most of their time. Readers here expect concrete detail, an accessible format, and selective interpretation of detail. Methods used to achieve these goals include the following:

- Any of the above three titles is acceptable, though "Experience" is the most standard.
- The convention is to use past tense throughout this section, even to describe jobs that you currently hold. Some writers elect to discuss current jobs in the present tense.
- As a rule, list your work experience in reverse chronological order—most recent first—and provide the actual dates of employment. Go back several years, even early into high school if necessary. Provide exact job titles (invent them honestly if no actual titles were used), and give the locations of your employers. All jobs need not be directly relevant to the position you are applying for, but be sure that the descriptions of your job duties are worded such that they enhance your accomplishments and responsibilities.
- Use action words to describe your job skills and make each job description specific and efficient. Especially if you favor the present tense in your descriptions, you might using the "-ing" form of active verbs ("performing" rather than "perform").
- Do not feel compelled to describe every job duty ("waitstaff" and "newspaper carrier," for example, can be self-explanatory).
- As a rule, do not include your supervisor's name or phone number, unless you are seeking an internship (where formal applications are rare) and have express permission to do so.
- Including job salaries is rarely a good idea, but providing the number of hours you worked per week can be helpful.
- If computer skills were linked to your job duties, connect the work with them directly, even including software package names or describing what you used the computer programs for.
- Use identical margins and format for parallel items (e.g., line up all of your job titles with each other, and if you boldface one then boldface them all).
- As you describe your experience, be certain to answer these two fundamental questions: "What was done?" and "How was it valuable?"

Computer Skills

Computer Skills is not a mandatory resume section, although many students include it, knowing that employers are typically interested in your computer expertise. Present the material efficiently, as follows:

- Consider an overall approach that suits your skill level. Some students discuss computer skills in narrative form, others simply list their experience with specific hardware and software packages, and others combine computer skills and other types of skills into one section.

- If relevant, include the version number of software packages, programming languages, and operating systems you've used.
- If you worked on websites as part of your job or as a hobby, consider including the specific URLs so that the reader can access them. If you created an online portfolio that you're proud of, certainly offer that URL, perhaps even in the heading.
- Computer skills might be presented in a simple list or in the form of an informal table, depending on your level of expertise and space constraints.

Activities / Honors / Volunteer Work

For this section, choose whichever title or combination of titles above best fits your examples. "Activities" is the most commonly used. Honors could be presented separately if they are impressive enough or if there are simply too many to include within the "Activities" section. In addition, follow these tips:

- Dates are highly recommended, in that they illustrate your level of participation in activities, but some writers do exclude the dates and favor a simpler approach. Be consistent within the category in relation to whether or not dates are included.
- List the most noteworthy extracurricular activities and include offices that you have held. Include any honors you have received, especially scholarships, but do not repeat items that were included in other sections of the resume.
- Choose descriptions of your leisure activities wisely and sparingly, even to the point of presenting them all on one final line for the sake of efficiency.
- Try to include a conversation piece. I know students who have gotten into great discussions in interviews because they listed beekeeping or piano playing or their golf handicap under "Activities."
- Use high school activities if needed, but avoid letting them sound too "high schoolish" as you present them (better to name your school sports team than to simply list "high school basketball"). Where possible, link your activities to a community or business ("Volunteer, Bear Creek Nursing Home") more so than to a high school, even if those activities took place when you were still in high school.
- The bottom line in this section: Provide a window into your uniqueness, whatever that uniqueness is. A volunteer firefighter, Eagle Scout, or licensed pilot can stand out as much as a scholarship recipient or professional sorority officer.

References

Employers generally like to see this section included as a convention and a courtesy, but in truth it is optional because employers already know that you can provide them with references. When you do include a References section, heed this advice:

- Keep the section highly efficient, perhaps just one line long, i.e., "References available upon request."
- As a rule, do not include the actual names of your references on your resume unless you have their permission to do so and are simply seeking an internship or scholarship; for a full-time permanent position you want your resume to inspire the employer to contact you and specifically request your references. Employers are often looking for specific kinds of references, and you do not want to hurt your chances by listing references who might not be quite right for their needs, or giving an employer the opportunity to call or write one of your references without your knowing about it.
- When references are formally requested, type up their full contact information, including address, phone, fax, and e-mail, on a page separate from your resume.

8.3: Quality Checking Your Resume

Once your resume is composed, it must be quality checked. Three prominent issues that arise in a quality check are content, format, and computer-related problems.

Reconsidering Content

- Look over the resume and be certain you have considered effective wording and strong candidate material within each category, as detailed in the previous page of this manual.
- Consider accuracy and professionalism. If you simply volunteered at a position two hours per week, make sure your wording reflects this. Do your examples and wording reflect someone with a professional attitude or are they too informal or potentially vague?
- Look over your job descriptions carefully. You should be reporting exactly what you did and how it was valuable. Make sure we can see that your work was of use to someone and that performance was a concern.
- Browse for any major time gaps between jobs or other activities. If there are any, fill them in or otherwise eliminate them if possible.
- Review your Activities section with the idea of choosing an overall picture that reflects you and you alone. It should essentially contain an objective listing of information—data, and perhaps some description—unique to you. Your goal in this section is to make the reader want to meet you—to see you as an interesting and worthwhile person.
- Ask yourself: Have I only included content that I would feel comfortable discussing in an interview? At an on-site interview, your resume might be right on the interviewer's desk. Expect that you could be quizzed specifically about any resume content, and if you aren't sure you could pass such a quiz, eliminate the content.

Reviewing Overall Format

- With few exceptions, an undergraduate resume should be limited to one page. Those that go beyond one page should seek to fill two pages neatly so that we don't end up looking at a large block of white space.
- Maintain at least one-inch margins on all four sides of the page, and spread your information out so that it is visually balanced. Do not be afraid of white space as a formatting tool.
- Be sure you have used identical margins and format for related information. Keep parallel information parallel in form. For instance, treat all major headings in the same way.
- Exploit punctuation marks—especially dashes, semicolons, and colons—to present your material efficiently. You can brush up on punctuation marks in chapter 2 of this manual.
- Be line-conscious, especially horizontally, considering how much material can fit on a single line. If you are fighting for space and you see that just one or two words are gobbling up an entire line unnecessarily, revise accordingly.
- Remember that readers look at your resume left-to-right. Where logical, go to a new line for prominent new information. For instance, most writers put their degree name on a different line than their school name. Avoid line breaks that allow a single description of important information (say, your degree name or a course name) to spill onto more than one line.
- Present the final version of your resume on durable white or off-white paper. Absolutely avoid odd colors such as purple, green, or pink.

Making the Computer your Ally

- Change fonts types or sizes if needed to fit the resume to one page, but use just one or two fonts throughout the resume—Times, Chicago, and Helvetica are popular resume fonts—and go no lower than 10-point and no higher than 12-point for the bulk of the resume text. Many writers do choose a larger or fancier font for their name at the top of the resume, but be sure it's readable and attractive.
- When lining up material, use tabs rather than space bars or even line up like columns by creating a table; otherwise, your output may appear differently than it does on the screen, or print differently from one printer to the next.
- If you need a bit more space horizontally for just a line or two, see if you can "stretch" the relevant lines by resetting the margin on the ruler at the top of the page just for the lines in question.
- Absolutely work with a hard copy of your resume. Do not trust that the way it looks to you on the computer screen will exactly match the output.

- Proofread with perfection in mind, even having someone else proofread the resume too. Do not rely just on the spell checker, and certainly not on the grammar checker—neither will ever be capable of proofing a resume effectively.
- If you need to submit the resume by e-mail to an employer, do not count on a Word version of the resume looking the same on someone else's computer as it does on yours—fonts may not translate perfectly, tabbed material may be misaligned, and line length may be compromised. The safest bet is to convert the resume to a pdf, check the resulting pdf to be sure it's exactly how you want it to look, and then e-mail the pdf file.

As a final quality check, seek collective agreement that your resume is perfect. Other readers—your peers, professors, parents (gasp!), and the staff at your school's Career Center—can add fresh perspectives (and even corrections) to your resume. You get the last word, of course, but be sure that more than one other person agrees that you have presented yourself in the best possible way on paper. It pays off.

8.4: Common Action Words Used to Describe Job Experience

Accepted	Coordinated	Experienced	Made	Recognized
Achieved	Correlated	Experimented	Maintained	Recommended
Adapted	Counseled	Explained	Managed	Reconciled
Adjusted	Created		Mapped	Recorded
Administered	Critiqued	Facilitated	Measured	Recruited
Advised		Financed	Mediated	Reorganized
Allocated	Decorated	Formed	Modeled	Reported
Analyzed	Defined	Formulated	Moderated	Researched
Appraised	Delegated	Founded	Monitored	Retrieved
Approved	Demonstrated		Motivated	Reviewed
Arranged	Designed	Generated		Revised
Assembled	Detailed	Governed	Navigated	
Assessed	Determined	Grouped	Negotiated	Scheduled
Assigned	Developed	Guided	Nominated	Screened
Assisted	Devised			Served
	Diagnosed	Handled	Observed	Set forth
Balanced	Digitized	Headed	Operated	Shaped
Budgeted	Directed		Ordered	Simplified
Built	Discovered	Implemented	Organized	Solved
	Displayed	Improved	Originated	Sorted
Calculated	Dissected	Improvised	Overcame	Sparked
Catalogued	Distributed	Increased		Strengthened
Checked	Drafted	Indexed	Participated	Supervise
Clarified		Informed	Performed	Supplemented
Classified	Earned	Initiated	Persuaded	Systematized
Collected	Edited	Innovated	Pioneered	
Communicated	Effected	Inspected	Planned	Trained
Compared	Empowered	Inspired	Predicted	Transcribed
Compiled	Encouraged	Installed	Prepared	Transformed
Composed	Enforced	Integrated	Presented	Translated
Computed	Engineered	Interpolated	Presided	
Conceived	Enlarged	Interviewed	Prioritized	Unified
Conducted	Enlightened	Investigated	Produced	Utilized
Confronted	Enlisted		Programmed	

Constructed	Established	Justified	Promoted	Valuated
Consulted	Estimated		Protected	Validated
Contracted	Evaluated	Keynoted	Provided	Verified
Controlled	Examined			
Converted	Executed	Led	Quantified	Weighed
Conveyed	Expanded	Logged	Questioned	Wrote

8.5: Sample Conventional Resumes

The sample resumes that follow, which you can download by clicking on the link below, all came from student writers guided by tried-and-true conventions of content and form. All of these writers use the left margin for their headings followed by a new margin for the descriptions about one-third of the way across the page. Though the overall form of these resumes varies slightly, the resumes all include the traditional, expected sections of "Objective," "Education," "Experience," and "Activities," but the writers make sure to tailor the content to their background by making choices such as combining language skills with computer skills and activities with honors. Several of the writers chose to include material related to high school, both to fill out the page and because their high school experience was so recent. Note also that not everything detailed under "Experience" is a paid position—the resume by the first-year student smartly gets mileage out of volunteer experience at a campus weather service and a homeless shelter. Finally, the types of activities and honors showcased at the bottoms of the resumes range from fraternity awards to blood donorship to water-skiing, showing that these writers are interested in representing individual and interesting traits about themselves. By studying these conventional resumes and examining their likes and differences, you have models on which to build your own, whether you're a first-year student or a graduating senior.

Click here to download a pdf of six sample conventional resumes.

8.6: More Advanced, More Daring Resumes

Even though technical fields favor conventional and old-school rules, many students, particularly those with extensive experience or a diverse background, stretch the limits slightly—and smartly—when creating their resumes. Creative format and content choices on your resume certainly are permitted, as long as they enhance rather than detract from utility and appearance.

Creative Format Choices

Although format must remain accessible so the eye can readily scan the resume both horizontally and vertically, creative format choices such as the following can enhance resume content:

- Jazzing up the heading. If nowhere else, many writers give the heading of the resume a bit more dazzle by using different fonts and sizes, perhaps even drawing a line or using an underscore beneath the heading that crosses the entire page.
- Experimenting with tabs and margins. By experimenting with format options for the entire document or for portions, you can change margin settings in order to get more information onto a particular line or onto the entire page. Informal tables and the use of tabs also economize on space. Still, aesthetically, avoid using less than one-inch margins at the page's edge or more than three different indentations within a single line.
- Providing visual emphasis. Obviously, capitalization, boldface, underscore, and italics enhance both the appearance and hierarchy of information on the resume. Beware, though, of graphic overkill, and keep in mind the intuitive hierarchy we employ as readers: Capitals and boldface typically represent important information, while underscore and italics imply subordinate material.
- Using a resume template. Resume templates, which tend to offer a variety of fonts, preset fields for blocks of text, and even sample text itself, can certainly make a resume look pretty. Keep in mind, however, that resume templates do have constraints in format, they often put categories into a different order than they would be on an undergraduate resume, and the resulting resume may not be suited to the conventions of your field. If using a template, be sure you manage resume content and appearance in a way that suits your circumstances and keeps you in charge of form.

Creating Special Sections

One way to elevate your resume is through difference. Special sections highlighting specific traits that employers seek can make your resume rise above the crowd. Typical approaches writers take include the following:

- Creating a special section based on specialized experience. Common special categories include "Leadership Experience," "Military Service," "Professional Qualifications," "Communication Skills," "Teaching Experience," and "Research Experience."
- Taking a "skills" approach. Drawing from the model typically used in post-graduate professional resumes, some writers open the body of the resume with a "Skills Summary" or similarly titled section, detailing their skills and how they acquired them. A common strategy is to think both quantitatively ("Four years of experience programming computers using . . .") and qualitatively ("Superior customer relations skills acquired through . . ."). The skills approach can go beyond simply one section, with other section titles including the word "skills" and work experience descriptions focusing on the skills acquired. The focus should be on outcomes and personal and professional attributes that would apply to any job performed, regardless of your field of study.

Self-Study

Two websites you can explore for tips on writing "skills" resumes reside at:

"Skills Resumes" article from St. Could State University

"Tips to Show Your IT Skills on your Technology Resume" article from monster.com

8.7: Sample Advanced, More Daring Resumes

In the six sample resumes delivered by pdf when you click on the link below, you'll find students who present their material creatively, experimenting a bit with form, tailoring the resumes to suit their background or circumstances, and stressing their skills and experiences to help them stand out from the crowd.

The first resume in the group stresses two related experiences by creating the category "Internships," which are presented with such thoroughness that the writer has the courage and wisdom to treat three unrelated jobs with only three lines. The second resume also stresses experience and skills by creating special categories, while the third resume—from a student with three professional experiences within her field—decides to spread the text out completely over the horizontal space of the page so that she has room to stress the details and value of her various internships. Her resume also ends strongly with special categories for leadership and additional professional qualifications—she even goes so far as to give the date on which she received clearance for Top Secret information.

In the last three resumes, all written by seniors who had recently graduated, physical prominence is given on the page to specialized computer skills, teaching certification and classroom experience, and an overall skills summary. The first writer, chasing a technical computing job, provides the URLs to which he has contributed so that readers can further investigate his credentials and affiliation, and he breaks down his computer skills into five separate categories. The next writer, seeking a teaching position, makes sure to spell out his specialized teaching background and shows how his volunteer experience involved teaching as well. The final resume, used by the writer to land an international sales job outside of her field, articulates her transferable skills and stresses her international travel and "Jane-of-all-trades" approach to life—a broad range which takes her from being a photographer for a large student newspaper to working as a kayak/mountain bike tour guide in Alaska.

All six of these resumes show that even the one-page constraint need not stop writers from exercising creativity of form and providing depth of content specific to their life circumstances. All of these resumes represent a high level of individuality, and our sense is that no one else but the writer could have composed them.

