

Writing Better Reports

A Handbook for Civil & Environmental Engineers



David Adams
Department of Civil & Environmental Engineering
Michigan State University
August, 2001

© Copyright 2001 by the Department of Civil & Environmental Engineering,
Michigan State University.

We think that the ideas presented here reflect a broad consensus about what constitutes good technical writing. Please feel free to copy and use this handbook as long as you attribute its source.

Table of Contents

1.0 OVERVIEW	4
2.0 GUIDELINES FOR CLEAR TECHNICAL STYLE.....	6
2.1—USE STRONG VERBS	6
OVERVIEW	6
MINIMIZE PASSIVE VOICE CONSTRUCTIONS.....	6
REDUCE USAGE OF “IS” VERBS.....	8
2.2—ELIMINATE UNNECESSARY WORDS	10
OVERVIEW	10
TRIM INFLATED PHRASES	10
2.3—KEEP RELATED WORDS TOGETHER	12
OVERVIEW	12
AVOID MISPLACED MODIFIERS	12
KEEP SUBJECTS AND VERBS TOGETHER	12
GIVE PRONOUNS CLEAR ANTECEDENTS	13
CHOOSE YOUR WORDS CAREFULLY	13
2.3—PARALLEL CONSTRUCTIONS IN TECHNICAL REPORTS.....	15
2.4—USE LISTS TO CLARIFY INFORMATION	18
OVERVIEW	18
2.5—USE FORECAST AND ECHO STATEMENTS	20
2.6—EDIT AND REVISE SYSTEMATICALLY	21
3.0 USING APPROPRIATE FORMAT FOR LETTERS & MEMOS	22
OVERVIEW	22
USE AN APPROPRIATE FORMAT—LETTERS & MEMOS.	22
OBSERVE THE 15-SECOND RULE.....	25
CONNECT WITH THE READER.....	25
4.0—ORGANIZING YOUR REPORTS	26
5.0 DESIGNING YOUR REPORTS.....	28
6.0 USING A WRITING PLANNING SHEET.....	30
APPENDIX: ADVICE TABLE ON TECHNICAL MEMOS	33

I.0 Overview

"We don't actually manufacture anything. Most of the time, the tangible products of this department [engineering] are reports."

—a project engineer at a major electronics firm.

If you end up working the way most engineers do, writing and other communications tasks will be a regular and important facet of your daily life. Most surveys suggest that you will spend on average between 60-70% of your time communicating with others. In response to concerns by alumni and employers, we have made writing an important part of your training as engineers. We hope *Writing Better Reports* will help you with that task.

This guide has two goals:

- 1) To help you develop a clear technical writing style;
- 2) To acquaint you with some conventional approaches to certain communication tasks of engineers.

That emphasis sets technical writing apart from other types of writing.

A poet, for example, may write a poem that a reader can't understand. The language and content of the poem may be too foreign to that reader's experience. Yet it may still be a wonderful poem. But if an engineer pens a report that a manager can't understand, that report cannot be wonderful. In technical writing, readers *must be able to use* a report. Making sure they can is the writer's task.

This guide begins by summarizing the opinions of faculty who teach in this department, their opinions on student writing. Those opinions translate into guidelines, which you should be able to use to improve your reports. You will also read about the format of memos and letters, as well as the importance of *planning* and *revision*.

Faculty express strong opinions about what they dislike in student reports. In the autumn of 1999, faculty in the Department of Civil & Environmental Engineering at MSU completed a survey regarding problems in student writing. They listed the problems in order of importance. A summary list of those problems would read like this:

- Weak organization. Writing that seems as if it were dashed off with no plan behind it.
- Lack of clarity. Major points and relationships are difficult to comprehend.

- Imprecise use of terms, technical and otherwise.
- Weak summarizing (or none at all), so that it's difficult to tell what's important in a report.
- Garbled, seemingly endless sentences.
- Failure to get to the point; reports that try to overwhelm readers with the sheer volume of words.
- Defensive writing, in which writers seem to be covering up what they *don't know* rather than saying what they *do know*.
- Poor spelling and sentence mechanics.
- Poorly constructed and labeled tables or graphs.

This list should not surprise anyone. These complaints are typical of those expressed by readers of technical reports. Looked at closely, this list reveals paired concerns. *First* there is a tone of frustration in these "peeves." Well, readers *do* get frustrated. Trying to make sense of complex information is a hard task all by itself. When the writing just makes the task harder, naturally readers get a bit annoyed (hardly the attitude you would prefer in the person reading and evaluating your report).

Second, these complaints point toward a dislike of writing that is not clearly organized and that does not convey precise meaning. There are things you can do to avoid such writing. In the pages that follow the list above is recast as a set of guidelines for writing technical reports. These guidelines don't cover *every* problem or situation you are likely to encounter when writing a report. But they will help you address some concerns of the people who will read your work in the CEE department.

