EVERYTHING YOU WANTED TO KNOW ABOUT REPORT WRITING BUT WERE AFRAID TO ASK

Some Notes on Technical Report Writing

By

Eric J. Miller, Ph.D. Professor, Department of Civil Engineering Director, Transportation Research Institute University of Toronto

Department of Civil Engineering, University of Toronto Toronto, Ontario February 1, 2008 Revised February 2, 2017

EXECUTIVE SUMMARY

This document discusses various elements of report writing as a guide to graduate students preparing term project reports, journal articles, theses, etc. It is intended to address some typical issues that our graduate students encounter in their writing. Topics discussed in this document include: report organization; report style; treatment of tables, figures, exhibits and appendices; grammar and syntax; spelling and word usage; referencing, footnotes and acknowledgements.

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1. Introduction

This document discusses various elements of report writing as a guide to graduate students preparing term project reports, journal articles, theses, etc. It is far from a complete guide to report writing. Rather it is intended to address some typical issues that our graduate students encounter in their writing. For a more complete guide, the reader is encouraged to consult Strunk and White (1979), among others.

This document discusses the following topics:

- Report organization.
- Style.
- Tables, figures, exhibits and appendices
- Grammar and syntax.
- Spelling and word usage.
- Referencing, footnotes and acknowledgements.

It then concludes with a brief summary.

2. REPORT ORGANIZATION

Perhaps the single most important attribute of a well written report is that it is logically organized. The report structure must be clear to the reader and follow a logical path that "makes sense" to the reader. An old adage of report writing is that it consists of three steps:

- 1. Tell them what you're going to tell them.
- 2. Tell them.
- 3. Tell them that they've been told.

In other words, a report must have, at a minimum, an introduction, a main body, and a summary/conclusion. In all but the shortest reports the main body will be divided into further sections or chapters, which, in turn, may be further divided into sub-sections, and so on. In particular, longer sections may have their own introductions, main body (with possible sub-sections) and summary/conclusions. The key concern is that the reader should always understand where he/she is in the "story" that is being told: what is coming next, how does it relate to what has gone before and what will come next, etc. To aid in this, short transition pieces at the beginning and/or end of sections that refer back or point ahead can help the reader flow from one section of the report to the next.

The logic of a report's sections/chapters will obviously depend on the content of a report, but a very typical technical report structure takes the following form:

- Title Page
- Executive Summary / Abstract
- Table of Contents / List of Figures and Tables
- Introduction

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 $^{^{1}}$ There is a 1999 4th edition of this book, but the 1979 3rd edition is the one that sits on my bookshelf, so I am referencing it here.

- Motivation/Background
- Literature Review
- Methods
- Data
- Results
- Summary/Conclusions/Recommendations/Future Work
- References
- Appendices (if required)

Each of these elements is discussed briefly below.

All but the briefest of reports should have:

- A title page that provides the title of the report, the author's name and affiliation, the date and location of the publication and, if appropriate, to whom the report is being submitted.
- An executive summary (or abstract in the case of a journal paper or thesis) that provides a brief, concise, clear summary of the report's key elements. This executive summary can paraphrase or even copy words and sentences from the report's introduction and summary sections. It must <u>not</u> get bogged down in detail. The two purposes of the executive summary are:
 - 1. To provide sufficient information to the reader so that s/he can decide whether to read the full report or not.
 - 2. If the reader is not going to read the entire report, to provide the "take-away message" of the report.²
- A table of contents and (as required) lists of figures and tables.

The report introduction should be succinct and to the point. It should clearly state the purpose/objectives of the report, perhaps provide a brief motivation for the study (if this is required) and provide a brief overview of the report's organization – an "annotated table of contents" if you will. In most cases it is not only acceptable but desirable that the very first sentence of the introduction should more or less start with "The purpose of this study is ...".

The purpose of the introduction is to introduce, not to present much in the way of actual "content". If the study motivation/background cannot be very quickly discussed (e.g., in a paragraph or two) then it is generally preferable to provide only a very high-level motivating sentence or paragraph in the introduction and then have a full section dedicated to the background discussion as the second section of the report. This way the introduction remains truly an introduction to the report, leaving the presentation and discussion tasks to the main body of the report.