Click here to download a pdf of six sample advanced, more daring resumes.

8.8: The Graduate Student and Post-Graduate Resume

Undergraduates often tell me they are amazed at how long it takes to compose a resume (part of this is mere perception, I think, due to the weighty nature of the document's importance). I tell them they should plan to spend between a few hours and a day every year revising their resume for the rest of their professional lives, and that an undergraduate resume with a strong foundation is their best preparation. Obviously, post-graduate and graduate student resumes are grounded in the same principles as undergraduate resumes, but new rules emerge with the new circumstances.

Differences Between Post-Graduate and Undergraduate Resumes

- Length. Beyond your undergraduate education, you are no longer fettered by the one-page limit. Unless otherwise specified by an employer or selection committee, two pages and more are expected so that you can fully describe your background and list your accomplishments. However, seek visual balance on each page, and try to make each work independently, including your name on each page and a page number beyond page 1.
- Organization. Unless you are writing a curriculum vitae (see below), education is less stressed than it is on an undergraduate resume. Often, this section is moved beyond the first page of the resume, and some writers even put it last. Also, an "Objective" section is not necessarily included, and if you are seeking a professional job outside of academia, you typically open your resume with a "Qualifications Summary"—an "in-a-nutshell" articulation of your relevant skills. You can think of this section as a "mini-cover letter," summarizing for an employer everything you have to offer.
- Detail. On the graduate student and post-graduate resume, you are expected to expand in particular on work-related experience. Comment on the specifics of your work and interpret how it was useful to your employer. Especially in research-oriented fields, do not shy away from jargon, nomenclature, or specialized detail. Your goal is to portray yourself as an insider to those who have a technical, specialized understanding matching or surpassing yours.

Writing a Curriculum Vitae (CV)

Unfortunately, many use the terms "curriculum vitae" and "resume" interchangeably, so writers are confused about whether there's actually a distinction between them. Strictly speaking, a curriculum vitae (which translates to "course of life") is different from a resume in that it is aimed squarely at working within academia. Therefore, academic history—especially where it includes teaching, research, publications, and service—is fleshed out in much more detail than it would be in a resume. If you're chasing an academic post with your CV, you need to stress the same "three-legged-stool" criteria by which tenure judgments are made: Teaching, Research, and Service. Some writers use these criteria within their CV headings, and all find ways to stress them within their descriptions. A section for publications—which helps reflect on both your teaching potential and research—is expected in a CV, and those who have not published might still provide a list of papers submitted, talks given, theses written, or conferences attended. The goal is to demonstrate professional involvement and the potential to serve a host university as a productive teacher, valuable researcher, and a person of service. Some schools and professional organizations provide sample CVs, and I urge ambitious graduate students to browse the web and model their CVs on those published by faculty in the program to which they are applying.

Self-Study

These websites from institutions of higher learning are tailored to grad students writing resumes and CVs:

"Graduate Students' Resume Writing Guide," from Dartmouth

"Curriculum Vitae Tips and Samples," from the Career Services Office at the University of Illinois

8.9: Sample Graduate Student and Post-Graduate Resumes

The samples written by the six writers featured in the pdf below help represent the differences between undergraduate and post-graduate resumes. One fundamental distinction to be made is whether the resume or curriculum vitae (CV) is tailored towards a professional job or an academic position. As the samples show, those seeking a professional job stress skills and achievements that will apply to the job being sought, while those seeking admission to graduate school or an academic position stress teaching, research, and publications.

From a form standpoint, note that the writers did not constrain themselves to one page, and that they spread material evenly over multiple-page documents, providing the page number and name of the writer on those pages after page 1. A variety of font sizes and font types are used along with a generous amount of white space so that the material can be read easily, and parallel material (such as job titles and section headings) is treated in parallel fashion from one page to another. Finally, there are two different versions of a curriculum vitae by the same writer—one three pages long and one a single-page version—to demonstrate how a writer can provide a summary of material when a single-page CV is requested.

The content of these resumes and CVs is, by definition, specialized, assuming readers who want evidence of a high level of aptitude and performance. Therefore, the writers offer technical detail, and acronyms known within the field (IPM, ARM, TRIP, NCGE, ASTM, etc.) and practical outcomes are stressed. Even by the active verbs used within the resumes (co-authored, managed, oversaw, coordinated, taught, trained, investigated, etc.), we can see that roles involving authorship, collaboration, learning, leadership, and project management are showcased. With the graduate student and post-graduate resume, the goal is always to demonstrate advanced ability and a high level of accomplishment, witnessed by the specialized evidence presented.

Click here to download a pdf of sample graduate student and post-graduate resumes written by six writers.

Self-Study

You'll find sample resumes by graduate students here:

"Sample Resumes for Graduate Students" from the University of Pennsylvania

Sample graduate student resume from the career advice website workbloom.com

8.10: Computer Scanning of Resumes

One of comic Steven Wright's jokes provides a nice little lesson in irony: "I used to work in a fire hydrant factory. You couldn't park anywhere near the place." Similarly, our work lives are rich in irony: Just as technology has enabled any one of us to build a resume that is stunning in appearance, blaring bells and whistles, the irony is that technology now also sometimes requires us to create resumes virtually stripped of form and dazzle. Companies, especially large ones, occasionally require job candidates to submit a "scannable resume"—that is, a resume written so that a scanner, using optical character recognition software, can code your resume into a database. Once in the database, the resume can be selected for the later viewing by human eyes (yes, irony emerges again) based on the number of "hits."

Presumably, if a company is scanning your resume it will typically announce that fact and give you guidelines for writing and submitting it. If there is any doubt, you could always phone, e-mail, or visit a company's website to determine if the company scans resumes. Frankly, computer scanning of resumes was much more popular in the 1990s and has waned in the years that followed, so you may never need to be concerned about the issue. However, if you do need to prepare a scannable resume, you must school yourself in matters of format, content, and method of delivery.

Matters of Form

- To curb potential problems of pattern recognition, avoid horizontal and vertical lines, bullets, boldface, italics, and underscoring.
- Use common publishable-quality fonts such as Times, Helvetica, and Century.
- Use a minimum of indentations, perhaps simply formatting all new lines at the left margin. Use the paragraph form to list information rather than the table form.
- Keep the font size conventional—between 10 and 12.

Content of the Scannable Resume

- Under your name and address, provide a paragraph of "Skill Keywords" designed to earn "hits" from the scanner. Build this paragraph from your background and the job ad.
- Aside from the keywords section, provide the same material you would in a print resume.
- Use jargon and keywords throughout freely, but avoid abbreviations and acronyms—they may be too specialized to be recognized.
- To maximize "hits," favor nouns over verbs—"operator" rather than "operated."

Delivering the Scannable Resume

- Avoid delivering a scannable resume by e-mail or fax unless specifically requested to do so; mail an original, unfolded.
- When applying to a large company, consider sending both a print version and a scannable version of your resume along with a cover letter, which identifies them as such.

Self-Study

Here are two recommended links from academic sites on writing computer scannable resumes:

"Scannable Resumes" article from Career Services at Virginia Tech

"What Is a Scannable Resume?" article from the Purdue Online Writing Lab

8.11: Sample Computer Scannable Resume

In the example provided via the link below, we see how a writer effectively adapted his resume to make it scannable by computer. Note that the writer favors the left margin, even for his name, and he provides a "Skill Keywords" section at the top to define his skills and maximize the number of hits that his resume will receive. Despite making sure the resume is scannable, the writer keeps his paragraphs short enough that they are still highly readable, and aside from the "Skill Keywords" section the content is the same as he would provide in a conventional resume.

Click here to download a pdf of a sample computer scannable resume.

CHAPTER OVERVIEW

9: Professional Letters

9.1: Introduction

> ***Chance favors the prepared mind. —Louis Pasteur***

Some say that if you really want a boyfriend or girlfriend, you'll find one as soon as you stop actively looking (I'm not sure it actually works). More likely, as the above pithy, insightful quote by Pasteur implies, good fortune comes to those who are ready for it. I recall a student who received a phone call from a company two years after she had sent in her resume. "We're hiring now," a company representative told her. "What have you been doing for two years?" It turns out that, unable to get a job, she had gone to graduate school and was just finishing up her master's degree. The consulting company promptly hired her, and she had suddenly landed her dream job.

Although this may be an unusual scenario, it demonstrates the power of a written document filed away in some company folder. The more professional a paper trail you leave, the more impressive a candidate you become. Any letter you write to a company—from a query letter to a thank you and even to a letter rejecting a job offer—is a professional act and a networking opportunity. Even if composing a letter at midnight with a Coke and bag of Doritos handy, you should be sure that the letter carries with it a tone suggesting that you are sitting across the desk from an interviewer—because some day you may be, with that very letter within the interviewer's arm's reach.

Self-Study

Check out these two sites in cyberspace for tips on composing cover letters . . .

"How to Write a CV and Cover Letter" article from themarketinghelpline.com

"Six Secrets to Writing a Great Cover Letter" article from forbes.com

. . . and this site for tips on a post-interview thank you e-mail:

Advice and samples on how to write a thank you e-mail from careermatch.com

9.2: Writing Cover Letters

When reading cover letters, the key benchmark I use is simple: Do I get to know both the person and the professional? As we read a cover letter, we should have a sense that no other candidate could have written this particular document in this particular way. Hence, we respect and honor the individual.

In conversation, the term "cover letter" is used loosely to mean any professional letter that you write in an attempt to get a job, with the term "cover" denoting that the letter is usually a "cover piece" designed to introduce and accompany your resume. Thus, too many writers think of the cover letter as mere mechanical introductory fluff—disposable goods—when in fact it can be more important than your resume.

The best tip that I have heard on cover letter writing is that the letter is for the *audience*, not for you. Certainly you are selling yourself, but you do that best by molding your skills to what an employer needs and by knowing all that you can about your audience. This tells you that you should visit a company's website, read the company literature, and have a specific person's name and title to write to (you can always request this by phone or e-mail before you write). In sum, know what your audience is interested in and how you might fit into a company's plans, not the other way around. Unless an employer instructs you otherwise, always include a cover letter with your resume as you apply for a job.

Tone: Making it Sound Good

- The proper tone for the cover letter is one of an informed, straightforward, courteous, relaxed, literate writer.
- Use "I" comfortably as a sentence subject, but avoid being too informal—overusing contractions or jargon could make you appear unprofessional.
- Avoid being too cocky, aggressive, idealistic, or unrealistic; come off as mature, self-aware, and confident.

Appearance and Mechanics: Making it Look Good

- Limit cover letters to one page, and type them using single-spaced or 1.5-spaced typing, with about one-inch margins or more on all sides of the page.
- Skip lines between paragraphs.
- Favor short paragraphs over long ones.
- Use highly readable, tight, fonts, such as Helvetica or Times, and point sizes no larger than 12 and no smaller than 10.
- Spell check, then proofread the hard copy carefully. Present the final version of the letter on durable white or off-white paper.
- Mail your letter and resume flat in a large envelope rather than folded in a small one. That way they will be easier to read and Xerox.

The Heading and Greeting: Following the Formats

- At the top right or left corner of the page, type your address, your phone number, your e-mail address, and the date. Below that, at the left margin, put the name, title, and address of the person receiving the letter.
- Skip a line or two, then type "Dear," the person's title (Dr., Ms., Mr.), name, and a colon.
- If possible, find out the proper title, spelling, and gender of the receiver of the letter (all it usually takes is a phone call or a little web surfing). If you cannot be certain of the recipient's gender, it is acceptable to use both the first and last name (i.e., "Dear Jan Morris"). If no name is available, use a logical title such as "Dear Human Resources Representative." Greetings such as "Dear Sir or Madam" and "To Whom it May Concern" are old-fashioned—some even find them offensive—and should be avoided.

The Opening Paragraph: Showcasing Your Homework

- Ideally, open with a reference to how you derived knowledge of the company or position.
- If possible, provide context by some artful name dropping ("Ms. Judith Sowers, a Quality Control Specialist in your Meredith plant, informs me that you are seeking . . ."). Otherwise, simply be forthright about why you are writing the letter ("I am writing to you because . . .").
- Include particulars about the company's activities and vision—prove that you have done your homework and know something about the company's products and mission. Even quote a mission statement if you can.

- Establish your own professional context by naming your major and school.

The Body Paragraphs: Selling your Skills

- One paragraph may suffice here, but use more if necessary, especially if you have several different skills or experiences to sell. Stick to one topic per paragraph.
- Through concrete examples, provide evidence of your work ethic and success—cite courses, co-ops, papers, projects, theses, or internships you have completed. Make your examples both quantitative and qualitative. Some writers use a bulleted list to introduce narrative examples of their skills. Some even provide URLs for their home pages or other web pages they helped to create.
- Introduce your resume ("As the enclosed resume shows . . .") and interpret it for your audience rather than simply repeat its details. Apply your education, work experience, and activities directly to the job, proving that you are a highly capable candidate.

The Closing Paragraph and Signoff: Exiting Gracefully

- Keep your closing short and simple. Do not waste time. Be gracious and sincere, not falsely flattering nor pushy. Respectfully indicate your desire for further action, reminding the company of your availability.
- Remembering that a company could try to call you over a break or during the summer, indicate relevant phone numbers right in the text. Provide your e-mail address as well.
- Under the final paragraph, skip a line or two, then, directly under your heading address, type "Sincerely," then handwrite and type your name beneath.
- Indicate that a resume is included along with the letter by typing the word "Enclosure" at the left margin near the bottom of the page.

Self-Study

Loads of sample cover letters are available online. Here are four URLs:

Sample cover letters from LiveCareer website

Advice and sample cover letters from careermatch.com

9.3: Sample Cover Letters

As with resumes, great cover letters tend to be based on excellent models, so below is a pdf where you can download a variety of models that you can use. The letters are organized by level of experience, beginning with a letter from a sophomore seeking an internship and moving on through a graduate student seeking a research position. Along the way you'll also find a letter from a returning adult student with military service and a graduated senior seeking an international sales position outside of her field. Despite this variety, all of these sample letters are successful, for reasons analyzed below.

From a form standpoint, all ten sample letters are kept to one page, in some cases by the writer using size 11 font rather than size 12, and by skipping fewer lines or no lines between letter sections. All of the letters include ample white space with lines skipped between paragraphs so that the material is not crowded, and they all include full addresses with the writer's address and signature aligned with each other. Note also that the sample letters include a minimum of three paragraphs and in some cases even use one-sentence paragraphs—thus the letter recipient is not daunted by the task of reading. Finally, in one letter emphasizing skills that the writer has to offer, she goes so far as to enumerate and physically underscore her skills, indenting the paragraphs in which they appear as well, so that those skills stand out for the reader. Such an approach exudes confidence without the letter breaking any fundamental rules of form.

As far as content and rhetorical stance, even the first letter by a sophomore includes some specialized material, mentioning CVD reactors, while other letters provide relevant quantitative information ("I have assisted with . . .nearly 100 Unix workstations") and qualitative assessment (. . . an experience that made me a confident public speaker."). Most importantly, we see these writers showcasing their homework about the companies, noting IBM's "constant striving to become a six-sigma company," citing part of the company's mission statement verbatim, and dropping names of company employees. Through these tactics, we realize that these letters have been tailored to the specific job circumstances, and we recognize that we are reading purposeful, informed writing. One of the most impressive sentences in these letters tackles the difficult rhetorical challenge head-on:

> *"Admittedly, I do not have a specifically business- or technology-related degree; nonetheless I have some proficiency with both as well as a sharp, probing mind and a keen, demonstrated interest."*

In her letter, this student goes on to prove her bold claim, and the letter got her the interview, which landed her the job.