2.0 Guidelines for Clear Technical Style

2.1—Use Strong Verbs

Overview

You can eliminate a host of writing problems by using strong, precise verbs in your writing. Weak verbs generate wordiness, misplaced modifiers, and vagueness—none of which contribute to effective writing. In this module we will illustrate two methods for strengthening verbs:

- Minimize passive voice constructions.
- Reduce usage of “is” verbs.

Minimize passive voice constructions

Simply stated, *active voice* describes a sentence structure in which the subject of the sentence performs the action of the verb. *Passive voice* describes a sentence structure in which the subject of the sentence receives the action of the verb. Note the examples below:

Active Voice	Passive Voice
Repeated tests yielded inconclusive results. (5 words)	Inconclusive results were yielded by repeated tests. (7 words)
Subject → Verb → Object	Object ← Verb ← Subject

Notice that the second version contains two more words. Passive voice sentences are almost always longer. That extra length can really cloud readability over the course of a report, not to mention wasting space. Active voice sentences tend to make relationships more directly clear since they follow the natural Subject → Verb → Object word order that is most common in English. You should use active voice constructions in most instances.

Use passive voice constructions sparingly, for example—when you wish to de-emphasize the subject or provide transition across sentences:

- The car was returned to the owner immediately. (*Here the person returning the car is understood or unimportant.*)

- The case was dismissed for lack of evidence. A lack of evidence remains the most common reason that magistrates dismiss cases brought by this office.

(Note how the subject ends one sentence then begins the next.)

Example

Here is an example of how to strengthen verbs by converting passive voice to active voice.

Weak	Improved
The cost reduction goals in the annual plan will not be reached by the accounting and engineering divisions. (18 words).	The accounting and engineering divisions will not reach the cost reduction goals in the annual plan. (16 words).
It has been found that fewer pipes were degraded by oxidation than had been expected. (15 words)	We found that oxidation degraded fewer pipes than expected. (9 words) <i>or</i> Testing revealed that oxidation degraded fewer pipes than expected. (9 words.)

Skilled writers can employ a passive voice sentence to maintain the flow of ideas across two sentences. For example:

The project has experienced an unacceptable number of *test failures*.
These failures have been traced to the use of non-standard materials.

But you should avoid passive voice in most instances. Below you can see how it's possible to write the same sentence in different voice and point-of-view.

First person, active voice

We repeated the test four times; in each test failure occurred at or above 160°.

Third person, active voice

Harris and Chamber repeated the test four times; in each test failure occurred at or above 160°.

or

Four repetitions of the test revealed structural failure occurring at or above 160°.

Third person, passive voice

Structural failures occurring at or above 160° were revealed in each of four repetitions of the test.

Reduce usage of “is” verbs.

Forms of the verb “to be” yield the weakest verbs in English because they only denote that something exists. They do not fix meaning with any precision. And because the verb is weak, you usually have to add more words to sharpen the meaning of the sentence, often strings of prepositional phrases or modifiers. While you might wonder what the meaning of “is” is, it marks the most common verb we use in both speaking and writing. Below you will find the forms of this verb:

is	are
was	were
am	be

These verbs are not incorrect (I just used one.), but when you rely on them too heavily, you can clutter your prose with wordy, ineffective constructions. Normally you might find a perfectly good verb hiding in the sentence as some other part of speech. For example:

Weak & Wordy	Strong & Precise
Forestry is the dominant sector in Maine’s economy. (8 words)	Forestry dominates Maine’s economy. (4 words).

If you need a rule of thumb, limit your use of “is” verbs to around one-third of your sentences.

Example

Here is an example of how to strengthen verbs by choosing alternatives to common “is” constructions.

Weak & Wordy	Improved
There is a lack of will by these officials to resolve the issues. (13 words).	These officials lack the will to resolve the issues. (9 words).
This project is made up of three segments. (8 words).	This project consists of three segments. (6 words)

Here's an even longer example.

Weak & Wordy

Data from the last seven quarters are revealing a steady drop in occupancy rates in our three largest hotels. Allowing for differences in size, the overall occupancy rate in these properties is down 37% during the period. Morgan Mountain is down 32%; Coast Hill Chalet is down 39%; and the Riverwalk Palace is down 35%. This trend is unacceptable. Interim financial reports are already well below targets. The reasons for the drop are not clear from the current level of analysis. Senior management feels that it is necessary to discover the reasons for the falling occupancy rate within the next two months. A meeting to address this issue is to be convened at corporate headquarters on January 18 at 8:00am. It is expected that all management personnel will be present.

(130 words)

Improved

Data from the last seven quarters *reveal* a steady drop in occupancy rates in our three largest hotels. Allowing for differences in size, the overall occupancy rate in these properties *fell* 37% during the period.

Morgan Mountain	Coast Hill Chalet	Riverwalk Palace
-32%	-39%	-35%.

