# Chapter 4  Report Writing Style

## Style defined

The term “style” in this chapter refers to the manner of English usage appropriate for a laboratory report. There is also the issue of document style and layout: how best to merge the written text with images and navigational aids to make a more presentable medium, especially for web documents and presentations. That would extend to choices for margins, how text might wrap around figures, and font and size issues, which are on the boundary of the topics addressed in this chapter. Here, the subject is restricted to technical English usage and those elements of physical and document style that are compelling for reason of clarity.

Style is a matter of the language being adapted to the medium. For example, text messaging has a style adapted to a medium where symbols, the keystrokes of the message, are expensive. They must be keyed in using limited means more constrained than a normal keyboard. Yet, the messages themselves are reliably communicated, so there does not have to be the degree of redundancy needed in verbal speech. As a contrasting example, military radio speech has its own distinctive style adapted to the bandwidth constraints as well as high noise. Instead of “Where are you?” or “Whr R U”, the query would be phrased, “Interrogative your position.” These contrasting styles use numerous acronyms and other symbols that must be learned as a way of overcoming bandwidth and time limitations.

## Laboratory Report Writing and the Issue of Clarity

Laboratory reports follow a more conventional style that might be called “Formal Technical Writing.” The bandwidth is not nearly so constrained as either text messaging or military radio, and the medium conveys the information reliably; the words are not likely to disappear from the page. The key issue is the reliable communication of difficult to understand concepts. Thus, it is important that words be used with precision. Any stylistic embellishments that might be evocative, but which might cause confusion, need to be avoided. In comparison to other English styles, technical writing seems dull. That is deliberate; clarity is the most important attribute.

It is too common in technical reports that the writer knows and understands what he is writing about, but is unable to clearly transfer that knowledge to the reader. Several issues can cause this problem. One of those is a matter of writing style. For example, although occasionally awkward, several short sentences rather than one longer sentence is desirable because specific facts are not intermingled. Similarly, a very long paragraph can cause confusion.

Another problem leading to lack of clarity is the use of technical terms. An example is the multiple uses of the word “tolerance”. That same word is used for the linear tolerance for a mechanical surface roughness, as well as geometric tolerance for dimensions. The latter meaning of the word “tolerance” is related but, in practice, is very different. For example, edge surface roughness is nearly impossible to describe without a special note that uses words. Geometric tolerances are clear from a well understood symbol on a drawing, eliminating any question regarding exactly what is being described. Using the right word correctly is essential for the reader to understand what the writer intends.

### Conveying Information in a way Sensitive to the Culture

Styles also exist in a social context. The context for technical writing is typically institutional, meaning that such communications exist in a corporate, academic, or government institutional framework and culture. The writer of a report generally has a business relationship of some sort with the readers of the report, perhaps a subordinate, a proposal writer seeking business, or a vendor seeking customers. So, the writing must not only convey the technical message, but also is intended to convey to the reader a message that the writer (and his organization) is technically competent, understands the technology and the reader's problems, and is worthy of trust. In contrast to styles in other media and cultures, such as music lyrics and sports trash talk, the writer is generally not trying to puff himself up or brag. That would be offensive and counterproductive within an institutional culture, especially a government culture. Usually a report writer must assume that the reader is of a more senior or client status, so it is important to be seen as unassuming, and not pushy.

### Writing for your Audience

Ultimately, get to know the social structure and the expectations of peers and superiors in your context, and be attentive to these in your writing. In traditional writing, this would be called writing to the target audience. There may be unusual customs and usage tied to tradition or personalities that defy the normal rules. For example, as a matter of custom and tradition, the first entry of the year in the deck log of a U.S. naval vessel, perhaps one of the most turgid forms of technical writing, must be written in verse. Learn the rules of the environment you are in.

From here down, the assumptions will be that the writing is in a technical context, either the institutional context typical of business and government, or the academic context of laboratory reports intended to prepare students for those real-world jobs. The following sections offer specific advice concerning aspects of English style and some related formatting elements.