Click here to download a pdf of ten sample cover letters.

9.4: Professional Letters

Beyond the cover letter, you will undoubtedly be faced with the need to write other professional correspondence, be it by e-mail or envelope. These letters are just as important in that they can also become part of a file devoted to all of your correspondence with a company or individual. Professional letters you write are likely to be kept in a file along with your resume as part of your permanent record. Letters are also your opportunity to show professional courtesy, impress companies with your knowledge of and interest in them, and allow readers to know you as a person. Good letters humanize you. And employers tend to choose people they feel they know—not strangers.

In addition to the cover letter, the other types of professional correspondence you are most likely to write include:

- A Query Letter, making a specific request for information.
- A Thank You Letter, expressing thanks for an interview or invited visit.
- An Acknowledgment Letter, acknowledging the receipt of a job offer or some materials.
- A Letter of Decline or Letter of Acceptance, declining or accepting a job offer.

While writing a letter for any of these circumstances, follow the same basic guidelines for tone, appearance, mechanics, and format as you do for cover letters. However, keep these letters brief—just a few short paragraphs—so they can be read in one-minute's time. Using a gracious, professional tone, fill your letter with specifics particular to the circumstances, for example:

- The date of your previous correspondence or interview.
- The names of any other individuals relevant to the correspondence.
- Details about what action, if any, you want your audience to take.
- Clarifications of any points worth repeating or open to potential misunderstanding.
- Carefully worded, warm, personal remarks, especially if you have had repeated contact with the same person, and especially if you are asking for a favor.

Follow these guidelines carefully and you can be assured that your letter will inspire your reader to take appropriate action, whether that is simply to place your letter into a file respectfully or perform a more involved task that you requested professionally.

Self-Study

For further advice on writing professional letters, I recommend:

"Writing the Basic Business Letter" article from Purdue's Online Writing Lab (OWL)

"Writing Professional Letters" guide from the University of Wisconsin-Green Bay

9.5: Sample Professional Letters

In the sample letters available in pdf form below, we trace the story of one particular job seeker from her query for company information to her thank you letter after her interview to a sample letter of acceptance (as well as a sample letter of decline) once she receives a job offer. Though these letters are hypothetical, they are modeled on real letters that I have worked on with students over the years, and they represent real scenarios and decisions that students are faced with—scenarios that must be responded to in writing.

In form, the letters are all professional and conventional, following the same overall format guidelines that apply to cover letters. In tone, the letters are increasingly warm and personal, especially as the writer develops a relationship with the company representative whom she has met. In content, the letters are specific to the circumstances ("'Project Paradigm' holds a special interest for me . . .") and both efficient and purposeful, so that they can read quickly and comprehended easily. Note that even in the final example, which declines the job offer, the writer remains cordial, specific and explanatory, and hopeful that she may have further contact with the company in the future. In a word, she remains professional.

Click here to download a pdf of five sample professional letters.

CHAPTER OVERVIEW

10: Journal Articles about Writing

10.1: Introduction

Here we take a look into the horse's mouth, or sit in the editor's or professor's armchair, as it were. If it is not obvious to you yet it will be soon: not only English teachers care if your writing is stylish and correct—your professors care, employers care, and magazine and journal editors certainly care. This chapter offers proof. There is plenty of stylistic advice available out there in trade publications and the scientific journals themselves, indicating that editors and journal readers do indeed expect clear technical writing from those who submit work to them. In this chapter I have harnessed just a small sampling of the good advice that is out there awaiting you. Below is a quick summary of the chapter's contents.

"Comments From the *Geological Society of America Bulletin* Editors" reviews the pet peeves of journal editors in the geological sciences.

"Advice to Scientist Writers: Beware Old 'Fallacies'" helps us to reconsider basic writing practices that we sometimes hold as truths when they are not.

"Precise Writing for a Precise Science" is written by a professor of chemistry arguing for the relationship between clear communication and clear science.

"The Universal Recipe, Or How To Get Your Manuscript Accepted By Persnickety Editors" is by a veteran journal editor sharing his insights about what makes a scientific article publishable.

"The Science of Scientific Writing" is a methodical deconstruction of science writing to the point of generating seven practical maxims that science writers can apply to their work.

Self-Study

For some additional excellent advice on science writing, turn to these websites:

"Handouts & Demos" page from the Writing Center at the University of North Carolina

"Writing Technical Articles" page from Columbia University

10.2: Comments From the Geological Society of America Bulletin Editors

"Comments From the *Geological Society of America Bulletin* Editors" and its sequel are tips from some irritated but nevertheless well-meaning and buoyant journal editors about what kinds of errors cross their desks in all-too-generous handfuls. The comments originally appeared in the *Geological Society of America Bulletin*, copyright © 1989 by the Geological Society of America, Inc. Anyone in the earth sciences will certainly benefit from reading these articles and keeping them on hand, and others will find them illuminating as well. These comments illustrate just how important it is that, as a scientist-writer, you choose your words with great care and with their literal meaning in mind. To emphasize their points, the editors, John Costa and Art Sylvester, even occasionally resort to sarcasm!

Click here to download a pdf version of the article "Comments From the *Geological Society of America Bulletin* Editors."

To open the article "Comments From the *Geological Society of America Bulletin* Editors" within this page, click here.

Comments From the Geological Society of America Bulletin Editors by Art Sylvester and John Costa

An increasing number of GSA members lament the general deterioration in the quality and clarity of writing by earth scientists. They complain especially about the misuse and overuse of words and phrases that lead to vague, awkward, or cumbersome sentences, and that require several readings before a meaning is derived. It may be only coincidental that the derived meaning is the one intended by the author.

Insofar as it is one of the duties or prerogatives of editors to educate potential or eventual authors, when necessary or appropriate, we offer this commentary as some of our "suggestions to authors." Our suggestions should not be regarded as "GSA style"; however, authors may find some red or purple ink in manuscripts that cross our desks if those authors misuse or overuse the words and phrases discussed below.

- *We may say "volcanics," "clastics," "metamorphics," "metasediments," "intrusives," and "granitics" to each other in the field, but it is quite improper grammatically to add an "s" to an adjective to make a plural noun. It may be tedious and repetitious to read, but it is correct and unambiguous to write "volcanic rocks," "clastic rocks," "metasedimentary rocks," "intrusive rocks," and "granitic rocks."*
- *The terms "lithologies" and "mineralogies" should never be used until and unless we accept "geologies," "biologies," and "zoologies." Replace them with "rocks" or "rock types," and "minerals." "The lithology of a study area" and "the mineralogy of a suite of rocks" are quite correct phraseology.*
- *Many writers of geologic literature use "compression" indiscriminately for both stress and strain, as in the context of "compressional structures." Geologic structures are manifestations of strain; thus, in rock mechanics the convention is that "tension" and "compression" are terms that should be used in discussions of stress; whereas the corresponding strain terms are "extension" or "elongation," and "contraction" or "shortening" or even "constriction."*
- *It has come to seem that a paper is not "scientific" unless it contains two words: "essentially" and "constrain," preferably together in the construction "essentially constrains." Both are perfectly good, although overused, words, and they have their place in good writing. The English language is rich in other words, however, that may be used effectively to convey more explicit meaning, including "generally," "commonly," "typically," "nearly," "almost," "mainly," "chiefly," "partly," "characteristically," "usually," and "largely." Writers may find that "control," "limit," "restrict," "bound," "define," "contain," "characterize," and "restrain," and their related nouns are more meaningful than "constrain" and its related noun "constraint."*
- *The sentence "evidence suggests that the Earth is flat" carries no information. What kind of evidence? Geologic? Geodetic? Compelling? Permissive? Pseudo-scientific? Circumstantial? Specious? Just as vague for the same reason is the statement "data suggest that the Earth is flat." Imaginary data?*
- *At the same time, "data," "strata," "phenomena," and "spectra" are plural.*

- *We prefer to avoid using "evidence" as a verb, as for example, in the sentence "the presence of snakes in the grass was evidenced by their rattling sounds." We also maintain that the verb "postulate" is more euphonious than "hypothesize."*
- *Strictly speaking, the whole "comprises" its parts, but our dictionaries (Webster's II New Riverside Dictionary, The American Heritage Dictionary) say that the jury is almost evenly divided on its formal use, and that "comprise" may be used as a synonym for "consists of," "is composed of," "encompasses," and so on, but "comprised of" is wrong.*
- *Our dictionaries also say that "occur" and "occurrence" are better used when "happen" and "happening," respectively, can be substituted. Rather than "the rocks occur in the cliff," it is better to say "the rocks are in the cliff," "the rocks are present in the cliff," or "the rocks are exposed in the cliff." We expect that paleontologists will complain, however, because the "occurrence of fossils" is deeply rooted in the literature.*
- *The word "portion" is preferred when the word "share" can be substituted for it. Otherwise use "part," which is no less a profound or erudite word.*
- *"Suggest" is a frequently overused "weasel word" in manuscripts. Many writers build a house of cards with "suggest," when stronger words such as "indicate," "imply," "show," and "prove" may be more appropriate. Authors commonly write "Joe Schmoh suggested that the Earth is flat," when in fact Schmoh may have "proposed," "concluded," "indicated," "maintained," "asserted," "inferred," "implied," "stated," "believed," "postulated," "thought," "guessed," or "considered" that the Earth is flat. Other "weasel words" and phrases include "probably," "appears to be," "seems to be," "may be," and "could be." Their overuse should be avoided as much as possible.*
- *"Show" is being overused, however. "The outcrop shows iron stains" is better expressed, in our opinion, by "the outcrop is iron stained" or "the outcrop has iron stains."*
- *The awkward use of the infinitive "to be" is surfacing in scientific writing with increasing frequency, such as in "Joe Schmoh thought the Earth to be flat," or "Joe Schmoh showed the rock to be lithified." It is more straightforward to write "Joe Schmoh thought that the Earth was flat" and "showed that the rocks are lithified." Here is another example of vagueness: "Statistics reveal April's GNP to be lower than March's." Does that sentence mean that the April GNP is lower than March's or that it will be lower?*
- *"Since" is a time word; so also are "occasional," "while," and "frequently." "Occasional outcrops of obsidian were observed since the bulldozer passed through the hill." Were the outcrops there only on Tuesdays because the bulldozer passed through, or only on Tuesdays after the bulldozer passed through? Use "whereas" in place of "while" in those cases where time is not implied.*
- *We have yet to read an article that stated the velocity of a "rapid facies change." We have observed and mapped abrupt facies changes, however.*
- *"Sediments" are rock-disintegration products, such as sand, silt, and gravel. We would like to be invited to go on a field trip to see "Ordovician sediments." Although we realize that sediments were deposited in basins of Ordovician age, we'll bet 30¢ that they are "sedimentary rocks" today and should be so called.*
- *Because lines "trend" and "plunge," and surfaces "strike" and "dip," it is incorrect to say "northwest-trending faults," whereas "northwest-striking faults" is correct. Authors may object that the traces of faults on maps are lines, but because a map almost always represents the horizontal plane, the intersection of a fault surface with the map surface is a unique line: the strike.*
- *It is also increasingly common to see authors put together a string of nouns to construct what they believe is a more educated or profound name for a very simple thing, such as a "single component rock sample acquisition system" (five nouns to mean rock hammer).*
- *We believe that it is preferable to write "margin of the plateau," instead of "the plateau's margin," because inanimate objects cannot possess.*
- *Can anyone tell us what "packages" or "packets" are in the geologic context, and where either is formally defined? We can cite several different sizes and shapes of things that "package" has been used to describe, including an individual stratum, several strata, a sequence of stratified rocks, a temporal sequence of rocks, an areally restricted outcrop of a distinctive rock or group of rocks, fault blocks—even tectonic terranes. The definition that makes the most sense to us is that "package" and "packet" are the latest geologic buzzwords. So is "scenario," which ought to be replaced with "hypothesis."*

The Chicago Manual of Style is a standard for scientific journals and is probably the best reference for these matters. We have learned that a new edition of Suggestions to Authors of Reports of the U.S. Geological Survey, a long-time standard for authors,

may be printed soon. Melba Murray has just published a second edition of her excellent book, Engineered Report Writing. We also recommend Robert L. Bates' new little book, Writing in Earth Science, published by AGI ($3.95); it covers 95% of the "housekeeping" problems we encounter.

Sequel to "Comments From the Geological Society of America Bulletin Editors"

The positive reaction of many Bulletin readers to our September 1989 Comments about misuse and overuse of words emboldens us to write a sequel. First, we wish to share the readers' views on some of our comments about style.

To our assertions that it is poor style to allow inanimate objects to be possessive, Robert Bates snorted: "Does that mean I should not say 'the rocket's red glare,' or 'the dawn's early light?' Nuts!" We respond, "touché!" He also said that his university has a department of classics, and although he realized that it probably should be properly termed Department of Classical History and Literature, he wasn't going to tell that department to change its name. We agree with him on that point, but we still think it is poor style to make plural nouns out of certain geologic adjectives, such as "lithic" to "lithics," and "clastic" to "clastics." Similarly, making "basaltic" into "basaltics," and "geologic" into "geologics" should also be discouraged.

Dr. Bates shared some other pet peeves with us, including "little pomposities" such as "prior to" for "before" and "is dependent upon" for "depends on." He said, "Encountered in reading, these are like the bump-bump, bump-bump on an old highway. They don't slow you down much, but they take a lot of pleasure out of the trip."

Several readers maintained that language actively evolves, and that we editors should flow with that tide, because rigorous editing may stultify creativity. We appreciate these sentiments, and we encourage innovation, but we maintain that poor syntax, excessive jargon, or prolific buzzwords may obfuscate an author's message. It is the author's scientific responsibility to write a story that readers will understand, rather than to make an exercise in creative prose. The editor's responsibility is to help an author present his/her message as clearly and succinctly as possible for the majority of readers. As an example, we shall continue to ask authors to rewrite sentences such as "Like, hey, dude, ah, yuh know, whoaah!" Even though that phrase has currency and unequivocal meaning in some circles, it conveys little scientifically to us.

- *The "datum/data" controversy prompted the most responses to our September 1989 Comment; however, we shall cleave to the convention that data are plural, because instances arise where we need to retain the clear use of "datum," such as a topographic datum, a geodetic datum, an age datum, and a stratigraphic datum. Incidentally, data show nothing. It is the analyst's interpretation of the data that may yield some kind of a conclusion. Users of seismic reflection data tell us that many of those data "show" nothing unambiguously without interpretation.*
- *Jess Johnson compared "further" and "farther": "You wouldn't say 'I'm going fur away'; therefore 'far, farther, and farthest' for distance. The lawyer, when he finished cross examination, said 'no further questions'; it would sound strange to say 'no farther questions,' and so use 'further' in the context of 'additional.'" Dr. Johnson also admonished producers of manuscripts on word processors to proofread a hard copy rather than a screen. We agree from the nature of the errors we see on word-processed manuscripts and from our own experiences with them.*
- *Mason Hill pointed out that "faults do not move"; thus it is improper to talk about "fault movement" and how "a fault moved through time." Movement (of one block relative to another) may occur along a fault, a fault may offset something, and it is correct to talk about fault displacement.*
- *Amos Salvador maintained that "facies" is the most overworked and ambiguous term in the geological vocabulary. He pointed out that the AGI Glossary of Geology (1987) has seven different definitions of "facies." Without additional modifiers, such as "biofacies," "lithofacies," or "metamorphic facies," the term may be meaningless out of context. For that reason, Salvador recommended, and we concur, that the use of "facies" should be avoided if clarity of expression is desired.*
- *The use of "young" as a verb as in "the stratified sequence youngs to the west," is anathema to several stratigraphic readers. They and we prefer to say that "the stratified sequence is younger to the west." A nautical reader called attention to the fact that "westerly" is a nautical term; thus, geologists should say "the rocks were thrust westward."*
- *We are still plagued by the indiscriminate overuse of "show," especially in figure captions. A recent example was "Map showing the geology of the Hardshell area" whereas "Geologic map of the Hardshell area" has always sufficed in the past. In this regard, we also consider it poor style to write first sentences of paragraphs such as: "Figure 5 shows the isotopic variations of basalt in the Hardshell area." The first sentence of a paragraph should introduce and even summarize the*

remainder of the paragraph. It should not be a description of the contents of a figure or repetition of what is already in the figure caption.