It is common practice for the literature review to stand alone in many reports, since it defines the "point of departure" for the original work being presented in the report. Occasionally, however, it can make sense to divide the literature review up into sections, with each section appearing in the relevant location within the report. An example of this might be to review the relevant

² Note that senior managers, politicians, etc. may rarely read full reports!

methodological literature in the methods section, the survey methods literature in the data section, and so on. Regardless of the organizational structure adopted, the net effect must be that the relevant literature has been reviewed (and properly referenced), the relevance of this literature to the present study is clearly established, and how the current work departs from the literature must be made clear.

Whether methods are discussed before data or *vice versa* will, again, depend on the logic of the given report. For example, if the methods have been chosen to correspond to the available data, then in this case it makes sense to discuss the data and their limitations first. Regardless of order, it is essential that both methods and data are fully discussed so that the reader understands their appropriateness to the task at hand, their strengths and weaknesses, and that the author(s) themselves understand the methods and are applying them properly.

In some laboratory settings it is common practice to present the results of an experiment in one section and then analyze/discuss the results in one or more subsequent sections. This division between presentation and discussion of results simply does not work well in most transportation applications and should be avoided. Rather, results should be presented and discussed in a holistic way.

The final section should:

- Summarize the study purpose, key tasks and key findings.
- Present any conclusions and/or recommendations that have emerged from the study.
- If appropriate, discuss future work flowing from the work undertaken within the study.

This final section should be concise and to the point. It also should <u>not</u> introduce new ideas, discussion, analysis, etc. That is, the final section summarizes what has already been presented and discussed in the main body of the report; it does bring previously unseen material into the discussion.

Finally with respect to report organization, it is important to maintain a consistent and clear means of denoting chapter/section organization. Different approaches/styles for doing this exist. Undoubtedly the most common in technical reports, and most other forms of technical documents (and the one that I would strongly recommend), is a hierarchical numbering scheme, e.g.:

- 1. Introduction
- 2. LITERATURE REVIEW
 - 2.1 Introduction
 - 2.2 Random Utility Choice Models
 - 2.2.1 Multinomial Logit Models
 - 2.2.2 Nested Logit Models

. . .

As is discussed in greater detail in the next section, styles can differ from author to author and report to report. The key common element in the hierarchical numbering scheme is that the hierarchical section and sub-section numbers provide a clear indication to the reader of where in

the overall report structure s/he currently is and how this point in the document relates to the rest of the report. As indicated above, different font sizes, capitalization, use of bold/italics, etc. can be used to further augment the reader's "sense of place" within the document, but this is largely a matter of aesthetics rather than an essential element of the scheme.

3. STYLE

Arguably the second most important element of a report is its style. "Style" includes many elements, including:

- Typographic elements (fonts, line spacing, etc.).
- Sentence/paragraph construction ("writing style").
- Choice of tense, etc. (grammar and syntax).
- Handling of figures, tables, etc.
- Handling of citations, references, etc.

The latter three topics are discussed in their own sections below. Writing style is the most individualistic and complex element of style and will not be addressed in detail in this document. Again, the reader is directed to Strunk and White (1979) for an exceptional discussion (and illustration) of good writing style. A few key points concerning writing style that are worth emphasizing, however, are the following:

- Technical report writing should be concise. Say what needs to be said: no less, but certainly also no more.
- Avoid long sentences and long paragraphs whenever possible. Keep your points sharp and clear.
- Be descriptive but not flowery.
- Be calm and measured in your discussion; avoid rhetoric and polemics.
- Generally write in the present tense except when describing past actions ("in the survey respondents were contacted ..."), or when the present tense is clearly awkward to use.
- Generally write in the third person. It is becoming more common, however, to use the first person when the third person is clearly overly "arch" or contrived.

"Style guides" for theses, journal papers, etc. often exist to guide you with respect to your report's typographic elements. If such a guide exists, follow it. Nothing upsets a thesis supervisor, journal editor or paper reviewer (not to mention an employer) more than failure to adhere to clear guidelines concerning line spacing, margins, etc., etc. Further, failure to initially adhere to these guidelines simply means much more work down the line when the supervisor, editor or boss makes you re-write the document in the approved style.

In the absence of such guidelines, choose a typographic style that is clean, professional looking and helps the reader process the page's content with ease. A few suggestions include:

- Use at least a 12-point font (but usually not much bigger).
- Choose a font that is "crisp" and "clean" looking. As indicated by this report, my strong preference is to use Times New Roman, but Calibri and Ariel are also popular. One of the most popular fonts for "font geeks" is Helvetica, which, interestingly, does not seem to be support by MS Word.