### Person, Tense, and Voice

Laboratory reports should generally use past tense, third person, passive voice. The report writer is first person, "I" or "We." A report written in first person would say, "We measured the Voltage at the output node for each frequency." It is typical for students to write in first person, because it is the most direct. First person is more dynamic and immediate. It is also consistent with what most English teachers instruct. Why would it not be appropriate for a technical report? The answer is that it calls attention to the writer. By placing the subject first, it tends to emphasize that it is the writer who did all of these things. But the nature of scientific inquiry, and technical discourse in general, is to emphasize that it is the facts and the techniques, and the measurements themselves, not the writer, that are most important. It should not matter who did the work reported. To use first person comes across like bragging: "Look what I did! Others probably could not have done anything nearly so clever." Now, think about how well such a tone would go over in an institutional context. Some senior technical assistant to the boss is reading it, thinking, "Who does this guy think he is? I'll fix him!"

So, if you are not going to write in first person, what should you do? Second person, "you," is the reader. You are writing in second person if you write, "You will find the details of the calculations in appendix B." A special form of second person is the imperative, which is a command to the reader. "See Figure 3," is a common example which is often encountered, and may be overlooked as inoffensive. But in general, you should avoid imperatives.

Students occasionally mistakenly use imperatives in the Procedure section, repeating instructions that were given to them in the laboratory exercise directions. Again, consider the institutional context. An imperative is the writer giving an order to the reader. In an institutional setting, imperatives are often used, but generally in things called "directives" or "policies." Those are documents written by a more senior manager as orders to subordinates. For a technical report writer, generally a junior person, to use imperatives is presumptuous. A reader is likely to think, "Why does this idiot think he can give orders to me?" The reader will typically assume:

1) That the writer was lazy and simply copied materials (probably without quotes or other attribution) from the instructions or some other source, or

2) The writer is not competent in English technical communication, and therefore should not be trusted to generate technical reports that matter, or

3) The writer thinks he is more important than he really is.

None of these are good.

So, if you are to avoid both first person and second person, that leaves third person, "He", "She," "It," and "They." But, if you use active voice and third person, you have to refer to yourself in the third person: "John Smith measured the Voltage at the output node for each frequency." This is just as bad as first person, and in addition, comes across as somewhat pompous.

The solution to all of these problems is to use third person, but in the passive voice. "The Voltage was measured at the output node for each frequency." Nothing is said about who made the measurements. The reader is going to assume that it is the writer (or someone in his employ) who made the measurements, unless the report says otherwise. That's exactly the tone that fits best in the institutional setting.

In laboratory reports you are making a report on something that has happened in the past. So, you should use past tense. Occasionally you may see reports use future tense in reference to the process of reading the report, such as "You will find the details of the calculations in Appendix B." This form uses both second person and future tense. In such cases, it is better to avoid second person and use present tense, "The details of the calculations may be found in Appendix B." Anything about what was done, recorded, or concluded should be in past tense. Keep in mind that the time frame is in reference to the reader of the report.

You have probably thought to yourself, by this point, that the author of this manual is not following his own instructions. That is true. This manual is written largely in first person and second person, not third person passive voice. It is littered with imperatives. This is a matter of emphasis. It also helps make the material a bit more personal and active, the kinds of things English teachers tell you to strive for. It also reflects that this manual is intended to have a role more like the institutional directive than the institutional report. That is, you are expected to comply with its provisions! Or, at least, keep its suggestions in mind as useful guidance.

You may also be noticing that the style of this chapter is not consistent with that of other parts of this manual. That is because much of this manual is less formal, and intended to be more easily readable, than a typical technical report. It also has to do with the origin of the separate parts of this overall document. So, as you approach your writing task, think explicitly about the style you use to convey your message. It needs to be different for different purposes.

**Technical precision**

As a writer reporting technical matters in a professional context, it is very important to use the jargon of the culture correctly. Failure to do so identifies the writer as being incompetent, and unable to communicate clearly. To give an example from another context, if someone asks at a football game, "How many runs were cashed?" what would you think? "Do 'runs' mean touchdowns scored on the ground? Or maybe 'points?' 'Runs' is baseball. Why is this person using 'cashed' instead of 'scored?' He obviously doesn't know the right terminology and usage of football."

The same issues apply to technical writing. This manual is too limited to address this topic comprehensively. An important part of all of your science and engineering courses is to learn how to use the terminology correctly. That means understanding the underlying principles behind the terms. If your writing does not correctly use technical terms, it suggests that you do not understand the basic concepts associated with those technical terms, and thus calls into question your competence.