- *So far, no one has offered definitions for "package," "packet," or "bundle" in the geologic context, or defended their use in preference to such good words as "bed," "stratum," "unit," "sequence," "block," "domain," "area," "region," and sundry other equally useful words.*
- *It is still distressing to see authors (and hear speakers) use "compression" for both stress and strain. Among rock mechanicists, "compression" is used only in the context of stress.*
- *Regrettably, it seems that the frequent use of "lithologies" as a synonym for "rocks" will die only when authors realize they do not say or write "geologies." Recently we saw that "Essentially four lithologies, each essentially composed of differing mineralogies, comprise the geologies essentially of four counties." Bah!*
- *"Superpose" has been preferred in place of "superimpose" since 1888, according to the AGI Glossary, because both words mean the same thing. The related word, "superimposition," has established usage largely in a geomorphic context in association with streams and glaciers. Otherwise, we prefer "superposition," in the stratigraphic and structural contexts. It sounds strange to talk about the "Principle of Superimposition."*
- *We see a creeping tendency to substitute "fabric" for "structure." This is improper, because fabric has always had a singular and historic connotation: "The fabric of an object is described by all of the spatial data (fabric elements) which it contains. A rock is said to have a simple fabric when it contains a single fabric element, such as lineation or foliation. A rock is said to have a compound fabric when it contains more than one fabric element, such as lineation or foliation" (with modification from Clark and McIntyre, 1951; see also Oertel, 1962). A fabric element is a penetrative structure on the scale of observation. A single fault is not a fabric element, although if it is one of a multitude of similarly oriented faults on the scale of a county or a state, then it is an element of the fabric defined by all of the faults.*
- *Why do authors, when submitting a manuscript for consideration for publication in the Bulletin, typically write in their cover letter: "Joe Schmoo and myself submit the enclosed manuscript. . . ."? Suppose Joe withdrew, then would the author have written "Myself submits the enclosed manuscript. . . ."? We also see manuscripts "submitted by Joe Schmoo and myself" instead of "by Joe Schmoo and me." Myself is a reflexive pronoun and should be used only when "I" is the subject of the sentence.*
- *Watch and listen for the latest buzzword: "architecture." It is being used as a synonym for "structure," "geometry" (even "anatomy"), and diverse structural arrangements, including coils in molluscs ("the helicoidal internal architecture of Helix pomata"), the preferred orientation of c crystallographic axes in quartz ("the architecture of c-axes in the Hardshell quartzite"), the unconformable relations of strata ("the disparate stratal architecture between the Hardshell and Softshell Formation"), the variable attitudes of faults in a mountain range ("the crosscutting architecture of normal and reverse faults in the Hardshell area"), and collages of blocks on the continent scale ("the compressional architecture of Alaska"). Ugh!*

Art Sylvester
John Costa

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10.3: Advice to Scientist Writers- Beware Old Fallacies

"Advice to Scientist Writers: Beware Old ‘Fallacies’" underscores how, as writing practices change, we must change with them—and at times we even must challenge advice about writing that we have heard all our lives. The article appeared in the October 31, 1988, issue of *The Scientist*, and is reprinted with the permission of John Wiley & Sons, New York, copyright © 1988 by Henrietta J. Tichy. Tichy blasts away at the maxims that scientists have to struggle with whenever they write. Obsolete advice such as "essays are made up of five paragraphs" or "never end a sentence with a preposition" can ring in our ears and guide our writing habits for years, yet we always have far more options at our fingertips than any such rigid rules suggest. The irony is that the very rules that guided us to become better writers are often the same ones that we have to shrug off or challenge as our writing matures. Because of our education and our quirky selective memories, Tichy says, we often carry "writing fallacies" around with us that we must unlearn. The author urges us to make a start on some good "unlearning" by attacking our writing fallacies. And she’s funny too.

Click here to download a pdf version of the article "Advice to Scientist Writers: Beware Old ‘Fallacies," by Henrietta J. Tichy

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"Advice to Scientist Writers: Beware Old ‘Fallacies" by Henrietta J. Tichy

> *This article, downloaded from Style for Students Online, originally appeared in the October 31, 1988, issue of The Scientist, and is reprinted with the permission of John Wiley & Sons, New York, copyright © 1988 by Henrietta J. Tichy.*

Bits of advice from fallacy land have a strong influence on writing. If cooking were controlled by such misconceptions, indigestion and poisoning would threaten at every meal. Unfortunately, scientists’ writing has been poisoned by erring precepts that are no more accurate than a word passed around the circle is for the last listener.

Few people can concentrate on applying a dozen or more of these rigid rules without feeling so constrained that they hate to write. When they are forced to write, everything—diction, sentences, paragraphs—becomes awkward and unnatural, and every revision is made slowly and painfully. The best thing that scientist writers can do for themselves is to escape from the anxiety and strain caused by unnecessarily strict rules.

A good example of one such deadly rigid rule, "always use the passive voice," is a prescription so frequently pressed on writers of informational prose that it has proved to be one of the most harmful of all the fallacies. It is frequently enunciated by a person in a position superior to a writer’s, such as a graduate school professor who insists that students write as the professors do —in the passive voice —in order to appear scholarly, to show objectivity, or to acquire a style like that of journal articles. Unfortunately, some writers have had poor advice impressed upon them so strongly that they cling to the misinformation tenaciously. (A consultant, late for an appointment with a foreign-born engineer who had learned English during his two years in the United States, apologized effusively. "It is nothing," the engineer replied courteously. "A cigarette was smoked and a book was read while waiting.")

Now, adroit use of the passive voice where it is suitable benefits style by permitting variations in meaning, stress, pace, and rhythm; but excessive use of the passive limits all components of expression. To write entirely in the passive would seem not just unwise but impossible; yet some misled scientists attempt it. The passive voice weakens style when it is used, consciously and unconsciously, to evade responsibility. One popular passive construction is "It is thought that . . . ." When used anywhere in science and technology, the construction indicates that a general opinion or truth follows. But when scientist writers use it, they are likely to mean "I think that . . . ," "we think that . . . ," or even "I hope that somebody reading this thinks that. . . ." Writers using these and other examples of "the evasive passive" run the risk of having their careful readers sound like hoot owls as they ask, "Who? Who? Who?"

The truth is, the active voice in most cases is much neater and briefer. "The safety committee recommended . . ." is better than "the recommendation was made by the safety committee . . . ."

Another taboo, the rule against ending a sentence with a preposition, is a point about emphasis incorrectly applied. Near the end of an English sentence a major stress falls, sometimes on the last word, sometimes on a word just before the last word, sometimes on the final phrase. For effective emphasis, the word stressed should be important: "She said that she would complete the work on Monday." The stress is on Monday. Careful writers avoid stressing an unimportant word, like a

preposition. But in many a sentence that ends with a preposition, the stress falls on the word before it. If that word is important, there is no need to rephrase the ending. Thus, it is acceptable to write "He is a difficult person to agree with" or "Children should have bright objects to play with."

Still another fallacy advises writers to avoid beginning sentences with certain words, such as "however," "but," and "and." There is a better way to approach this matter, still keeping in mind that the first word or words in a sentence are usually stressed, and they should indeed be important words. Occasionally even the much maligned however may be important because a writer wishes to emphasize that an unexpected shift in thought follows. But and and, which are also listed as forbidden first words by some teachers, seldom are stressed when they introduce a sentence. But they are often useful as unobtrusive initial conjunctions.

And then we have the harmful fallacy telling us to "avoid all personal pronouns. Never use I or we." First-person pronouns have long been absent from technical writing. They disappeared in the United States about 1920, when the impersonal style began to dominate in science and technology. (In the writing that comes out of the United States government —particularly from the Pentagon—I and we or any other indication that a human being is writing are taboo.) However, an attempt to achieve objectivity by avoiding personal pronouns is a mistake, and the idea that using the third person instead of the first person achieves modesty is equally wrong. Discarding necessary words like I and we merely leads to awkward writing marked by excessive use of the passive and by reliance on weak indirect constructions. Writers deprived of I and we turn to unnatural and objectionable substitutes: the author, one, the present writer, this reporter, and so forth. Sometimes, avoiding the use of the first person in an effort to sound modest backfires. Consider the sentence "The national secretary of the society initiated the following improvements in the management of the central office." This sounds far more immodest than the simply stated "I initiated the following improvements . . ."

Today, prohibition of the first person is obsolete, although writers should avoid constantly using it. Most scientific and technical journals now permit authors to use I for a single writer and we for more than one writer, especially when the material is personal, as in interpretation of results and in predictions. Indeed, many editors urge this use whenever appropriate. The American National Standard for the Preparation of Scientific Papers for Written or Oral Presentation states, "When a verb concerns action by the author, the first person should be used, especially in matters of experimental design ('To eliminate this possibility, I did the following experiment')."

Half a century or so ago, when the personal pronouns and active voice were reduced to a minimum or eliminated, much writing on science and technology became lifeless and dull. This led to the fallacy that writing on professional subjects has to be dull and that there is no use trying to do anything about it. However, in my experience there is a marked correlation between the excellence of writers' understanding of a subject and the clarity and grace of their written thoughts on it. Indeed, many major businesses and industries are pressing hard for readable prose from their scientists. To achieve it, good writers and editors have been freeing themselves from unnecessary rules and regulations. Instead of droning never use the active voice and never use personal pronouns, they have been concentrating on the functions of the active and passive voices, on the functions of personal and impersonal pronouns, and on the avoidance of usage and style not suited to the idiom of the English language. It will be interesting to watch the changes that occur.

10.4: Precise Writing for a Precise Science

"Precise Writing for a Precise Science" is a marvelous example of common and easily overlooked errors on the sentence level. As this selection points out well, rigorous writing and rigorous science go hand in hand. I chose to reprint this article because, put simply, it teaches us to pay careful attention to every sentence we write. Written by Roger K. Bunting, Professor of Inorganic Chemistry at Illinois State University, this article demonstrates how the reader's perceived meaning of a sentence may not always match the writer's intended meaning, and the lessons in the article reach far beyond the world of the chemist. As noted at the end of the article, "A scientific report ought to be presented with a level of rigor and precision of the language commensurate with those of the scientific findings." Readers of this article must agree with the author: Dr. Bunting, whose publications are typically about such subjects as polymer electronics research or the chemistry of photography, writes me by e-mail that "[the article] seems to have made a greater splash than any technical article I've published!" "Precise Writing for a Precise Science" first appeared in *Journal of Chemical Education*, Vol. 76, no. 10, October 1999, pp. 1407-1408, and is reprinted here with the permission of *Journal of Chemical Education*, copyright © 1999.

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"Precise Writing for a Precise Science," by Roger K. Bunting

Despite the pervasive necessity of effective communication skills in virtually any contemporary career endeavor, a good command of the tools of communication seems to have eluded a great many graduates of chemistry programs. Poor sentence construction and grammatical solecisms are all too common in both written and oral reports of scientific findings. The English language is the principal tool of modern scientific communication, and its effective use should be a goal of anyone preparing for a career in science.

Following is a collection of examples of familiar grammatical constructions, presented in scientific context, that could be better phrased in accordance with the commentary that follows each.

Examples

The product has a melting point similar to benzophenone.

A melting point in no way resembles a chemical compound, but it may resemble another compound's melting point. The sentence should read ". . . a melting point similar to that of benzophenone."

Solubility was the principal criteria for choosing the nitrate salt.

Criterion and phenomenon are two words of Greek origin often misused as their plurals. Spectrum, too, (of Latin origin) is often casually replaced with its plural spectra by those who most often utilize spectroscopy.

Pentaborane and ammonia were reacted at low temperature.

Few besides chemists are brazen enough to use react as a transitive verb. The chemicals react, chemists don't react them. This usage is quite common, however, but it makes one wonder about the user's understanding of thermodynamics!

An historical approach to the teaching of chemistry presents a different perspective.

The sentence begins with a construction that currently enjoys a level of snob appeal, and it avoids successive aspirations when vocalized. It is unjustified, however (the h is not silent), and would be better phrased as "A historical."

There was very little data to support the conclusion.

In chemistry, data is still commonly used in the plural sense, and most chemists are careful to write data are instead of data is. The error is less obvious here, however, and this construction is often seen and heard. The sentence should read "There were

very few data." (As a simple check, if a sentence doesn't sound right when data is replaced by facts, it probably isn't correct.)

A simple IR spectrum infers a highly symmetrical structure.

Infer means to draw a conclusion—the responsibility of the spectroscopist, not the spectrum. One could say that the spectrum implies, but this too is a personification. A better sentence would be "A highly symmetrical structure can be inferred from a simple IR spectrum."

To we who are chemists, scientific reasoning is second nature.

A subordinate clause must always be considered as completely independent from the rest of the sentence; the sentence must be grammatical without it. Inserting the clause who are chemists in no way alters the fact that the sentence must begin "To us." Similarly, the construction within the subordinate clause must be grammatical on its own. For example, "The information was given to whomever requested it." The entire clause is the object of the preposition to. The sentence should read "to whoever requested it."

Compounds which contain azido groups are often explosive.

The subordinate clause is "restrictive"; that is, the sense of the sentence is changed if it is omitted. Restrictive clauses should begin with that. The sentence should read "Compounds that contain azido groups." Nonrestrictive clauses, which are not essential to the meaning of the sentence, begin with which and are set off with commas. The following is an example using a nonrestrictive clause: "Azido compounds, which contain the N3 group, are often explosive."

If we lay in the sun we may increase the risk of skin cancer.

Lay is a transitive verb (it requires a direct object). Lie is intransitive. Some of the confusion arises from the fact that in this case the past tense of the intransitive verb is the same as the present tense of the transitive verb. The sentence should read "If we lie in the sun," or, in the past tense, "If we lay in the sun we may have increased the risk of skin cancer."

The professor felt badly about the poor exam scores.

A verb that relates state of being is followed by a predicate adjective, not an adverb. That is, the word modifies the professor, and does not describe the manner in which he performed some action. "The professor felt bad about the poor exam scores."

The project was completed by a colleague and myself.

A reflexive pronoun (myself) should be used only subsequent to a corresponding pronoun (I or me) in the same sentence. Correct form: "by a colleague and me." A modern aversion to the word me has even engendered the use of the nominative I as direct object, indirect object or object of a preposition, usually in compound form. Such constructions as "for my colleague and I" are heard, unfortunately, with increasing frequency.

We abandoned our work with nitrogen trichloride when we realized it was explosive.

No chemist would misunderstand the intended meaning, but the sentence literally says that the work was explosive. The intended antecedent of the pronoun it is the object of the preposition with. The sentence should read ". . . when we realized the compound was explosive." Ambiguity from a casual use of pronouns is all too common.

Applying VSEPR principles, the most likely structure was predicted to be planar.