This trend *cannot continue*. Interim financial reports *are* already well below targets. The current level of analysis *fails to explain* the drop. Senior management *expects* to know the reasons for the falling occupancy rate within the next two months. All management personnel *will attend* a meeting to address this issue at corporate headquarters on January 18 at 8:00am.

(103 words)

Notice how a list can reduce the number of words. Notice that two “is” verbs remain. That fact is just to remind you that you can use them; just be economical about that use.

2.2—Eliminate Unnecessary Words

Overview

For some reason we grow up with the impression that more is better when it comes to writing. In too many instances we get reports that we ought to weigh instead of read, as if the writers expected us to pay them by the pound. In an age when we are already deluged with information, we can't afford to wade through such grain silos of reports looking for a kernel of meaning. Don't complicate the reader's job by writing inflated sentences.

We've already seen how using strong verbs can eliminate extra words. In this module we'll examine another strategy for writing lean sentences.

- Trim inflated phrases.

Trim inflated phrases

Here are examples of common inflated phrases along with some concise alternatives. Prefer the concise. The extra words add nothing. You might follow the advice of the poet Ezra Pound: "Use no word that does not contribute to the presentation." Are any of these familiar?

Wordy	Concise
For the purpose of	for
Along the lines of	like
In the event that	if
Make an announcement	announce
Subsequent to	after
For the reason that	because
With regard to	about, concerning
In view of the fact that	since, because
It is interesting to note that	note that
We are of the opinion that	we believe
Affects an improvement	improves
In a situation in which	when
Makes an adjustment in	adjusts
Are in receipt of	received
Has made a report on	reported
Together with	with
Being in possession of	possessing

Example

Here is an example of how to strengthen sentences by eliminating unnecessary words.

Wordy	Improved
It is often the assumption that due to the fact that our operations may be viewed as being widely dispersed, that connections in real-time for the purpose of meetings might be deemed too difficult. (34 words).	People assume that our widely dispersed operations make it difficult to schedule face-to-face meetings. (14 words).
In the opinion of supervisors, too many times field engineers are required, by virtue of current regulations, to undertake reporting of activities that make insufficient contributions to what is the primary mission of this division. (35 words).	Supervisors contend that current regulations too often require field engineers to spend time writing reports that do not contribute to the primary mission of this division. (26 words).

2.3—Keep Related Words Together

Overview

When you describe complex issues or events, make sure you write sentences in which related words appear together. Readers easily get lost when they have to rearrange material that you should have arranged properly in the first place. Sometimes you even provide a little comedy when you don't mean too. Here's an example:

Well-stewed but firm, the manager preferred tomatoes.

Can you see the problem?

In this module we'll examine two strategies for keeping related words together.

- Avoid misplaced modifiers
- Keep subjects and verbs together.
- Give pronouns clear antecedents.

Avoid misplaced modifiers

Most misplaced modifiers occur because the modifying phrase doesn't actually modify the subject of the sentence.

Misplaced Modifier	Improved
Flying 20 feet higher than the trees, the warden noticed the osprey.	The warden noticed the osprey flying 20 feet higher than the trees.

Keep subjects and verbs together

Readers follow a sentence better when you keep the subject and verb together.

Separated Subject and Verb	Improved
Developing and launching, without a labor agreement, this new line of products will be difficult and risky.	Without a labor agreement, developing and launching this new line of products will be difficult and risky.

Give pronouns clear antecedents

Pronouns can confuse readers. Remember that pronouns must have a clear *antecedent* (the word to which the pronoun refers) and must agree with the number and gender of the antecedent.

Pronoun without a clear antecedent	Improved
Judy and Mary were both at the meeting, but, as usual, she left early.	Judy and Mary were both at the meeting, but, as usual, Judy left early.
The report showed a continuing drop in thefts and assaults in January and February. These suggest a new trend.	The report showed a continuing drop in thefts and assaults in January and February. These results suggest a new trend.

Choose your words carefully

As tools of expression, words are so much less exact than mathematics. Yet behind a good report is a writer who would not settle for whatever words came into mind. Since people seldom use words carefully in speech, some of that slackness carries over into their writing. Slack usage can distract readers and undermine a technical report. Here are three points (not the only ones) to consider about word choice.

- *Prefer that word which conveys the most precise meaning.*

For example:

The pipes exhibited a *high frequency* of failure during peak demand.

What is "high frequency?" It could mean too wide a range of frequencies. Give values wherever possible, then characterize them.

The pipes failed more than 40% of the time during peak demand; by our standards that is a high rate of failure.

- *Be consistent in using terms.*

Don't call something a "program" in one sentence, then refer to it as a "system" three sentences later. Readers *need* consistent usage. Novice report writers who have been taught to vary their vocabulary in essay writing sometimes misunderstand that advice, and by trying to constantly substitute words, end up confusing readers.

- *Use the right word.*

Here's an example:

Another delaying *mechanism* is the tendency of this material to corrode in saltwater.