Since many of the courses to which this manual applies are electrical, some common usage problems in reports on electrical circuits will be described. First, it is important to understand the difference between Voltage and Current. Voltage is analogous to force and pressure. Current is a flow, of electrons in the opposite direction of what we call "current." So, the usage of "Voltage" and "Current" need to reflect these attributes. You cannot properly refer to the Voltage through a resistor, for example. The preposition matters. The word "through" implies movement, a flow, which would apply to current, but never to Voltage. If you really are talking about Voltage, you need to use the preposition "across." "The Voltage across the resistor was measured," is the proper usage.

It is common to refer to Voltage across a component or between two nodes. But, it is also proper to refer to Voltage "at a node" as well. "The Voltage at the anode was 5.2 Volts." In such cases, the Voltage is assumed to be that between the node and the reference, or ground, node. If you are going to refer to the Voltage at a particular point, or node, in a circuit, you must make sure that the reader knows what the reference, or ground, node is. It should be clearly marked in the schematic. Similarly, in the mechanical domain, giving the position of a mass is meaningless unless the reference zero point is known. Similarly, is pressure absolute or in reference to ambient pressure?

Voltage, at least DC Voltage, carries a sign. Be sure that you do not neglect to include the sign. Often the ground node in a circuit is the most negative, so the Voltages of other nodes are positive or zero. This is not always the case. Op-amp circuits, for example, usually use a negative power supply, so nodes can have either positive or negative Voltages. For AC, negative Voltages are used to refer to phase with respect to some reference signal, usually the source of power. Thus, household 240 Volt AC power can be referred to as a supply of +120V and -120V AC. Remember that unless otherwise specified, AC Voltages are assumed to be root mean square (r.m.s.) values. If you want your reader to understand that an AC Voltage is peak or peak to peak, you need to be specific and say so. Indeed, whenever an AC Voltage is given, this annotation should be included in the units.

Sometimes two terms seem to be synonyms, but have important technical distinctions. Be aware that just because units may seem to be the same, the meaning is not. For example, when AC Voltage is multiplied by AC Current, units can be cancelled to produce “Watts”, a unit of power. But, the correct term is “Volt-Amperes” to avoid confusion with the power being delivered. If the phase difference between Voltage and Current is 90 degrees (for sinusoids), the power delivered is zero! This kind of distinction is important when analyzing electric utility power system distribution losses. Does $(V^2)/R$ describe line loss or does $I^2R$? Both are defined to be power! However, only $I^2R$ tells the utility how much power is lost in distribution.

In the Mechanical domain, there is often confusion over the usage of the terms “force” and “load”, for example, the force or load on a beam. “Force” is the term most directly derived from physics, and is well defined, and has well defined units. The idea of a “load” is more specific to engineering; the mechanism or structure has some purpose that requires that it bear or support a “load” which is generally a force, but could possibly be defined as a pressure, a mass to be supported, or some other form related to force. For example, a bridge may need to support a load defined by a certain number of typical tractor trailer trucks or rail locomotives. When should one use one term or the other? One suggested approach is to use “load” when speaking generally, in terms of function, but use “force” where giving specifics, such as a particular force having a value and units attached. You should aim for consistency in your usage.

Remember that the most important attribute of technical writing is clarity. Endeavor to be precise with your use of words. Doing so will convey your message clearly and give a good impression.

## Units

In engineering work, almost every number is associated with some appropriate unit: Volts, Amperes, Watts, seconds, pounds, grams, or some other unit derived from physics. You must always include units when you give numbers. Even “unitless” numbers, such as the gain of an amplifier, the ratio of Voltage out to Voltage in, usually have implied units which cancel, in this case Volts per Volt. It is often helpful to the reader to include the units in such cases. Wherever numbers are used, give the units. When you show calculations, keep the units with the numbers throughout, doing unit cancellations as appropriate.

Use the standard abbreviations for units, including the prefixes that indicate decimal shifts, such as m, μ, K, M etc. Note that this means using the "Symbol" font in order to get the "μ" which is the equivalent of the normal text "m". If you actually spell out "micro", but use the other abbreviations, you are telling the reader that you are not competent in using word processing to render the Greek character. Use these scaling prefixes so that you can avoid large exponents, scientific notation, and lots of zeros before or after a decimal. Only really enormous or tiny numbers, like Avogadro's number, or the charge of the electron, should need scientific notation.