Applying is a dangling participle. There is no noun that it could modify except structure, and the structure clearly did not apply the principles. The sentence should be rephrased as follows: "By application of VSEPR principles . . . ." Equally poor are sentences like "The solution was filtered, resulting in the recovery of the product." Which resulted should be used in place of resulting.

It is important that the procedure is followed precisely.

The subjunctive mood has diminishing importance in the modern English language, but its use persists in certain instances such as "that" clauses and "if" clauses (condition contrary to fact). This sentence would be best written as ". . . that the procedure be followed precisely." (The proper subjunctive form "If I were you" is common, but the equally proper "If this be true" is seldom used. There are few consistencies in the use of the subjunctive.)

The ester dissolved in benzene was saponified.

This is a very poor construction because dissolved could be either a verb or a participle, and the sense is not clear until the reader reaches the end of the sentence. A better construction would be "The ester was dissolved in benzene and saponified."

I told the professor that I did not remember him lecturing on the topic.

Students may be forgetful, but it's unlikely that he or she forgot the professor! The sentence should read "did not remember his lecturing." Lecturing is a gerund here (a noun form), not a participle.

The crystals darkened, which indicated there had been decomposition.

The past perfect tense "had been" implies an event more remote than the past tense. Presumably the crystals darkened at the same time that the decomposition occurred, not subsequent to it. Both verb forms should be in the past tense, or both in the past perfect.

Submit your vitae and the names of three references.

Cats, superstition has it, are endowed with multiple lives, but not chemists. Here the plural vitae has been used for the singular vita (Latin), which means life. In the above context, vita refers to a summary of one's professional life. This misuse is common in classified advertisements. Curriculum vitae, however, is a proper singular form ("course of life"), declined according to the rules of Latin.

And what is the name of a reference? Probably the writer meant the names of three referees. A citation lists a reference; a person consulted is a referee.

The coordination of metal ions in aqueous solution is generally octahedral.

A general rule is one that always applies. A better choice for the above sentence would be usually, or commonly, or typically octahedral.

Ammonia readily complexes with many transition metals.

It's been said that any noun can be "verbed," and most verbs no doubt had their origins in nouns, but complex is not yet widely accepted as having attained verb status. In the above sentence complexes could be easily (and preferably) used as a noun: "Ammonia readily forms complexes."

A scientific report ought to be presented with a level of rigor and precision of the language commensurate with those of the scientific findings. However, a rigid adherence to all grammatical "rules" would render a writing devoid of style, and such adherence is by no means mandatory or even recommended. But an understanding of the rules, their origins, and their contemporary interpretations allows the informed writer or speaker to selectively use grammatical devices to his or her advantage, to most effectively convey the information so that it will be received in the manner intended.

Recommended Reading

Schoenfeld, R. *The Chemist's English*, 3rd ed.; VCH: New York, 1989.

Morris, W.; Morris, M. *Harper Dictionary of Cotemporary Usage*, 2nd ed.; Harper & Row: New York, 1985.

Bryson, B. *The Mother Tongue*; William Morrow: New York, 1990.

General References

The ACS Style Guide, 2nd ed.; Dodd, J. S., Ed.; American Chemical Society: Washington, DC, 1997.

The Oxford Companion to the English Language; McArthur, T., Ed.; Oxford: New York, 1992.

10.5: The Universal Recipe, Or How To Get Your Manuscript Accepted By Persnickety Editors

"The Universal Recipe, Or How To Get Your Manuscript Accepted By Persnickety Editors" is a detailed look at how the best writers put together and publish their scientific reports in journals. The beauty of this piece is its universality and comprehensiveness; by definition, the advice in this article crosses disciplinary lines. From the sharp mind of a seasoned editor, this article gives us an inside track on just what editors are looking for when they select scientific articles for publication. This article is the best I have seen at what it does, and is made more enjoyable by the editor's wit, examples, and exactitude. From the entertaining title of the original article to the gracious closing acknowledgments, we see again that editors are people too (some, I suspect, even ride mountain bikes and keep pets). This article is reprinted with the kind permission of the author, Frederick A. Mumpton, copyright © 1990 by The Clay Minerals Society.

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"The Universal Recipe, Or How To Get Your Manuscript Accepted By Persnickety Editors,"

by Frederick A. Mumpton

The Recipe

Overview

Despite the enormous diversity of the many branches of science and technology, the manner of reporting scientific and technical information seems to have resolved itself over the years into a rather standard format—a format that appears to be just about the same regardless of the particular area of science being discussed. This format has emerged by trial and error and today seems to be the most universally accepted means of conveying scientific ideas and information. Although minor variations may be found, the standard format or recipe for acceptable manuscripts consists of the following major parts:

1. Title

2. Authorship

3. Abstract

4. Introduction

5. Experimental (or Methods & Materials)

6. Results

7. Discussion

8. Conclusions (or Summary & Conclusions)

9. Acknowledgments

At this point, a few readers of this article will undoubtedly say to themselves that this standard format or recipe is all well and good for most papers and for most authors, but "my" work is different and therefore "my" manuscript should be organized in a "different" or "special" way. In answer, this editor says "not so," or at least not so for 99.99% of the manuscripts he has ever dealt with. Rarely does a scientific investigation require a reporting style that differs substantially from this standard format. Granted, some manuscripts may benefit by a separate Theory section or Theoretical Background section (probably inserted after the Introduction), or a Regional Geology section (inserted either before or after the Experimental section), or even an

extended Literature Review section (inserted after the Introduction), but the presence of such extra sections does not change the overall organization of the manuscript, nor do such sections detract (if they are properly written) from a straightforward, "eins, zwei, drei" manner of presentation. The standard format or universal recipe allows authors to tell the reader specifically what problem they attempted to solve (Introduction), how they went about solving it (Experimental section), what they found out (Results), and how they interpreted these results (Discussion). It also allows them to tell the reader something about the significance of their findings (Summary and Conclusions).

The key to writing an acceptable scientific paper is organization. Most editors, technical referees, and critical readers agree that disorganized writing may reflect a disorganized investigation, and a disorganized investigation is tantamount to a poor investigation, of little use to anyone. This editor strongly suggests that authors organize their reports into the standard format here. I also recommend that authors prepare extended hierarchical outlines of their reports before they put pen to paper (or finger to keyboard). I recognize that many authors do not need outlines before they write, but as a minimum I suggest that their final manuscripts be reduced to outline form as soon as they are completed. In this way any lack of organization becomes readily apparent.

The major sections of such an outline are, of course, the major sections of the universal recipe. These sections are discussed below in terms of the purpose, the kind of information that should or should not be reported, and the pitfalls that should be avoided in preparing each section. Although I would like to claim them as my own, few of the ideas expressed here originate with this editor. Almost all are well discussed in numerous books on technical or scientific writing, some of which are listed at the end of this article. I strongly urge all authors or potential authors to read or re-read one or more of these works and to refer to them constantly as they prepare their next manuscript.

Title

The title of a scientific paper should tell the reader what the paper is all about. It should not be too short or too general (the title of Theophrastus' treatise "On Stones" would be considered inadequate today), or too long (the title "Unit-Cell Dimensions of Potassium Feldspar in Early to Middle Pleistocene Rocks of Southeastern North Dakota as a Function of Alkali Element Composition of Circulating Ground Waters and of Organic Carbon Content of Overlying Lignitic Shales" might put the readers to sleep before they get into the body of the paper). Because everyone who picks up the journal will undoubtedly read the title of the paper, the title is the author's first chance (and maybe the only chance) to tell the readers what the paper is all about and thereby convince them to read on.

In addition to being not-too-long and not-too-short, the title should tell the reader just what will be covered in the paper. It should not give the reader the impression that an entire field will be treated in the paper when in reality only a small part of that field is discussed. Thus, the title "Adsorption of Amino Acids on Kaolinite in Ethyl Alcohol" is more informative than "Amino Acid-Kaolinite Reactions." Moreover, words that do not contribute specifically to the subject of the paper have no place in the title. For example, the first four words of the title "Preliminary Results on the Effect of Magnesium in the Formation of Chlorite" add nothing, and the title is better written "Effect of Magnesium in Chlorite Formation." The title also should not be an alphabet soup of abbreviations or acronyms, many of which may not be understood by the non-expert reader.

Authorship

Authorship of technical papers is a delicate subject and one that most editors are happy to avoid. For the most part, the individuals to be listed as authors and the order in which they are listed should be settled well before the manuscript is submitted for publication. From an editorial point of view, however, a few comments are in order. First, it is perplexing to see long lists of individuals named as the authors of a technical paper, even in this age of cooperative or group research. Lengthy lists of authors suggest unresolved problems of laboratory politics, rather than accurate accounts of the principal contributors to the work at hand. Conversely, some works appear to cry out for additional authors, especially those that draw heavily on student theses or that are based on unpublished information obtained from another party. Hence, the list of authors should include the principal contributors to the project; those who participated in the project in a peripheral manner or only briefly should not be forgotten, but recognized with appreciation in the Acknowledgments section. I will not attempt to state what is an acceptable number of authors, but merely state that credibility decreases as the number increases beyond five or six. Nor will I spell out specifically the meaning of "principal contributor" or "peripheral manner," but leave interpretation of these somewhat ambiguous terms to the authors (or potential authors) themselves.

One subject concerning authorship does merit serious consideration, and that is that all authors of a paper are responsible for the content of that paper. If a particular coauthor does not agree with what has been said in the paper, that coauthor should divorce himself or herself from that paper. In this regard, the principal author (generally the writer) should make sure that all authors of the paper have an opportunity to review, criticize, and contribute to the preparation of the manuscript before it is submitted for publication and before it is resubmitted after having been revised to address the referees' comments. Fulfilling this obligation in itself should drastically limit the number of authors.

Abstract

Not enough can be said about the importance of the Abstract. With the exception of the Title itself, more people will read the Abstract than any other part of the paper. In this era of mega publications, few researchers have time to read everything, even in their own fields of specialization. I am loathe to admit it, but the editor is probably the only person who reads every word of every article in each issue of a given journal. Most of us scan the titles in the table of contents and then turn to the abstracts of the papers that seem to be of interest. If the abstract turns out to be uninformative (i.e., if it really doesn't summarize the highlights of the paper), or if it is merely a table of contents of what is to be found in the rest of the paper, most of us will grumble a little about authors who try to keep their findings secret and probably move on to another paper.

Only the true expert or avid lover of the subject will read the entire paper, and these people will read it regardless of how well or how poorly the abstract is written. It is therefore not for the expert in the subject that authors prepare informative abstracts —it is for everyone else who might read them. Because most of these non-experts will not read beyond the abstract, it is vital that authors convey everything they can about the paper—the rationale for undertaking the investigation, the important findings (including specific data, rather than arm-waving generalities), and the pertinent interpretations of those findings—in the abstract. In short, the abstract should be a fact-filled condensation of the entire paper. Many editors and reviewers take the attitude that if a subject is not of such significance as to be summarized in the abstract, perhaps it does not belong in the main body of the paper either.

Note that in the above discussion I haven't said that abstracts are easy to prepare. They are not. For me at least, the abstract is the most difficult part of the manuscript, chiefly because I am forced to condense each part of the paper into a sentence or two and to construct those sentences with great care so that each contains the maximum amount of information. The author part of me says that surely my colleagues will want to read my wonderful paper in its entirety, and, therefore, I don't have to tell them everything in the abstract, but the editor part of me knows differently; hence, if I want the maximum number of people to benefit from or be aware of the results of my investigation, I must make sure that the abstract says as much as possible.

To illustrate the difference between uninformative and informative abstracts, I recommend reading the abstracts in the program of some past scientific conference and then reading the abstracts of these same papers as they are published in the conference proceedings or in a primary journal, after a persnickety editor and a couple of referees have had a chance to work on them.

Introduction

Magazine advertisements and television commercials must arouse interest in the first few words—otherwise the audience will turn the page or go to the kitchen for a cold beer. Likewise, the Introduction of a scientific paper must in a few short sentences convince the reader that it is worthwhile to read on. The Introduction must set the stage for the paper to follow and convey to the reader the rationale for undertaking the investigation. It should spell out the specific objectives of the investigation and describe the nature and scope of the problem, why that problem is important, how the author attempted to solve that problem, and of what significance are the results that the author expected to obtain. Some Introductions also mention very briefly the principal findings of the investigation, so as not to keep the reader in suspense until the Conclusions. If all these questions are addressed in the Introduction, the reader will know what to expect in the rest of the paper. Authors must recognize that their scientific results may be of enormous significance and that their interpretations may be truly awe-inspiring, but if readers cannot grasp why the investigation was conducted in the first place, they may never bother to read about these wonderful results or these revolutionary conclusions.

The Introduction is generally the place to review the literature, at least to the extent of demonstrating how the present investigation relates to past work. Every paper ever written on the subject, however, need not be mentioned; the author should cite only those papers that bear directly on the problem to be attacked in the present investigation. Authors should also be careful to indicate exactly why a particular work was cited and exactly how the cited work relates to the subject under

discussion. It is frustrating, for example, to read in the Introduction of a paper on "Hydrolysis of Manganese During the Weathering of Ultramafic Rocks" that "Jones and Smith (1978) noted manganese hydroxides in weathered serpentinites." I sometimes want almost to shake the author to learn what it was that Jones and Smith found out about manganese hydroxides in such rocks or what Jones and Smith discussed that is germane to the problem being investigated in the present paper.

Authors should also avoid citing the literature for information that is common knowledge. I once noted the statement in the Introduction to a paper submitted to Clays and Clay Minerals that "Clay minerals are abundant in sedimentary rocks and soils (Grim, 1953)." Such information was, of course, mentioned in the cited work, but was it really necessary for the author to cite Professor Grim's book—or any published work for that matter—for such common knowledge? On the other hand, because one of the purposes of the Introduction is to show the reader how the present investigation meshes with or fills a gap in our current knowledge, authors should not overlook important works on the same subject by other researchers. Even if the author doesn't agree with them, fairness requires that other points of view be recognized and considered. Furthermore, simply because an important work happens to be published in a language not understood by the author is no excuse not to include it in the review of the literature.

Well-written Introductions invariably end with what many have called a "succinct statement of the problem." Here, in one or two sentences the author should state precisely what the rest of the paper will be about and, perhaps, exactly what will be shown as a result of the investigation. For example, the closing statement in the Introduction to the paper on the hydrolysis of manganese mentioned above might be: "To investigate the hydrolysis reactions of manganese during the weathering of ultramafic rocks, samples of fresh serpentinite and peridotite were treated with weak acids at room temperature for periods ranging from weeks to years. Reactions were followed by analyzing solid products and residual solutions and plotting the results on appropriate Eh-pH diagrams." The "statement of the problem" at the end of the Introduction is therefore analogous to a speaker saying: "I've told you what subject I'm going to discuss, and I've told you why that subject is important. Now I'm going to give you specific details on the subject and then my interpretation of them. Pay attention—you don't want to miss what's coming next!"

Experimental section

The Experimental section of any scientific paper is probably the easiest to write and is often the first section to be tackled by the author. It is no less important, however, than any other section, inasmuch as a basic criterion of scientific publishing is that the reader be able to duplicate an author's results using the same procedures. The Experimental section should therefore be a straightforward presentation of what materials were used in the investigation (reagents, rock, water, soil, or mineral samples), how these materials were treated (chemically, thermally, electrically), how starting materials and products were characterized (by X-ray powder diffraction, nuclear magnetic resonance, infrared spectroscopy, optical microscopy, transmission electron microscopy, or extended X-ray absorption fine-structure spectroscopy), and how the data were "massaged" and evaluated (statistically, mathematically).