Probably not a great sentence to begin with, but a *tendency is not a mechanism*.

Perhaps the most important factor in using words carefully is to consider the possible interpretations of what you've said. Will your readers interpret your words correctly? Or might readers misunderstand you?

2.4—Parallel Constructions in Technical Reports

Parallel construction, which you may have encountered in earlier study, takes on special emphasis in technical reports. This emphasis manifests itself at three levels of writing: headings, lists, and sentences. Using parallel construction means that you place equivalent types of information in equivalent grammatical structures, essentially a matter of symmetry.

Such parallelism accomplishes two things: 1) it helps *your reader* understand the grouping and ordering you employed when organizing your document; 2) it lets *you* see how clearly and precisely you have organized your information.

Below are some examples of parallel construction at different levels.

Headings. Think of headings as elements of your Table of Contents (or outline). Use parallel headings at equivalent levels in your reports.

<i>Parallel</i>	<i>Not Parallel</i>
1.0 Circuit Design 1.1 Preamplifier 1.2 Modulator and demodulator 1.3 Ripple and lead networks	1.0 Circuit Design 1.1 <i>Selecting the</i> preamplifier 1.2 Modulator and demodulator 1.3 Ripple and lead networks

Lists. Although lists may fall within a sentence, they often appear as discrete parts of a document. The simplest way to keep list items parallel is to remember what type of information they represent and begin each list item with the same part of speech.

<i>Parallel</i>	<i>Not Parallel</i>
They considered the following issues: <ul style="list-style-type: none"> • how to separate useful amounts of U^{235}. • how to determine its cross-sections for fast neutron fission. • how to determine the affect of those cross-sections on critical mass. 	They considered the following issues: <ul style="list-style-type: none"> • <i>the separation of</i> useful amounts of U^{235}. • what were its cross-sections for fast neutron fission. • how do those cross-sections affect critical mass.

Sentences. The most common instance of faulty parallelism in sentences occurs in shifted constructions: phrases or clauses that have different structures.

Parallel

- 1) The report was both accurate and readable
- 2) The main steps in soldering an electrical connection include preparing the soldering iron, making the joint, and applying the solder.
- 3) First splice the wires and then wrap the exposed metal.

Not Parallel

- 1) The report was both accurate and *it was easy to read*.
- 2) The main steps in soldering an electrical connection include *preparation of* the soldering iron, making the joint, and applying the solder.
- 3) First splice the wires and then *the exposed metal must be wrapped*.

The passage below contains *two* serious instances of faulty parallelism. Read on and you'll see how to correct them.

Although voluminous data exist from various attempts to solve the thermal stratification problem, this study compares the experimental results of Matulevicius⁷ to computed results. The Matulevicius data were chosen because they were taken in a highly controlled laboratory environment, an effort to create a truly two-dimensional flow, and the Modified Rayleigh number. This Rayleigh number represents a condition of limited turbulence, a flow regime in which many space-based applications are included. Such applications make this regime a logical starting point in the checkout process.

The faulty parallelisms appear highlighted by italics.

Although voluminous data exist from various attempts to solve the thermal stratification problem, this study compares the experimental results of Matulevicius⁷ to computed results. The Matulevicius data were chosen *because they were taken in a highly controlled laboratory environment, an effort to create a truly two-dimensional flow, and the Modified Rayleigh number*. This Rayleigh number represents a condition of limited turbulence, *a flow regime in which many space-based applications are included*. Such applications make this regime a logical starting point in the checkout process.

Here is one possible rewrite:

Although voluminous data exist from various attempts to solve the thermal stratification problem, this study compares the experimental results of Matulevicius⁷ to computed results. The Matulevicius data were chosen for three reasons: *1) they emerged in a highly controlled laboratory environment; 2) they represented an effort to create a truly two-dimensional flow; 3) they employed the modified Rayleigh number*. This Rayleigh number represents a condition of limited turbulence, *a flow regime that includes many space-based applications*. Such applications make this regime a logical starting point in the checkout process.

2.5—Use Lists to Clarify Information

Overview

All good writing has a visual structure. We might forget this fact unless we stare at a page of badly designed writing. Such a design is anything that tends to bury information—whether it’s filling the page with words until it resembles a bowl of black ink, or jamming information together with no obvious visual pattern. A list is one way to give structure to information on a page.

Below is an example of information in plain text and in a list.

Plain text	List
We completed a cost-benefit analysis on the following: replacing the old fleet with new vehicles, installing a computerized distribution and tracking system, providing drivers with cellular phones and hand-held bar code readers.	We completed a cost-benefit analysis on the following: <ul style="list-style-type: none">▪ replacing the old fleet with new vehicles▪ installing a computerized distribution and tracking system▪ providing drivers with cellular phones and hand-held bar code readers.

The visual structure you see here is called “chunking,” and this structure helps readers to recognize and remember bits of related information.