- Either space between paragraphs without indenting or indent but do not space (although indenting and spacing is also sometimes used). Not spacing or indenting is <u>not</u> an acceptable alternative.
- Generally use at least 1 inch margins all-round (and generally don't use much wider margins unless instructed to do so).
- Number all pages.
- Left-justification-only is often preferred over full justification since the latter can generate odd spacing between words within a given line.
- Be consistent in your use of bold, italics, underlining, etc. Also don't overdue their use.

Regardless of the style adopted, by far the most important requirement is to be absolutely consistent in your use of this style. Do not sometimes indent paragraphs and sometimes not. Do not write "Figure 1" on one page and "Fig. 2" (or even "figure 2") on another. And so on.

4. GRAMMAR & SYNTAX

4.1 Introduction

The third area in which students often stumble is in the "mechanics" of their writing: their grammar and syntax. This is probably especially the case for ESL students, but by no means is this problem restricted to this group. The occasional grammatical error is not a major issue, but numerous, persistent errors can seriously degrade the reader's ability to read the text smoothly and, in the limit, can even impede understanding of this text. McLuhan's dictum that "the medium is the message" holds for print as well as other media: if the text is badly written the message conveyed may not be the one that you wish it to be. Nothing drives a thesis supervisor or a paper review wilder, quicker than poor writing that has to be "waded through" and laboriously corrected.

As with writing style, this document does not attempt to deal in depth with grammatical issues. Three issues, however, represent a majority of the problems that many students experience. These are:

- Choosing between singular and plural.
- Articles.
- Tense.

Each of these is discussed briefly in the following sub-sections.

4.2 Singular/Plural

Two issues exist here. The first is maintaining consistency between the noun and the verb in a given sentence. If the noun is singular, so must be the verb, and *vice versa*. Keeping sentences short and keeping the noun and verb close to one another in the sentence help maintain consistency.³ The squiggly blue lines that MS Word puts under verbs when it catches a

³ Note that in this sentence the verb is plural ("help") since there are two gerund phrases ("keeping sentences short" and "keeping the noun and verb close to another in the sentence") that are collectively the subject of this sentence. If I had written instead "keeping sentences short and the noun and verb close to one another in the sentence" then the verb would have been singular (helps"), since now there is a singular subject.

discrepancy can help,⁴ but Word is not sufficiently smart to catch all such instances, so beware, particularly in complex sentences and/or when the verb is located far from the subject noun. If in doubt, try comparing your sentence with a couple very simple sentences, in which consistency/inconsistency is (hopefully!) easy to see, such as:

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"The stick are light." (should be "is").
"The sticks is in the box." (should be "are")
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The second issue is choosing the right version (singular and plural) for the noun. It is possible that the writer in the first example above meant to refer to several sticks and so the error is not in the choice of the verb, but in using the singular rather than the plural version of the noun. There is not much defence against this problem except to rigorously check every noun to make sure that it is singular when you mean it to be singular and plural when you mean it to be plural until the right choice becomes a natural part of your writing. In these checks comparison of the noun with the verb may still help, since if an inconsistency becomes apparent you can ask yourself which is correct (or which you mean to use), the noun or the verb, and then change the incorrect one.

4.3 Articles

Probably no one aspect of the English language causes more problems for many ESL students (even ones who have done their schooling in English) than the proper use of articles. Two simple words – "a" and "the" – but what difficulties they can cause! A big part of the problem, of course, is the vast number of inconsistencies and exceptions that are permitted in English, but hopefully a few rules (that generally – but not always – apply) might help.

First, singular nouns generally have an article. "A" (or "an") and "the" are both singular articles. "A" is used when the noun one is referring to is a general (non-specific) example of the object, while "the" is used when referring to a particular, specific example. For example:

"A stick is a piece of wood." (Could be any stick, any piece of wood.)

"The stick he carved from the leftover wood is missing." (The sentence refers to a specific stick carved from a specific piece of wood.)⁵

Of course, "the stick is a piece a wood" might be a correct sentence, if it was expressed in the context of a specific stick that had been previously explicitly referenced. Similarly, "the stick he carved from a piece of leftover wood is missing" might also be correct if one doesn't know or care about which piece of leftover wood was used for the carving. "The" usually connotes "this", while "a" usually connotes "any", even if "this" or "any" might not actually be substitutable into a given sentence. Or, for object-oriented types reading this, "a" is used to modify a class, while "the" modifies an instance of a class.

⁴ For example, in the last sentence in Section 3.1 I first wrote "Each of these are discussed ..." and Word caught the mistake.