The locality, source, and properties of all starting samples should be reported in as much detail as possible to allow the reader to compare the author's results with other data reported previously on the "same" material. In so far as the locality is concerned, note, for example, that "Germany" hardly suffices as a precise locality of a nontronite from Clausthal-Zellerfeld, Federal Republic of Germany. Samples obtained from reference collections, e.g., from the Source Clay Repository of The Clay Minerals Society, should be so indicated and designated with their assigned reference numbers. Standard methods used should be referenced, but need not be described in detail; however, new methods or modifications of standard methods should be described in as much detail as necessary to allow them to be used by the readers. The brand name and model of the instruments used should be stated, not as an endorsement of that product, but so that the reader can evaluate the quality of the data being reported. The precision of all measurements should be stated, and the statistical methods and computer programs used to evaluate the data should be identified and referenced.

Except as they add to the characterization of the starting materials or samples, results generally should not be reported in the Experimental section.

Results section

Despite the fact that many authors find it convenient to combine the experimental results obtained by a particular technique or on a particular suite of samples and an interpretation of these results in the same section, most readers find it extremely difficult

to follow a paper written in this manner. The reader generally wants to see the results of the investigation neatly presented in a separate section, unencumbered by discussion, interpretation, or comparison with the literature. The reader would then like to see the author's interpretations of these results in a separate section. In this way, the author's new data can be distinguished from information that is common knowledge or that has been reported by earlier workers. Although a few papers lend themselves to combining results and discussion in the same section, most do not, and, in general, interpretations and discussions should be presented in a section separate from Results.

The results themselves should be presented preferably in tables or as curves, graphs, or halftone illustrations. Details of experimental procedures should not be included in the Results section, but gathered together in the Experimental section, as noted above. Descriptions of the results should be as brief as possible and devoid of interpretation, although particular trends or ranges of the data should be pointed out. Some authors believe that because certain information was obtained in the course of their investigation, this information should be reported in their paper regardless of whether it is germane to the subject under discussion. Only those results relevant to the purpose of the paper, however, should be reported. Extraneous data, fascinating as the authors might find them, should be saved for another day and another paper.

Editors frequently encounter manuscripts that present exciting new experimental techniques, in which samples from several unrelated subject areas have been tested to demonstrate the universality of the method. Unfortunately the authors of many of these papers have tried to address major research problems on the basis of these new, but limited results in this same paper. The net result is that the major contribution, i.e., the new experimental technique, all but gets lost in the shuffle, and the authors do a woefully inadequate job with respect to the research problems. The moral of the tale is to limit a manuscript to a single subject and not try to solve all of the world's problems in a single paper. Use these preliminary data to begin a whole new investigation.

Discussion section

The Discussion is probably the most important section of the paper and should be carefully organized into specific subsections, each dealing with a different subject. In each subsection, the author should critically evaluate the data, show how they agree or contrast with published works, and interpret them for the reader. It is not sufficient for the author to point towards a table or graph and expect the readers to interpret the data themselves; the author must do the interpreting and, in so doing, must solidly base these interpretations on specific data reported in the present paper or on a combination of published information and current results.

Technical reviewers and editors have a habit of downgrading manuscripts if interpretations are not (or do not appear to be) strongly supported by data reported in the paper. All too often, authors make sweeping statements or draw broad conclusions without telling the reader specifically on which data these statements or conclusions have been based. Others merely refer the reader to "the data in Table 1" or to "the results reported above," and some only say "therefore" or "thus" as a means of specifying the data on which conclusions are based. Such tactics leave the reader wondering whether or not the author truly has evidence to support these statements or if the statements are more wishful thinking than data-based interpretations.

Authors should keep in mind that readers are not obliged to believe what they are told, but they will be more inclined to do so if they are provided with specific results and evidence every step of the way. Therefore, authors should present their specific data or information on which a conclusion will be drawn first in a sentence or paragraph in the Discussion section, and then discuss or interpret these data. Nothing is quite so annoying as being presented with what appears to be a statement of fact and then having to read on to discover the data on which the statement was based.

Many papers phrase all statements and discussion in the present tense, leaving the readers to determine for themselves whether the statements refer to the author's present findings or to facts already known. No hard and fast rules apply, but, in this editor's opinion, the author's results are best described in the past tense, reserving the present tense for information currently known or for information taken from the literature. Objects still possessing particular properties or characteristics, however, may properly be described in the present tense. For example, an author describing a rock sample might write that "The rock is red and has a granitoid texture," but that its density "was determined to be 3.00 g/cm3"; likewise, that the "bands characteristic of Al-O bonding were noted in the infrared spectrum," but that the "infrared spectrum in Figure 3 shows bands characteristic of Al-O bonding."

Conclusions (or Summary and Conclusions) section

Authors often confuse "Summary" with "Conclusions." A Summary section by definition sums up the results and interpretations of the paper, and, in some degree, may duplicate part of the Abstract. In some papers, the results of the investigation and the discussion of them are summarized in a final subsection of the Discussion; in others, a separate section is warranted, usually combined with Conclusions.

A Conclusions section is the section in which authors should discuss the importance of their findings. The conclusions should not merely repeat various points of the discussion, but should tell the reader why these points are important, something about their broad meaning, how they contribute to our understanding of the field being examined, and where more work is needed. A combined Summary and Conclusions section may be the appropriate place to summarize the findings of the investigation and to point out their overall significance.

As an author prepares the Summary and Conclusions section of the manuscript, the Introduction should be reexamined, especially the part in which the objectives of the investigation were spelled out, to see whether or not these objectives have been met. If they have not been met, the author should tell the reader why not, or should consider rewriting the Introduction to contain a different set of objectives.

Acknowledgments section

Although a necessary part of any scientific paper, the Acknowledgments section should be brief and to the point. It is only proper to recognize individuals and institutions that contributed financial support, samples, specific analyses, and technical assistance to the investigation, however, thanking everyone whom the author has ever been associated with over the last 20 years, like an Academy Award acceptance speech, is inappropriate. Unquestionably, the individuals who critiqued the manuscript before it was sent to a journal and the referees (identified and anonymous) who reviewed it for the journal should be acknowledged with appreciation. The journal editor need not be thanked, because everyone knows what a wonderful job this person does all the time.

References Cited section

Little can be said about the References Cited section, except that authors should submit their list of references cited in the exact style of the journal, down to the last jot and tittle of punctuation, spacing, etc. I am painfully aware that every journal has its own style, and wouldn't it be nice if they all used the same style, but they don't, and that's a fact of life that authors must live with. Keep in mind that editors will insist that authors follow the prescribed style of the journal, so why not do it right the first time? Most journals spell out the style to be used in their Instructions to Authors. If such instructions are not available, authors are advised to examine a recent issue of the journal in question to see how it's done.

In general, only works that have actually been published (or, perhaps, that have been formally accepted for publication by a journal) should be listed in the references. All others should be cited in the body of the text in the form of a personal (or written) communication, which includes the full name, institution, and current address of the individual from whom the information was obtained. Such information is necessary to allow the reader to communicate directly with that individual for clarification, verification, or further information. Authors should also check the final manuscript to make sure that each item in the list of references has actually been cited in the text and that each citation in the text is listed in the References Cited section.

Recapitulation

These ideas for the ideal manuscript for publication in Clays and Clay Minerals or for any other technical journal are offered to help authors write reports of their investigations that will be read, understood, and appreciated by their colleagues. No matter how great the experiment or how revolutionary the results, nothing is added to that vast accumulation of information we call science, if the author's work is not published or if it is published and still cannot be understood. Even worse, mankind reaps no benefit. My discussion has concentrated only on the main parts of a "Universal Recipe" for scientific manuscripts. In the final analysis, no two papers are exactly alike, and authors may wish to modify the universal recipe (but not too much) to fit each investigation.

The final word. Every manuscript submitted for publication should be critically reviewed by a third party who can be depended on to "tell it like it is." Authors should not submit manuscripts that represent anything less than their very best efforts, and critical reviews by colleagues for both technical content and manner of presentation are a vital part of the manuscript-

preparation process. Remember, dear author, the sole purpose of a scientific paper is to convey information in a succinct and unambiguous manner, and the data and discussion must be presented in concise, understandable statements. Anything that gets in the way of fulfilling this purpose—flowery prose, personal "style," imprecise words, tortuous sentence structure, or jargon-filled paragraphs—must be ruthlessly deleted from the manuscript by the author. Don't make the referees or the editor do this for you.

Raw, unreviewed manuscripts, best described as "rough drafts," place an excessive burden on the journal, its editor, and its technical referees. Many of the questions raised by the referees could probably have been answered beforehand by the authors if they had only asked a colleague to review their papers. Internal or external review prior to submission of the manuscript to a journal is an excellent means of catching poor organization, verbose explanations, convoluted reasoning, unwarranted interpretations, and unsupported conclusions. It also speeds up publication of that world-class paper we all strive to produce.

My Acknowledgments

I am grateful to past and present associate editors of Clays and Clay Minerals and to dozens of other scientific and editorial colleagues for their comments over the years about the need for and means of achieving good writing in scientific papers. R.A. Sheppard and Diane Schnabel of the U.S. Geological Survey, Denver, Colorado, significantly improved my "unimprovable" first draft. The following texts on technical writing focused my own thoughts on this subject and provided a base for the present note, especially Robert A. Day's How to Write and Publish a Scientific Paper.

Selected Texts on Technical Writing

Barnett, M.T. (1974) Elements of Technical Writing: Delmar Publishers, Albany, New York, 232 pp.

Bishop, E.E., Eckel, E.B., and Others (1978) Suggestions to Authors of the Reports of the United States Geological Survey: 6th ed.,U.S. Government Printing Office, Washington D.C., 273 pp.

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Dodd, Janet S., ed. (1986) The ACS Style Guide: A Manual for Authors and Editors: American Chemical Society, Washington D.C., 264 pp.

Hayes, Robert (1965) Principles of Technical Writing: Addison-Wesley, Menlo Park, California, 324 pp.

Hoover, Hardy (1980) Essentials for the Scientific and Technical Writer: Dover Publications, New York, 216 pp.

Katz, M.J. (1985) Elements of a Scientific Paper: Yale University Press, New Haven, Connecticut, 130 pp.

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10.6: The Science of Scientific Writing

"The Science of Scientific Writing" is a thoroughly detailed and important article about scientific writing from the journal *American Scientist.* You will find practical advice on how (literally) to put sentences together and walk along with the authors as they methodically generate seven practical maxims for good science writing. In the article, the authors, George D. Gopen and Judith A. Swan, develop seven maxims that will aid you as you write and revise your work. After reading this piece, some graduate students have excitedly approached me to say, "This article has entirely changed the way I think about writing and reading." As colleagues of mine have read and used this article, they have commented on the authors' thoroughness and high degree of credibility. Such credibility is no accident: Some of the material presented was developed in faculty writing workshops at the Duke University Medical School, where Professor Gopen, who holds a law degree from Harvard Law School, teaches writing. Professor Swan, with a background in biochemistry from the Massachusetts Institute of Technology, teaches writing at Princeton University.

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"The Science of Scientific Writing,"

by George D. Gopen and Judith A. Swan

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Science is often hard to read. Most people assume that its difficulties are born out of necessity, out of the extreme complexity of scientific concepts, data and analysis. We argue here that complexity of thought need not lead to impenetrability of expression; we demonstrate a number of rhetorical principles that can produce clarity in communication without oversimplifying scientific issues. The results are substantive, not merely cosmetic: Improving the quality of writing actually improves the quality of thought.

The fundamental purpose of scientific discourse is not the mere presentation of information and thought, but rather its actual communication. It does not matter how pleased an author might be to have converted all the right data into sentences and paragraphs; it matters only whether a large majority of the reading audience accurately perceives what the author had in mind. Therefore, in order to understand how best to improve writing, we would do well to understand better how readers go about reading. Such an understanding has recently become available through work done in the fields of rhetoric, linguistics and cognitive psychology. It has helped to produce a methodology based on the concept of reader expectations.

Writing with the Reader in Mind: Expectation and Context

Readers do not simply read; they interpret. Any piece of prose, no matter how short, may "mean" in 10 (or more) different ways to 10 different readers. This methodology of reader expectations is founded on the recognition that readers make many of their most important interpretive decisions about the substance of prose based on clues they receive from its structure.

This interplay between substance and structure can be demonstrated by something as basic as a simple table. Let us say that in tracking the temperature of a liquid over a period of time, an investigator takes measurements every three minutes and records a list of temperatures. Those data could be presented by a number of written structures. Here are two possibilities:

t (time)=15', T (temperature)=32°; t=0', T=25°;
t=6', T=29°; t=3', T=27°; t=12', T=32°; t=9', T=31°

Temperature over time

time (min)	*temperature (^oC)*
0	*25*
3	*27*
6	*29*
9	*31*
12	*32*
15	*32*

Precisely the same information appears in both formats, yet most readers find the second easier to interpret. It may be that the very familiarity of the tabular structure makes it easier to use. But, more significantly, the structure of the second table provides the reader with an easily perceived context (time) in which the significant piece of information appears on the left in a pattern that produces an expectation of regularity; the interesting results appear on the right in a less obvious pattern, the discovery of which is the point of the table.

If the two sides of this table are reversed, it becomes much harder to read.

Temperature over time, but with the sides reversed

temperature (^oC)	*time (min)*
25	*0*
27	*3*
29	*6*
31	*9*
32	*12*
32	*15*

Since we read from left to right, we prefer the context on the left, where we can more effectively familiarize the reader. We prefer the new, important information on the right, since its job is to intrigue the reader.

Information is interpreted more easily and more uniformly if it is placed where most readers expect to find it. These needs and expectations of readers affect the interpretation not only of the tables and illustrations but also of prose itself. Readers have relatively fixed expectations about where in the structure of the prose they will encounter particular items of its substance. If writers can become consciously aware of these locations, they can better control the degrees of recognition and emphasis a reader will give to the various pieces of information being presented. Good writers are intuitively aware of these expectations; that is why their prose has what we call "shape."

This underlying concept of reader expectation is perhaps most immediately evident at the level of the largest units of discourse. (A unit of discourse is defined as anything with a beginning and an end: a clause, a sentence, a section, an article, etc.) A research article, for example, is generally divided into recognizable sections, sometimes labeled Introduction, Experimental Methods, Results and Discussion. When the sections are confused—when too much experimental detail is found in the Results section, or when discussion and results intermingle—readers are often equally confused. In smaller units of discourse the functional divisions are not so explicitly labeled, but readers have definite expectations all the same, and they search for certain information in particular places. If these structural expectations are continually violated, readers are forced to divert energy from understanding the content of a passage to unraveling its structure. As the complexity of the content increases moderately, the possibility of misinterpretation or noninterpretation increases dramatically.

We present here some results for applying this methodology to research reports in the scientific literature. We have taken several passages from research articles (either published or accepted for publication) and have suggested ways of rewriting them by applying principles derived from the study of reader expectations. We have not sought to transform passages into "plain English" for the use of the general public; we have neither decreased the jargon nor diluted the science. We have striven not for simplification but for clarification.