In this module, we will examine several guidelines for producing lists:

- Include a lead phrase or sentence.
- Use parallel construction.
- Apply appropriate length & spacing.
- Use appropriate tags or icons.
- Use hanging indents.

Example

Here are two versions of a passage. The first ignores the guidelines; the second follows them.

Weak List

You must consider the following when you design your proposal.

- Do the current facilities support the size and weight of the new equipment?
- The cost must be within the capital budget projected over the next five years.
- Will current staff be sufficient to manage the project?
- Identify construction, zoning, and environmental regulations that may come into play during this project.

Improved List

You must consider the following when you design your proposal.

- Do the current facilities support the size and weight of the new equipment?
- Will the cost be within the capital budget projected over the next five years?
- Will current staff be sufficient to manage the project?
- Which construction, zoning, and environmental regulations may come into play during this project?

Notice the lack of parallel structure and hanging indents in the list on the left.

2.6—Use forecast and echo statements

This guideline relates to the section on organization, since forecast and echo statements do help organize information. Well-written reports display forecast and echo statements throughout. These writing devices, as their names imply, weave unifying links between ideas in a report. A forecast statement "frames" the material to come. An echo statement points back to the forecast. These devices can and should appear at every level of a document. The passage below is from an Introduction, so it frames the entire report.

This experiment involved using three different flow meters to measure the flow of water through a pipe. The purpose was threefold:

- 1) to evaluate the accuracy of various methods for measuring mass flow.
- 2) to understand the flow patterns generated by the different meters.
- 3) to evaluate basic flow properties through pipes.

All sorts of forecast and echo statements occur here.

- The first sentence previews the subject.
- The second introduces the list of purposes. The list not only previews the organization of the report, but also (by the infinitive at the start of each item) predicts the type of discussion to follow.
- Using the echo word "flow" also links the three purposes to the overall subject.

This next passage displays forecast and echo statements within a report.

One-dimensional heat diffusion describes the distribution of temperatures along a rod after a heat pulse is applied to a point on the rod. This distribution is controlled by two parameters: volumetric heat capacity and thermal conductivity. Volumetric heat capacity (s) is the amount of heat added to a given volume of material to produce a specified rise in temperature.

"This distribution" echoes "distribution of temperatures." The same sentence forecasts the two parameters to be discussed. The last sentence immediately links the definition of "volumetric heat capacity" to its mention as a parameter.

Use these devices to help readers manage and absorb what can become highly complex clusters of information.

2.7—Edit and revise systematically

This guideline assumes that you understand why editing and revising are integral parts of good writing. First draft prose is so *easy* to spot, one has to wonder why anyone would submit such work. Lack of time? Well, that's a universal complaint, but a poor alibi. When *will* there be enough time? At work bad reports have to be redone. Planning time up front for revising and editing will save you energy, and perhaps embarrassment, later on.

Still, it's easy to say "Go forth and revise!" Revising and editing can be complex tasks. Where do you begin? You need to develop a system that works for you. These suggestions may help.

- *Allow some time to pass before you revise.* You need to gain some distance from your words before you can see them with a cold eye. Even 2 or 3 hours away from the work will help, but try and allow yourself a day.
- *Have someone read your report to you out loud.* At work you will seldom write in isolation, so get in the habit of using another person as an editor. Just having someone read your report aloud to you will help you hear problems you couldn't see. Ask this person to tell you what was important in the report.
- *Look at each page.* Can you see hierarchy in the design?
- *Revise according to a plan.* Use your planning sheet (Chapter 6.0) as a guide to revisions. Measure what you've written against your plan, particularly your goals and uncertainties.
- *Edit in stages.* Don't try to catch every type of problem in one pass. For example, edit for organization and detail first. Those sorts of changes will govern the other editing you may do. If, for example, you cut a paragraph, it would have been a waste to check it for grammar first.
- *Allocate your energy.* If pressed for time, spend your energy revising the most crucial parts of the report (those parts that readers weigh most heavily—Conclusions, Results & Discussion, for example).
- *Know your tendencies.* If you constantly receive comments on the same writing issues, be aware that you need to pay special attention to correcting those problems. Bug someone until you understand how to correct those problems.

3.0 Using Appropriate Format for Letters & Memos

Overview

Letters and memos are different forms of the same thing, but you would normally send a letter to someone *outside* your organization and use a memo for readers *within* your organization. Much of the day-to-day communication in an organization occurs in one of these two forms. Both letters and memos have conventional formats.

In this module you will observe examples of each format, and review some basic tips for writing effective letters and memos.

- Use an appropriate format.
- Observe the 15-second rule.
- Connect with the reader.

Use an appropriate format —letters & memos.

Letter formats are pretty standard. Fortunately, most word-processing systems have templates for letters. The same is true for memos. Two basic examples follow:

Black Bear Entropy, Inc.