(Watch out if you ever make a massive font change to your document. Anything you did to insert a special symbol using the "Symbol" font will be wiped out. A "Ω" will be changed to "W" for example, and "μ" to "m", changing the meaning entirely.)

One particular problem to beware of concerns the term "mil". Students sometimes mistakenly use the term "mil" for millimeter, rather than as one-thousandth of an inch. This is especially confusing if a system or document uses a mix of both Imperial / English and metric units. For example, the electronic circuit packaging industry developed mainly in the United States used English units. As Asia increased its presence in the industry, metric units have become standardized (almost). It is not unusual to find a legacy 100 mil (inches) spacing defined on a data sheet or print, with all other dimensions being metric. Also, beware that sometimes "mil" is used to mean "milli-radian." This is particularly true in terminology concerning weapons and aiming.

Use appropriate prefixes so that you can use the number of digits to imply precision. Thus, "1000 Ohms" leaves ambiguous how many significant digits there are. The round zeros imply that it is probably less than four; could the value be exactly 1000 Ohms and not, say, 1001 Ohms? The reader cannot tell, but will guess that there are fewer than four significant digits. If, instead, you use "1.00 K Ω" or "1003 Ω," the matter is clear; there are three or four significant digits respectively. In the latter case, 1.003 K Ω would have been preferred. (It is better to use "Ω" than spell out "Ohms.")

Note that some unit choices are, by custom, not used. For example, Capacitor values are normally given in μF (microFarads) or pF but not mF or nF. A capacitor of $10^{-9}$ Farads would be .001 μF or 1000 pF, not 1 nF. Use of nF or mF might not suggest incompetence, but does suggest that the writer is not experienced, or attuned to the older traditions of the discipline. In this case, the reasons go back to an age before word processors and computers and unit standardizations, when the abbreviation "mfd" was used for μF and "mmfd" (micro – micro Farads) for pF. Those were the only units commonly used then for capacitors, and that's largely still true. If you place an order for capacitors, you find values given in μF and pF, but not nF. The symbol "μ" was unavailable on a normal typewriter. Increasingly, I see technical literature that violates this idea, primarily from foreign sources with less experience with practice than is assumed for competent engineers in the U.S. (Farad sized capacitors were almost unimaginable in earlier times; very large capacitors might be up to 120, 000 μF. Now, specifications in Farads are becoming more common, but less than Farad values are usually in thousands of μF, not mF.) You will sometimes see the lower case "u" used as a substitute for the Greek μ for "micro." That's common in computer design tools. However, in a report, use μ.

Another problem that is found in the field of engineering is tradition trumping the usual protocol in some field of the discipline. For example, it is rare, but not unusual, to find the symbol "m" used to define one-thousand, instead of the symbol "k". This is most commonly found in agriculture, but some other industries also follow this tradition.

Use appropriate units not just in the text, but also in tables and graphs.

**Fonts, Size, Spacing and such:**

Some reports are required to follow very particular guidelines for font, size, spacing, margins, capitalization, headings, and so forth. This is true of such things as conference proceedings. Often the organizers of a conference will promulgate with the call for papers a style guide and an MS Word template document to use in preparing the paper. The same may be true for other formal communications such as proposals submitted in the business world. For laboratory reports, there may be requirements for some of these particulars and not others. If specifics are not dictated, consider the following:

**1. Fonts**

Choose a "normal" font like "Times," which is unobtrusive, easy to read, and relatively common. The "Georgia" and "Verdana" fonts are both fonts designed to be highly readable on computer monitors. They have become standard fonts on most computers. This document, through this chapter, is in "Georgia." Some material is in "Times" or "Times New Roman" which are somewhat older and more traditional for printed reports. Which looks better? It may depend on whether you are looking at a computer screen or paper. If you happen to choose an unusual font for an electronically delivered document (an increasingly common situation), and the recipient does not have your font, a substitution will be made, that may cause havoc with your spacing, tables, pagination, and other details, besides possibly being very ugly. Avoid bizarre fonts that look like *handwriting* or Old English.