Reader Expectations for the Structure of Prose

Here is our first example of scientific prose, in its original form:

*The smallest of the URF's (URFA6L), a 207-nucleotide (nt) reading frame overlapping out of phase the NH_2-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene has been identified as the animal equivalent of the recently discovered yeast H^+-ATPase subunit 8 gene. The functional significance of the other URF's has been, on the contrary, elusive. Recently, however, immunoprecipitation experiments with antibodies to purified, rotenone-sensitive NADH-ubiquinone oxido-reductase [hereafter referred to as respiratory chain NADH dehydrogenase or Complex I] from bovine heart, as well as enzyme fractionation studies, have indicated that six human URF's (that is, URF1, URF2, URF3, URF4, URF4L, and URF5, hereafter referred to as ND1, ND2, ND3, ND4, ND4L, and ND5) encode subunits of Complex I. This is a large complex that also contains many subunits synthesized in the cytoplasm. **

(* The full paragraph includes one more sentence: "Support for such functional identification of the URF products has come from the finding that the purified rotenone-sensitive NADH dehydrogenase from Neurospora crassa contains several subunits synthesized within the mitochondria, and from the observation that the stopper mutant of Neurospora crassa, whose mtDNA lacks two genes homologous to URF2 and URF3, has no functional Complex I." We have omitted this sentence both because the passage is long enough and because it raises no additional structural issues.)*

Ask any ten people why this paragraph is hard to read, and nine are sure to mention the technical vocabulary; several will also suggest that it requires specialized background knowledge. These problems turn out to be only a small part of the difficulty. Here is the passage again, with the difficult words temporarily lifted:

The smallest of the URF's (URFA6L), an [A] has been identified as a [B] subunit 8 gene. The functional significance of the other URF's has been, on the contrary, elusive. Recently, however, [C] experiments, as well as [D] studies, have indicated that six human URF's (1-6) encode subunits of Complex I. This is a large complex that also contains many subunits synthesized in the cytoplasm.

It may now be easier to survive the journey through the prose, but the passage is still difficult. Any number of questions present themselves: What has the first sentence of the passage to do with the last sentence? Does the third sentence contradict what we have been told in the second sentence? Is the functional significance of URF's still "elusive"? Will this passage lead us to further discussion about URF's, or about Complex I, or both?

Knowing a little about the subject matter does not clear up all the confusion. The intended audience of this passage would probably possess at least two items of essential technical information: first, "URF" stands for "Uninterrupted Reading Frame," which describes a segment of DNA organized in such a way that it could encode a protein; second, both ATPase and NADH oxido-reductase are enzyme complexes central to energy metabolism. Although this information may provide some sense of comfort, it does little to answer the interpretive questions that need answering. It seems the reader is hindered by more than just the scientific jargon.

To get at the problem, we need to articulate something about how readers go about reading. We proceed to the first of several reader expectations.

Subject-Verb Separation

Look again at the first sentence of the passage cited above. It is relatively long, 42 words; but that turns out not to be the main cause of its burdensome complexity. Long sentences need not be difficult to read; they are only difficult to write. We have seen sentences of over 100 words that flow easily and persuasively toward their clearly demarcated destination. Those well-wrought serpents all had something in common: Their structure presented information to readers in the order the readers needed and expected it.

The first sentence of our example passage does just the opposite: it burdens and obstructs the reader, because of an all-too-common structural defect. Note that the grammatical subject ("the smallest") is separated from its verb ("has been identified") by 23 words, more than half the sentence. Readers expect a grammatical subject to be followed immediately by the verb. Anything of length that intervenes between subject and verb is read as an interruption, and therefore as something of lesser importance.

The reader's expectation stems from a pressing need for syntactic resolution, fulfilled only by the arrival of the verb. Without the verb, we do not know what the subject is doing, or what the sentence is all about. As a result, the reader focuses attention on the arrival of the verb and resists recognizing anything in the interrupting material as being of primary importance. The longer the interruption lasts, the more likely it becomes that the "interruptive" material actually contains important information; but its structural location will continue to brand it as merely interruptive. Unfortunately, the reader will not discover its true value until too late—until the sentence has ended without having produced anything of much value outside of the subject-verb interruption.

In the first sentence of the paragraph, the relative importance of the intervening material is difficult to evaluate. The material might conceivably be quite significant, in which case the writer should have positioned it to reveal that importance. Here is one way to incorporate it into the sentence structure:

The smallest of the URF's is URFA6L, a 207-nucleotide (nt) reading frame overlapping out of phase the NH_2-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene; it has been identified as the animal equivalent of the recently discovered yeast H^+-ATPase subunit 8 gene.

On the other hand, the intervening material might be a mere aside that diverts attention from more important ideas; in that case the writer should have deleted it, allowing the prose to drive more directly toward its significant point:

The smallest of the URF's (URFA6L) has been identified as the animal equivalent of the recently discovered yeast H^+-ATPase subunit 8 gene.

Only the author could tell us which of these revisions more accurately reflects his intentions.

These revisions lead us to a second set of reader expectations. Each unit of discourse, no matter what the size, is expected to serve a single function, to make a single point. In the case of a sentence, the point is expected to appear in a specific place reserved for emphasis.

The Stress Position

It is a linguistic commonplace that readers naturally emphasize the material that arrives at the end of a sentence. We refer to that location as a "stress position." If a writer is consciously aware of this tendency, she can arrange for the emphatic information to appear at the moment the reader is naturally exerting the greatest reading emphasis. As a result, the chances greatly increase that reader and writer will perceive the same material as being worthy of primary emphasis. The very structure of the sentence thus helps persuade the reader of the relative values of the sentence's contents.

The inclination to direct more energy to that which arrives last in a sentence seems to correspond to the way we work at tasks through time. We tend to take something like a "mental breath" as we begin to read each new sentence, thereby summoning the tension with which we pay attention to the unfolding of the syntax. As we recognize that the sentence is drawing toward its conclusion, we begin to exhale that mental breath. The exhalation produces a sense of emphasis. Moreover, we delight in being rewarded at the end of a labor with something that makes the ongoing effort worthwhile. Beginning with the exciting material and ending with a lack of luster often leaves us disappointed and destroys our sense of momentum. We do not start with a strawberry shortcake and work our way up to the broccoli.

When the writer puts the emphatic material of a sentence in any place other than the stress position, one of two things can happen; both are bad. First, the reader might find the stress position occupied by material that clearly is not worthy of emphasis. In this case, the reader must discern, without any additional structural clue, what else in the sentence may be the most likely candidate for emphasis. There are no secondary structural indications to fall back upon. In sentences that are long, dense or sophisticated, chances soar that the reader will not interpret the prose precisely as the reader intended. The second possibility is even worse: The reader may find the stress position occupied by something that does not appear capable of

receiving emphasis, even though the writer did not intend to give it any stress. In that case, the reader is likely to emphasize this imposter material, and the writer will have lost an important opportunity to influence the reader's interpretive process.

The stress position can change in size from sentence to sentence. Sometimes it consists of a single word; sometimes it extends to several lines. The definitive factor is this: The stress position coincides with the moment of syntactic closure. A reader has reached the beginning of the stress position when she knows there is nothing left in the clause or sentence but the material presently being read. Thus a whole list, numbered and indented, can occupy the stress position of a sentence if it has been clearly announced as being all that remains of that sentence. Each member of that list, in turn, may have its own internal stress position, since each member may produce its own syntactic closure.

Within a sentence, secondary stress positions can be formed by the appearance of a properly used colon or semicolon; by grammatical convention, the material preceding these punctuation marks must be able to stand by itself as a complete sentence. Thus, sentences can be extended effortlessly to dozens of words, as long as there is a medial syntactic closure for every piece of new, stress-worthy information along the way. One of our revisions of the initial sentence can serve as an example:

The smallest of the URF's is URFA6L, a 207-nucleotide (nt) reading frame overlapping out of phase the NH_2-terminal portion of the adenosinetriphosphatase (ATPase) subunit 6 gene; it has been identified as the animal equivalent of the recently discovered yeast H^+-ATPase subunit 8 gene.

By using a semicolon, we created a second stress position to accommodate a second piece of information that seemed to require emphasis.

We now have three rhetorical principles based on reader expectations: First, grammatical subjects should be followed as soon as possible by their verbs; second, every unit of discourse, no matter the size, should serve a single function or make a single point; and, third, information intended to be emphasized should appear at points of syntactic closure. Using these principles, we can begin to unravel the problems of our example prose.

Note the subject-verb separation in the 62-word third sentence of the original passage:

Recently, however, immunoprecipitation experiments with antibodies to purified, rotenone-sensitive NADH-ubiquinone oxido-reductase [hereafter referred to as respiratory chain NADH dehydrogenase or Complex I] from bovine heart, as well as enzyme fractionation studies, have indicated that six human URF's (that is, URF1, URF2, URF3, URF4, URF4L, and URF5, hereafter referred to as ND1, ND2, ND3, ND4, ND4L, and ND5) encode subunits of Complex I. This is a large complex that also contains many subunits synthesized in the cytoplasm.

After encountering the subject ("experiments"), the reader must wade through 27 words (including three hyphenated compound words, a parenthetical interruption and an "as well as" phrase) before alighting on the highly uninformative and disappointingly anticlimactic verb ("have indicated"). Without a moment to recover, the reader is handed a "that" clause in which the new subject ("six human URF's) is separated from its verb ("encode") by yet another 20 words.

If we applied the three principles we have developed to the rest of the sentences of the example, we could generate a great many revised versions of each. These revisions might differ significantly from one another in the way their structures indicate to the reader the various weights and balances to be given to the information. Had the author placed all stress-worthy material in stress positions, we as a reading community would have been far more likely to interpret these sentences uniformly.

We couch this discussion in terms of "likelihood" because we believe that meaning is not inherent in discourse by itself; "meaning" requires the combined participation of text and reader. All sentences are infinitely interpretable, given an infinite number of interpreters. As communities of readers, however, we tend to work out tacit agreements as to what kinds of meaning are most likely to be extracted from certain articulations. We cannot succeed in making even a single sentence mean one and only one thing; we can only increase the odds that a large majority of readers will tend to interpret our discourse according to our intentions. Such success will follow from authors becoming more consciously aware of the various reader expectations presented here.

Here is one set of revisionary decisions we made for the example:

The smallest of the URF's, URFA6L, has been identified as the animal equivalent of the recently discovered yeast H^+-ATPase subunit 8 gene; but the functional significance of other URF's has been more elusive. Recently, however, several human URF's

have been shown to encode subunits of rotenone-sensitive NADH-ubiquinone oxido-reductase. This is a large complex that also contains many subunits synthesized in the cytoplasm; it will be referred to hereafter as respiratory chain NADH dehydrogenase or Complex I. Six subunits of Complex I were shown by enzyme fractionation studies and immunoprecipitation experiments to be encoded by six human URF's (URF1, URF2, URF3, URF4, URF4L, and URF5); these URF's will be referred to subsequently as ND1, ND2, ND3, ND4, ND4L, and ND5.

Sheer length was neither the problem nor the solution. The revised version is not noticeably shorter than the original; nevertheless, it is significantly easier to interpret. We have indeed deleted certain words, but not on the basis of wordiness or excess length. (See especially the last sentence of our revision).

When is a sentence too long? The creators of readability formulas would have us believe there exists some fixed number of words (the favorite is 29) past which a sentence is too hard to read. We disagree. We have seen 10-word sentences that are virtually impenetrable and, as mentioned above, 100-word sentences that flow effortlessly to their points of resolution. In place of the word-limit concept, we offer the following definition: A sentence is too long when it has more viable candidates for stress positions than there are stress positions available. Without the stress position's locational clue that its material is intended to be emphasized, readers are left too much to their own devices in deciding just what else in a sentence might be considered important.

In revising the example passage, we made certain decisions about what to omit and what to emphasize. We put subjects and verbs together to lessen the reader's syntactic burdens; we put the material we believed worthy of emphasis in stress positions; and we discarded material for which we could not discern significant connections. In doing so, we have produced a clearer passage—but not one that necessarily reflects the author's intentions; it reflects only our interpretation of the author's intentions. The more problematic the structure, the less likely it becomes that a grand majority of readers will perceive the discourse in exactly the way the author intended.

It is probable that many of our readers—and perhaps even the authors—will disagree with some of our choices. If so, that disagreement underscores our point: The original failed to communicate its ideas and their connections clearly. If we happened to have interpreted the passage as you did, then we can make a different point: No one should have to work as hard as we did to unearth the content of a single passage of this length.

The Topic Position

To summarize the principles connected with the stress position, we have the proverbial wisdom, "Save the best for last." To summarize the principles connected with the other end of the sentence, which we will call the topic position, we have its proverbial contradiction, "First things first." In the stress position the reader needs and expects closure and fulfillment; in the topic position the reader needs and expects perspective and context. With so much of reading comprehension affected by what shows up in the topic position, it behooves a writer to control what appears at the beginning of sentences with great care.

The information that begins a sentence establishes for the reader a perspective for viewing the sentence as a unit: Readers expect a unit of discourse to be a story about whoever shows up first. "Bees disperse pollen" and "Pollen is dispersed by bees" are two different but equally respectable sentences about the same facts. The first tells us something about bees; the second tells us something about pollen. The passivity of the second sentence does not by itself impair its quality; in fact, "Pollen is dispersed by bees" is the superior sentence if it appears in a paragraph that intends to tell us a continuing story about pollen. Pollen's story at that moment is a passive one.

Readers also expect the material occupying the topic position to provide them with linkage (looking backward) and context (looking forward). The information in the topic position prepares the reader for upcoming material by connecting it backward to the previous discussion. Although linkage and context can derive from several sources, they stem primarily from material that the reader has already encountered within this particular piece of discourse. We refer to this familiar, previously introduced material as "old information." Conversely, material making its first appearance in a discourse is "new information." When new information is important enough to receive emphasis, it functions best in the stress position.

When old information consistently arrives in the topic position, it helps readers to construct the logical flow of the argument: It focuses attention on one particular strand of the discussion, both harkening backward and leaning forward. In contrast, if the topic position is constantly occupied by material that fails to establish linkage and context, readers will have difficulty

perceiving both the connection to the previous sentence and the projected role of the new sentence in the development of the paragraph as a whole.

Here is a second example of scientific prose that we shall attempt to improve in subsequent discussion:

Large earthquakes along a given fault segment do not occur at random intervals because it takes time to accumulate the strain energy for the rupture. The rates at which tectonic plates move and accumulate strain at their boundaries are approximately uniform. Therefore, in first approximation, one may expect that large ruptures of the same fault segment will occur at approximately constant time intervals. If subsequent mainshocks have different amounts of slip across the fault, then the recurrence time may vary, and the basic idea of periodic mainshocks must be modified. For great plate boundary ruptures the length and slip often vary by a factor of 2. Along the southern segment of the San Andreas fault the recurrence interval is 145 years with variations of several decades. The smaller the standard deviation of the average recurrence interval, the more specific could be the long term prediction of a future mainshock.

This is the kind of passage that in subtle ways can make readers feel badly about themselves. The individual sentences give the impression of being intelligently fashioned: They are not especially long or convoluted; their vocabulary is appropriately professional but not beyond the ken of educated general readers; and they are free of grammatical and dictional errors. On first reading, however, many of us arrive at the paragraph's end without a clear sense of where we have been or where we are going. When that happens, we tend to berate ourselves for not having paid close enough attention. In reality, the fault lies not with us, but with the author.

We can distill the problem by looking closely at the information in each sentence's topic position:

Large earthquakes
The rates
Therefore . . . one
subsequent mainshocks
great plate boundary ruptures
the southern segment of the San Andreas fault
the smaller the standard deviation . . .

Much of this information is making its first appearance in this paragraph—in precisely the spot where the reader looks for old, familiar information. As a result, the focus of the story contains shifts. Given just the material in the topic positions, no two readers would be likely to construct exactly the same story for the paragraph as a whole.