512 Melissa Boulevard
Skunk's Misery, ME 04999

Phone: 207/222-9029
FAX: 207/222-9001

Heading

Date

August 13, 2001

Inside Address

Emmylou Harris, Ph.D.
Principal
Moose & Squirrel Engineering, Inc.
312 Shady Oak Dr.
Winesburg Hts., OH 44766

Salutation

Dear Dr. Harris:

We enclose our proposal written in response to your RFP 21.07 for the System Management Software for your constructed wetlands leachate pumping system. As you know, we have designed successful systems that are now in place at three existing sites in Ohio.

Please note the additional modules for leachate sampling in our system design. These modules will place the system in compliance with the new regulations of the Ohio EPA for monitoring leachate components at new and existing landfills.

We look forward to the opportunity of working with you on this project. Please do not hesitate to contact me personally if you have any questions about the proposal.

**Letter
Body**

Closing

Sincerely,

Typed Signature

Toby Smithson
President

Steno/Enclosure Marks

TS:blg
Enclosure: Proposal

Black Bear Entropy, Inc.

Furry Systems Div.

To: Hobey Baker—Operations Director
CC: T. Wilson, J. Argyleson
From: Joy Thibadeau—Safety Officer
Date: 8/13/2001
Re: Serious Violations of Safety Regulations—Building A3

Last week (8/10) I completed the quarterly safety inspection of buildings A2 and A3. This inspection revealed serious safety problems in Building A3, problems that not only put technicians at risk, but also may expose the company to significant penalties from state and federal agencies. My complete report is attached, but this memo highlights the most significant issues under each safety category.

Hazardous Materials

*Subheadings
and lists help
give structure
to the memo.*

- I found approximately 5kg of beryllium powder left in open containers in Room 25. Employees in this room were not wearing protective clothing and were exposed to undetermined amounts of this powder. No Material Safety Data Sheet (MSDS) exists for this material, and there is no documentation as to its lot number.
- Technicians in the irradiation lab (Room 23) have been storing various isotopes in unlocked cabinets, and it appears that three inventory sheets for these isotopes have either disappeared or were not completed in the first place.

Safety Equipment

- Six of the 25 fire extinguishers in Building A3 were of the wrong class for their location, and two of the six were three months beyond their expiration date.
- Emergency showers in rooms 21 and 29 failed to operate when tested. Further inspection revealed that the valves were severely corroded and would not function should an emergency arise.

The attached report details these problems, as well as a series of less critical transgressions. The potential consequences for Black Bear could be dire. We corrected the problems for the moment although we still have not located the missing inventory sheets. I recommend that we institute weekly inspections, as well as a review of our current safety training for new employees. Let's discuss my report at Friday's meeting.

Enclosure

Observe the 15 -second rule.

Most readers decide whether they will read a letter or memo within the first 15 seconds of looking at it. You can use that 15 seconds to your advantage by following a couple tips:

- Make the subject line or title specific and have it indicate why the subject is important. For example:

Weak	Specific
Re: Safety Inspection	Re: Serious Violations of Safety Regulations— Building A3

- Get to the main point of the letter or memo.

Weak	Specific
As you know, it is my duty to perform quarterly safety inspections of all buildings in this complex.	Last week (8/10) I completed the quarterly safety inspection of buildings A2 and A3. This inspection revealed serious safety problems in Building A3, problems which not only put technicians at risk, but also may expose the company to significant penalties from state and federal agencies.

Connect with the reader.

Remember that letters and memos are extensions of business or institutional relationships—and these relationships occur among humans. The tone of your letters should reflect that fact and not sound as if they were written for a typewriter by a typewriter.

- Use first and second person pronouns (*I, we, you*) to establish a conversational tone.
- In letters or memo headings, use the reader's correct title.
- Put yourself in the reader's place. What will he or she expect to find in your letter or memo?

4.0—Organizing Your Reports

This guide doesn't pretend to cover every aspect of organizing reports. It does discuss why you need to write well-organized reports, define some of the tasks involved in doing that, and list three important characteristics of such reports.

You may have noticed that most of the concerns expressed by faculty in the Overview to this book touch upon questions of organization. In terms of the writing you do as engineers, you might define organizing as consisting of two tasks:

- You must group information.
- You must order information.

That sounds simple enough, but in practice it can be your most difficult writing problem. You can solve that problem by making sure your writing includes *Summary*, *Superstructure*, and *Subordination*.

Summary—to preview the information your reader is about to encounter.

Superstructure—to provide a consistent framework for grouping similar types of information in places where the reader can expect and recognize them.

Subordination—to indicate the relative links between, and relative importance of, different information. Rarely, if ever, is all the information you have of equal importance to your readers. Order is a natural indicator of subordination.

You can't *group and order*, or incorporate the features above, unless you can develop organizing principles. In other words, on what basis do you put things in groups? *How* do you decide in which order to present things? You may get some help from set formats (say, in a lab report), but much of the work is left to you.