One particular consideration is the spacing of characters, especially when constructing tables. Some fonts like "Times" have equal spacing for numbers, but not letters. So, if you are including a hexadecimal listing (where characters "A" to "F", or "a" to "f", stand for the numbers 10 to 15), your digits in numbers won't come out evenly spaced. Special fonts are normally used for this case, including "Verdana," and

"Monaco." Sometimes a font used for this purpose looks ugly for normal text, and certainly takes up much more space.

**2. Size**

You should choose a size that is convenient for reading without requiring special optical equipment, like a magnifying glass. This document uses Times (in later chapters) at 12 point, which is as small as I normally go, but Times 10 point (or its equivalent) is commonly used in journals and conference proceedings, for the obvious reason of allowing more to be compressed into a given number of pages. Times is smaller than most fonts for a given point size, so with some other font going to size 10 would cause less eye strain. Don't make your font too large, either, since that can make your report resemble children's literature. A laboratory report in a large and peculiar font, double spaced, conveys the impression that the student is doing everything imaginable to make the report look bulkier than it really is. Think about your choices of font and size together. Some fonts look good for small print but are ugly for large print, and some fonts that look good when large are unreadable in small sizes.

**2. Spacing**

If you have license within your report writing guidelines, you can choose single, 1 ½, or double spacing for your text. In school work where an instructor is going to be making marks, or in early drafts in business where a supervisor or editor will be doing the same, it is a matter of courtesy to provide more space between lines for such purpose. On the other hand, in a final document, single spacing is the norm, to avoid the waste of pages and paper. There is also the issue of how to space between paragraphs, around headings, and around figures and tables. Extra space here and there can be helpful in making figures and tables fall where you want them to. In a relatively short document like a laboratory report, you can manipulate your choice of spacing policy to enhance the overall document. Try to avoid a final page with just a few lines, by manipulating figure and table placement, paragraph organization, and other aspects of your paper's organization. Also, make a point of avoiding having a section heading with no following text at the bottom of a page.

**3. Margins and Pages**

You should normally provide margins of at least one inch on all sides (exclusive of the page numbering and any other header or footer information). If your report is to be bound into a book, leave extra space toward the binding. For school work and other circumstances where you are expecting there to be marking or editing, larger margins are helpful, and you should print one sided. Final reports in some cases, and books, should be two sided.

**4. Color**

You should avoid the use of color if at all possible, unless there is a very compelling reason. In industry, a report will often be "published" on paper: copies will be made and circulated. Usually the technique used is conventional printing (lithography) or xerography. In both, there is a high premium for rendering the document in color, multiplying cost by a factor much larger than two typically, even if most of the document is still monochrome (black on white, possibly with grey shades).

If your original document includes colors, but is reproduced inexpensively using such equipment, the color information will be lost. Color objects may come out light and unreadable, or even missing entirely. So, you should develop the habit of thinking about how to make documents look good in monochrome. Even grey scale images often render poorly when copied or printed.

However, perhaps my view on this is becoming dated. Professional technical writer Russel Stolins has written, "I can't think of a circumstance in which traditional printing would be used any longer to publish lab reports. It's going to be done via normal or color laser printer. Even many books (including many of mine) these days are published via high capacity digital laser printers rather than via offset printing." And, concerning the added cost of color printing and duplication, "True, at present. However, affordable color laser printers are gradually shifting this truth."

Now, color printing is getting less expensive, and some documents are published primarily on the computer where they will be viewed using color monitors, about the only kind people have now. So, the color issues described above are not going to be as important in the future. But even where documents are viewed in color on screen, they are often printed in monochrome, and you should be sure they will look good in that form. Be especially wary of color on color; such writing often disappears into a black blob when copied in a conventional copier. Keep in mind that colors will look different on paper than they do on the screen when you do feel compelled to use color.

The use of color in reports can be tricky. Many people, given the availability and license to use color, tend to over-use it. Usually color should be used sparingly, and for things where it is truly important or necessary. Don't use it simply because you can. Don't use it just because by default Excel gives you colored graphs. Take the time to use monochrome unless there is good reason not to.

**Summary:**

There is a lot that has not been addressed here. For other issues, refer to example reports of the sort you are writing, examples of articles in technical journals, the usage of terms in textbooks, and other respected sources in your technical field. Remember that clarity and precision in your writing is paramount. Avoid ambiguity. Try not to do anything that your intended reader will find annoying.