If we try to piece together the relationship of each sentence to its neighbors, we notice that certain bits of old information keep reappearing. We hear a good deal about the recurrence time between earthquakes: The first sentence introduces the concept of nonrandom intervals between earthquakes; the second sentence tells us that recurrence rates due to the movement of tectonic plates are more or less uniform; the third sentence adds that the recurrence rate of major earthquakes should also be somewhat predictable; the fourth sentence adds that recurrence rates vary with some conditions; the fifth sentence adds information about one particular variation; the sixth sentence adds a recurrence-rate example from California; and the last sentence tells us something about how recurrence rates can be described statistically. This refrain of "recurrence intervals" constitutes the major string of old information in the paragraph. Unfortunately, it rarely appears at the beginning of sentences, where it would help us maintain our focus on its continuing story.

In reading, as in most experiences, we appreciate the opportunity to become familiar with a new environment before having to function in it. Writing that continually begins sentences with new information and ends with old information forbids both the sense of comfort and orientation at the start and the sense of fulfilling arrival at the end. It misleads the reader as to whose story is being told; it burdens the reader with new information that must be carried further into the sentence before it can be connected to the discussion; and it creates ambiguity as to which material the writer intended the reader to emphasize. All of these distractions require that readers expend a disproportionate amount of energy to unravel the structure of the prose, leaving less energy available for perceiving content.

We can begin to revise the example by ensuring the following for each sentence:

1. The backward-linking old information appears in the topic position.

2. The person, thing or concept whose story it is appears in the topic position.

3. The new, emphasis-worthy information appears in the stress position.

Once again, if our decisions concerning the relative values of specific information differ from yours, we can all blame the author, who failed to make his intentions apparent. Here first is a list of what we perceived to be the new, emphatic material in each sentence.

time to accumulate strain energy along a fault
approximately uniform
large ruptures of the same fault
different amounts of slip
vary by a factor of 2
variations of several decades
predictions of future mainshock

Now, based on these assumptions about what deserves stress, here is our proposed revision:

Large earthquakes along a given fault segment do not occur at random intervals because it takes time to accumulate the strain energy for the rupture. The rates at which tectonic plates move and accumulate strain at their boundaries are roughly uniform. Therefore, nearly constant time intervals (at first approximation) would be expected between large ruptures of the same fault segment. [However?], the recurrence time may vary; the basic idea of periodic mainshocks may need to be modified if subsequent mainshocks have different amounts of slip across the fault. [Indeed?], the length and slip of great plate boundary ruptures often vary by a factor of 2. [For example?], the recurrence interval along the southern segment of the San Andreas fault is 145 years with variations of several decades. The smaller the standard deviation of the average recurrence interval, the more specific could be the long term prediction of a future mainshock.

Many problems that had existed in the original have now surfaced for the first time. Is the reason earthquakes do not occur at random intervals stated in the first sentence or the second? Are the suggested choices of "however," "indeed," and "for example" the right ones to express the connections at those points? (All these connections were left unarticulated in the original paragraph.) If "for example" is an inaccurate transitional phrase, then exactly how does the San Andreas fault example connect to ruptures that "vary by a factor of 2? Is the author arguing that recurrence rates must vary because fault movements often vary? Or is the author preparing us for a discussion of how in spite of such variance we might still be able to predict earthquakes? This last question remains unanswered because the final sentence leaves behind earthquakes that recur regularly. Given that this is the first paragraph of the article, which type of earthquake will the article most likely proceed to discuss? In sum, we are now more aware of how much the paragraph had not communicated to us on first reading. We can see that most of our difficulty was owing not to any deficiency in our reading skills but rather to the author's lack of comprehension of our structural needs as readers.

In our experience, the misplacement of old and new information turns out to be the No. 1 problem in American professional writing today. The source of the problem is not hard to discover: Most writers produce prose linearly (from left to right) and through time. As they begin to formulate a sentence, often their primary anxiety is to capture the important new thought before it escapes. Quite naturally they rush to record that new information on paper, after which they can produce at their leisure the contextualizing material that links back to the previous discourse. Writers who do this consistently are attending more to their own need for unburdening themselves of their information than to the reader's need for receiving the material. The methodology of reader expectations articulates the reader's needs explicitly, thereby making writers consciously aware of structural problems and ways to solve them.

A note of clarification: Many people hearing this structural advice tend to oversimplify it to the following rule: "Put the old information in the topic position and the new information in the stress position." No such rule is possible. Since by definition all information is either old or new, the space between the topic position and the stress position must also be filled with old and new information. Therefore the principle (not rule) should be stated as follows: "Put in the topic position the old information that links backward; put in the stress position the new information you want the reader to emphasize."

Perceiving Logical Gaps

When old information does not appear at all in a sentence, whether in the topic position or elsewhere, readers are left to construct the logical linkage by themselves. Often this happens when the connections are so clear in the writer's mind that they seem unnecessary to state; at those moments, writers underestimate the difficulties and ambiguities inherent in the reading process. Our third example attempts to demonstrate how paying attention to the placement of old and new information can reveal where a writer has neglected to articulate essential connections.

The enthalpy of hydrogen bond formation between the nucleoside bases 2'deoxyguanosine (dG) and 2'deoxycytidine (dC) has been determined by direct measurement. dG and dC were derivatized at the 5' and 3' hydroxyls with triisopropylsilyl groups to obtain solubility of the nucleosides in non-aqueous solvents and to prevent the ribose hydroxyls from forming hydrogen bonds. From isoperibolic titration measurements, the enthalpy of dC:dG base pair formation is -6.65±0.32 kcal/mol.

Although part of the difficulty of reading this passage may stem from its abundance of specialized technical terms, a great deal more of the difficulty can be attributed to its structural problems. These problems and now familiar: We are not sure at all times whose story is being told; in the first sentence the subject and verb are widely separated; the second sentence has only one stress position but two or three pieces of information that are probably worthy of emphasis—"solubility . . . solvents," "prevent . . . from forming hydrogen bonds" and perhaps "triisopropylsilyl groups." These perceptions suggest the following revision tactics:

1. Invert the first sentence, so that (a) the subject-verb complement connection is unbroken, and (b) "dG" and "dC" are introduced in the stress position as new and interesting information. (Note that inverting the sentence requires stating who made the measurement; since the authors performed the first direct measurement, recognizing their agency in the topic position may well be appropriate.)

2. Since "dG" and "dC" become the old information in the second sentence, keep them up front in the topic position.

3. Since "triisopropylsilyl groups" is new and important information here, create for it a stress position.

4. "Triisopropylsilyl groups" then becomes the old information of the clause in which its effects are described; place it in the topic position of this clause.

5. Alert the reader to expect the arrival of two distinct effects by using the flag word "both." "Both" notifies the reader that two pieces of new information will arrive in a single stress position.

Here is a partial revision based on these decisions:

We have directly measured the enthalpy of hydrogen bond formation between the nucleoside bases 2'deoxyguanosine (dG) and 2'deoxycytidine (dC). dG and dC were derivatized at the 5' and 3' hydroxyls with triisopropylsilyl groups; these groups serve both to solubilize the nucleosides in non-aqueous solvents and to prevent the ribose hydroxyls from forming hydrogen bonds. From isoperibolic titration measurements, the enthalpy of dC:dG base pair formation is -6.65±0.32 kcal/mol.

The outlines of the experiment are now becoming visible, but there is still a major logical gap. After reading the second sentence, we expect to hear more about the two effects that were important enough to merit placement in its stress position. Our expectations are frustrated, however, when those effects are not mentioned in the next sentence: "From isoperibolic titration measurements, the enthalpy of dC:dG base pair formation is -6.65±0.32 kcal/mol." The authors have neglected to explain the relationship between the derivatization they performed (in the second sentence) and the measurements they made (in the third sentence). Ironically, that is the point they most wished to make here.

At this juncture, particularly astute readers who are chemists might draw upon their specialized knowledge, silently supplying the missing connection. Other readers are left in the dark. Here is one version of what we think the authors meant to say, with two additional sentences supplied from a knowledge on nucleic acid chemistry:

We have directly measured the enthalpy of hydrogen bond formation between the nucleoside bases 2'deoxyguanosine (dG) and 2'deoxycytidine (dC). dG and dC were derivatized at the 5' and 3' hydroxyls with triisopropylsilyl groups; these groups serve both to solubilize the nucleosides in non-aqueous solvents and to prevent the ribose hydroxyls from forming hydrogen bonds. Consequently, when the derivatized nucleosides are dissolved in non-aqueous solvents, hydrogen bonds form almost exclusively between the bases. Since the interbase hydrogen bonds are the only bonds to form upon mixing, their enthalpy of formation can

be determined directly by measuring the enthalpy of mixing. From our isoperibolic titration measurements, the enthalpy of dC:dG base pair formation is -6.65±0.32 kcal/mol.

Each sentence now proceeds logically from its predecessor. We never have to wander too far into a sentence without being told where we are and what former strands of discourse are being continued. And the "measurements" of the last sentence has now become old information, reaching back to the "measured directly" of the preceding sentence. (It also fulfills the promise of the "we have directly measured" with which the paragraph began.) By following our knowledge of reader expectations, we have been able to spot discontinuities, to suggest strategies for bridging gaps, and to rearrange the structure of the prose, thereby increasing the accessibility of the scientific content.

Locating the Action

Our final example adds another major reader expectation to the list.

Transcription of the 5S RNA genes in the egg extract is TFIIIA-dependent. This is surprising, because the concentration of TFIIIA is the same as in the oocyte nuclear extract. The other transcription factors and RNA polymerase III are presumed to be in excess over available TFIIIA, because tRNA genes are transcribed in the egg extract. The addition of egg extract to the oocyte nuclear extract has two effects on transcription efficiency. First, there is a general inhibition of transcription that can be alleviated in part by supplementation with high concentrations of RNA polymerase III. Second, egg extract destabilizes transcription complexes formed with oocyte but not somatic 5S RNA genes.

The barriers to comprehension in this passage are so many that it may appear difficult to know where to start revising. Fortunately, it does not matter where we start, since attending to any one structural problem eventually leads us to all the others.

We can spot one source of difficulty by looking at the topic positions of the sentences: We cannot tell whose story the passage is. The story's focus (that is, the occupant of the topic position) changes in every sentence. If we search for repeated old information in hope of settling on a good candidate for several of the topic positions, we find all too much of it: egg extract, TFIIIA, oocyte extract, RNA polymerase III, 5S RNA, and transcription. All of these reappear at various points, but none announces itself clearly as out primary focus. It appears that the passage is trying to tell several stories simultaneously, allowing none to dominate.

We are unable to decide among these stories because the author has not told us what to do with all this information. We know who the players are, but we are ignorant of the actions they are presumed to perform. This violates yet another important reader expectation: Readers expect the action of a sentence to be articulated by the verb.

Here is a list of the verbs in the example paragraph:

is
is . . . is
are presumed to be
are transcribed
has
is . . . can be alleviated
destabilizes

The list gives too few clues as to what actions actually take place in the passage. If the actions are not to be found in the verbs, then we as readers have no secondary structural clues for where to locate them. Each of us has to make a personal interpretive guess; the writer no longer controls the reader's interpretive act.

Worse still, in this passage the important actions never appear. Based on our best understanding of this material, the verbs that connect these players are "limit" and inhibit." If we express those actions as verbs and place the most frequently occurring information—"egg extract" and "TFIIIA"—in the topic position whenever possible, we can generate the following revision.*

In the egg extract, the availability of TFIIIA limits transcription of the 5S RNA genes. This is surprising because the same concentration of TFIIIA does not limit transcription in the oocyte nuclear extract. In the egg extract, transcription is not limited by RNA polymerase or other factors because transcription of tRNA genes indicates that these factors are in excess over

available TFIIIA. When added to the nuclear extract, the egg extract affected the efficiency of transcription in two ways. First, it inhibited transcription generally; this inhibition could be alleviated in part by supplementing the mixture with high concentrations of RNA polymerase III. Second, the egg extract destabilized transcription complexes formed by oocyte but not by somatic 5S genes.

As a story about "egg extract," this passage still leaves something to be desired. But at least now we can recognize that the author has not explained the connection between "limit" and "inhibit." This unarticulated connection seems to us to contain both of her hypotheses: First, that the limitation on transcription is caused by an inhibitor of TFIIIA present in the egg extract; and, second, that the action of that inhibitor can be detected by adding the egg extract to the oocyte extract and examining the effects on transcription. As critical scientific readers, we would like to concentrate our energy on whether the experiments prove the hypotheses. We cannot begin to do so if we are left in doubt as to what those hypotheses might be—and if we are using most of our energy to discern the structure of the prose rather than its substance.

Writing and the Scientific Process

We began this article by arguing that complex thoughts expressed in impenetrable prose can be rendered accessible and clear without minimizing any of their complexity. Our examples of scientific writing have ranged from the merely cloudy to the virtually opaque; yet all of them could be made significantly more comprehensible by observing the following structural principles:

1. Follow a grammatical subject as soon as possible with its verb.

2. Place in the stress position the "new information" you want the reader to emphasize.

3. Place the person or thing whose "story" a sentence is telling at the beginning of the sentence, in the topic position.

4. Place appropriate "old information" (material already stated in the discourse) in the topic position for linkage backward and contextualization forward.

5. Articulate the action of every clause or sentence in its verb.

6. In general, provide context for your reader before asking that reader to consider anything new.

7. In general, try to ensure that the relative emphases of the substance coincide with the relative expectations for emphasis raised by the structure.

None of these reader-expectation principles should be considered "rules." Slavish adherence to them will succeed no better than has slavish adherence to avoiding split infinitives or to using the active voice instead of the passive. There can be no fixed algorithm for good writing, for two reasons. First, too many reader expectations are functioning at any given moment for structural decisions to remain clear and easily activated. Second, any reader expectation can be violated to good effect. Our best stylists turn out to be our most skillful violators; but in order to carry this off, they must fulfill expectations most of the time, causing the violations to be perceived as exceptional moments, worthy of note.

writer's personal style is the sum of all the structural choices that person tends to make when facing the challenges of creating discourse. Writers who fail to put new information in the stress position of many sentences in one document are likely to repeat that unhelpful structural pattern in all other documents. But for the very reason that writers tend to be consistent in making such choices, they can learn to improve their writing style; they can permanently reverse those habitual structural decisions that mislead or burden readers.

We have argued that the substance of thought and the expression of thought are so inextricably intertwined that changes in either will affect the quality of the other. Note that only the first of our examples (the paragraph about URF's) could be revised on the basis of the methodology to reveal a nearly finished passage. In all the other examples, revision revealed existing conceptual gaps and other problems that had been submerged in the originals by dysfunctional structures. Filling the gaps required the addition of extra material. In revising each of these examples, we arrived at a point where we could proceed no further without either supplying connections between ideas or eliminating some existing material altogether. (Writers who use reader-expectation principles on their own prose will not have to conjecture or infer; they know what the prose is intended to convey.) Having begun by analyzing the structure of the prose, we were led eventually to reinvestigate the substance of the science.

The substance of science comprises more than the discovery and recording of data; it extends crucially to include the act of interpretation. It may seem obvious that a scientific document is incomplete without the interpretation of the writer; it may not be so obvious that the document cannot "exist" without the interpretation of each reader. In other words, writers cannot "merely" record data, even if they try. In any recording or articulation, no matter how haphazard or confused, each word resides in one or more distinct structural locations. The resulting structure, even more than the meanings of individual words, significantly influences the reader during the act of interpretation. The question then becomes whether the structure created by the writer (intentionally or not) helps or hinders the reader in the process of interpreting the scientific writing.

The writing principles we have suggested here make conscious for the writer some of the interpretive clues readers derive from structures. Armed with this awareness, the writer can achieve far greater control (although never complete control) of the reader's interpretive process. As a concomitant function, the principles simultaneously offer the writer a fresh re-entry to the thought process that produced the science. In real and important ways, the structure of the prose becomes the structure of the scientific argument. Improving either one will improve the other.

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