You may group and order items by *time*, as with steps in a procedure. The steps may occur in an order, and you may group them in stages that make whole process easier to comprehend.

You may group and order items by criteria, or standards by which you judge a procedure or product. Such criteria might include *cost*, *specifications*, *speed*, etc.

You may group and order things by characteristics, as with certain qualities of a metal, such as *malleability* or *tensile strength* or *resistance to corrosion*.

You may group and order things by cause and effect (this gets tricky) such as when attributing turbulent flow to a mixture of physical features on an apparatus. The relative causes may be quite complex, and that's when organization becomes crucial to understanding.

Many groupings and orders are possible. *The best organization is that which makes it easiest for readers to locate, absorb, and use the information you have gathered.*

For example, suppose you were asked to examine different valves that might be used in a high-pressure pipeline and put the results in a report for a manager who must decide which to select. You could simply discuss the investigation of each valve in turn. Or you might organize the report around the features examined (such as price, technical specifications, reliability, etc.) and then discuss each valve under those categories. The diagrams below illustrate the two patterns.

Pattern 1	Pattern 2
Valve A. --price --specifications --reliability	Price --Valve A --Valve B --Valve C
Valve B. --price --specifications --reliability	Specifications --Valve A --Valve B --Valve C
Valve C. --price --specifications --reliability	Reliability --Valve A --Valve B --Valve C

Pattern 1 will have the reader jumping back and forth. In this case Pattern 2 might be the better choice because it puts comparative information together, where it is easier to find and easier to use. *Of course, you can always combine patterns and put the information in a table. That choice might be best of all.*

The overall patterns above display the superstructure of the report. The second level groups reflect subordination (price, apparently, most important here), and in a complex report you may have many levels of subordination. This is a brief example, but it leads to a final point about organization.

A report shouldn't look like a bowl of black ink. Remember, some things you write are more important than others. The visual and textual components of your report should clearly reveal its organization.

Group and order. That's the heart of organizing. And use summary to help readers absorb information. Organize *in-depth*, from the level of the whole report down to each paragraph.

5.0 Designing Your Reports

All of these guidelines aim to make your reports easier to read. In this case we'd like you to consider how the physical appearance of your report can affect its readability. Consider these two versions of the same passage.

The technique used to measure volumetric heat capacity and thermal conductivity consists of three major steps: 1) a heat pulse is applied to one end of the rod; 2) thermistors, connected to both the rod and the ADC of the Apple IIe, monitor changes in voltage at two points along the rod; 3) the voltage readings are converted to temperature readings, which are then used to plot the change in temperature as a function of time for both points along the rod. Fitting the model of the heat flow equation to this plot makes it possible to determine the values of the constants s (volumetric heat capacity) and k (thermal conductivity).

The technique used to measure volumetric heat capacity and thermal conductivity consists of three major steps:

- 1) a heat pulse is applied to one end of the rod;
- 2) thermistors, connected to both the rod and the ADC of the Apple IIe, monitor changes in voltage at two points along the rod;
- 3) the voltage readings are converted to temperature readings, which are then used to plot the change in temperature as a function of time for both points along the rod.

Fitting the model of the heat flow equation to this plot makes it possible to determine the values of the constants s (volumetric heat capacity) and k (thermal conductivity).

Both passages use a forecast statement and a list. But notice how breaking the list from the text makes the information easier to read. Multiply such effects over the length of a report and you might understand why readers prefer reports with the structure of the second version. Here are some other suggestions that might help.

- Maintain about a 50/50 ratio of text to white space. That means don't set margins at 0 and 80. A readable line runs about 55-60 characters. The white space should surround the blocks of information. Make all margins at least one inch.
- Make sure graphs and tables are labeled clearly, with values and symbols defined. Leave *at least* two spaces above and below these visual aids.
- Use boldface print for headers, underscore or italics for emphasis. Make sure your printer has sufficient ink or toner.

The table that follows offers some advice on designing displays of data.

Advice Table on Designing Displays of Data

Issue	Advice
Mapping information to the right type of display	<p>Some types of information just “fit” better in a specific type of graphic. For example, unemployment rates over time might fit better in a line chart. On the other hand, unemployment as a percentage of the total workforce might fit best as a pie chart.</p> <p>Other possibilities:</p> <ul style="list-style-type: none">Comparisons of data—bar graphProcedures—flow chart or checklistPrecise values or large data sets—tableInterrelationships—organization chart, matrixTrends, changes over time—line chartPercentages of a whole—pie chart.Component parts—drawing, exploded diagram, picture.
Color	<p>Avoid too many colors, or ugly combinations of colors. Remember, color must serve an informational purpose in your display. It should be part of the display, not a gimmick or distraction.</p> <p>Colors at the red end of the spectrum, or highly saturated colors, make poor backgrounds. Blue colors make better backgrounds, but poor choices for thin numbers or text.</p>
Labels & Titles	<p>Let the title tell the story of the display, and make sure every element is labeled. Identify all units of measurement. Your audience should understand the display without having to refer elsewhere.</p>

6.0 Using a Writing Planning Sheet

When it seems to take so much energy just to complete your engineering work or experiments, many writers may feel hard-pressed to produce a well-written report on time. Here are two suggestions that may help you manage the task of reporting:

- Use *planning* as a way to organize the task of writing.
- Consider writing the report as an act that begins *during* the work.

By planning your report ahead of time, you will be able to use information gathered during the task or experiment to give you a head start on writing the report.

Many writers find that using a simple device called a planning sheet helps them get a head start on producing a good report. And time spent in planning usually reduces time spent later (and more painfully) on revision. Planning sheets can serve as a sort of blueprint for the final report. They appear in a variety of structures and different levels of detail. Here is a sample planning sheet for you to consider.

“If I’ve got eight hours to cut down a tree, I’ll spend six hours sharpening the ax.”

—Abraham Lincoln

Technical Communication Quick Planning Sheet

Reader(s): (Roles, knowledge, attitude, etc.)

<input type="checkbox"/> Decision-maker
<input type="checkbox"/> Advisor
<input type="checkbox"/> Implementer
<input type="checkbox"/> Other Stakeholder

Situation:

Your Goals: (List them as outcomes)

Your Strategies: (How will you achieve these goals?)

Communication Uncertainties: (What you *need* to know to achieve your goals minus what you *do* know):

Diagram of Document Path (Who reads it in what sequence):

References:

Paul Anderson. *Technical Writing: A Reader-Centered Approach*. 4th Ed. 1999. Harcourt Brace.

Philippa Benson. "Writing Visually: Design Considerations in Technical Publications." *Technical Communication*. Fourth Quarter, 1985.

Gordon Mills & John Walter. *Technical Writing, 5th Ed.* 1987. Holt, Rinehart and Winston.

Edward Tufte. *Visual and Statistical Thinking: Displays of Evidence for Making Decisions*. 1997. Graphics Press.

Appendix: Advice Table on Technical Memos

Advice Table on Technical Memos

Advice	Explanation	Example
Give Structure to the information.	Make sure that headings, paragraphs, and lists reflect distinct groups of information arranged in an order that makes sense to your reader.	<p><i>Prefer</i> a structure that reveals the hierarchy of ideas.</p> <p>The equation we used would not suit your design for two reasons:</p> <ul style="list-style-type: none">• The 30 ft depth of your tanks will introduce stratification;• The use of salt water in your tanks will create a variation in specific gravity. <p><i>Avoid</i> either mixing unrelated ideas in a single chunk of information or hiding structure within linear text:</p> <p>The equations we used would not suit your design for two reasons. According to hydrostatic theory, the forces act on the center of pressure of the submerged are. The 30 ft depth of your tanks will introduce stratification. Another reason is that the use of salt water in your tanks will create a variation in specific gravity.</p>
Use a direct, personal tone.	Remember that memos are written by people for people (normally within the same organization). Address your reader directly in a level of formality that is appropriate to your working relationship and to the purpose of the memo.	<p><i>Prefer</i> a direct style:</p> <p>We remain available to answer any questions you have about these findings.</p> <p><i>Avoid</i> stiff, institutional prose:</p> <p>It is stated that investigators in the Engineering Applications Division will continue to remain available to render assistance in the understanding of the above listed findings.</p>

Advice	Explanation	Example
Respond to your reader's needs.	<p>Consider the factors that create your reader's Interest in your memo and address those factors in the way you organize your memo:</p> <ul style="list-style-type: none"> • Has the reader asked for specific information? • Is the reader aware of the subject and its importance? • Why does the reader need this information? • What level of detail or evidence will the reader require to accept the content of the memo? 	<p>Rephrase the request as a statement to open your memo:</p> <ul style="list-style-type: none"> • Here is the data you requested from the thermal diffusion experiments. The results should be useful to the Composite Materials Group and should answer their questions regarding the degree of uncertainty in our measurements. The attached graph illustrates the time vs. temperature readings for three composite rods.
Use the subject line (Re:) to your advantage.	<p>Let the subject line focus the reader's attention by highlighting the critical ideas in your memo.</p>	<p>Prefer a subject line such as:</p> <p style="padding-left: 40px;">Re: Serious Violations of Safety Regulations—Building A3</p> <p>Avoid overly broad, generic subject lines:</p> <p style="padding-left: 40px;">Re: Safety Inspections</p>
Get to the point.	<p>Except for “bad news” situations, begin your memo with the most important point you wish to make.</p>	<p>Prefer a direct, specific opening:</p> <p style="padding-left: 40px;">We believe the equations used in our procedures are valid for use in the design you propose <i>(followed by a list of reasons why along with any limitations or qualifiers to your statement)</i>.</p>

Notes