Note that in this sentence discussing the prior sentence "a" is used to modify "specific stick" since in this sentence I am speaking of "specific sticks" as a generality, not a specific "specific stick"!

Occasionally a singular noun can stand alone without an article. One example of this is demonstrated by this sentence. "Example" does not require an article since the adjective "one" already modifies it sufficiently (note that "one" could be replaced with "an" in this sentence without changing it substantively). Another example⁶ is when the noun is the <u>only</u> instance of its class⁷ and so it is both general and specific at the same time. Some examples:

"English is the language this document is written in." (There is only one language called English).

"Religion is the opiate of the masses." (There are many religions, but Marx was referring to the universal concept of religion.)

"A stick is a piece of wood." ("Wood" is unmodified. Here it stands for the general concept of wood.)

"The" is the only plural article; "a" is <u>never</u> used to modify plural nouns. As with singular nouns, "the" modifies specific instances. General ("class") plural nouns do not require an article. For example:

"Sticks shorter than 2 metres are no good for building the bridge." (Refers to all short sticks.) "Bring me the long sticks that are piled outside." (Refers to the specific sticks that are outside.)

I hope this helps! Hopefully you will do better than one of my former students who confessed that he simply scattered a certain number of "the's" on every page, in the hopes that at least a few of them would land in the right places!

4.4 Tense

As has already been discussed, one should write in the present tense as much as possible in technical reports, as long as the sentence does not become patently awkward. The rationale for this is that anything written "is" forever. For example, the objective of this paper <u>is</u> to provide students with guidance in report writing. The fact that I wrote it in the past does not alter the current objective of the report, which remains unchanged over time. Similarly, it is tempting to refer to later sections in the report in the future tense, reflecting the "linear" way that we normally read the report ("the next section <u>will</u> describe the results of the experiment"), but, in fact, the next section exists whether you will eventually read it or not, and so the preferred way to refer to is: "the next section describes …".

Experiments or any other specific action undertaken in the past should be referred to in the past tense (note the use of the past tense in the verb "wrote" in the paragraph above⁸). Examples:

If describing a laboratory method:

"1. Take 1 litre of water and mix it with ..." (present tense: the method remains the same for all time)

⁶ Note, another adjective ("another") replacing the article.

Note, "its" replaces the article for "class".

⁸ Similarly note the use of the future tense in the paragraph above ("... whether you <u>will eventually read ...</u>") to describe a specific action that might occur in the future.

Versus describing what you <u>did</u> in the experiment: "We next mixed 1 litre of water with ..." (a specific action undertaken once in the past)

Again, keeping sentences short and uncomplicated can help to keep one's tenses under control.

5. TABLES, FIGURES, EXHIBITS & APPENDICES

Every table and figure used in a document must be numbered and titled appropriately and must be referred to in the text. In a short document, simple sequential numbering is fine (Figure 1, Figure 2, etc.). In longer, multi-section documents it is usually better to use a hierarchical numbering scheme, at least for the highest level of section numbering (e.g., Figure 1.1 is the first figure in Section 1, Figure 4.2 is the second figure in Section 4, etc.). This both helps the reader keep track of his/her place in the text and also makes inserting/deleting tables and figures easier to do during report writing.

Consultants often combine tables and figures into a single category of exhibits. Theses and other academic papers usually maintain tables and figures as separate entities.

Figures and tables should be physically placed within the document as close to the first point at which they are referenced as possible: preferably immediately after the first reference point, but immediately preceding this point is also acceptable, depending on page layout considerations. Placing the figures and tables all at the back of the document is generally not good practice: it forces too much flipping back and forth on the part of the reader. The one exception to this rule is that some journals require tables and figures to be placed at the end of paper manuscripts being submitted for publication consideration. As in all other cases, follow the guidelines provided by the journal in question.

As in all aspects of report writing, consistency in labelling, numbering and referencing figures and tables is essential. Details are largely a matter of style ("Figure 1" versus "figure 1" versus "Fig. 1"), but whatever style you adopt, stick with it throughout the document. It once was the case that table labels generally went at the top of the table and figure labels went at the bottom. This convention does not seem to be enforced today, but whatever you choose to do, do it consistently throughout the document – or as consistently as possible given other style/layout considerations (i.e., figure labels may need to "move around" within the figure depending on the layouts of the figures involved).

The decision concerning when to include material as a table or figure within the main body of the document and when to include it as an appendix at the end of the document is a flexible one. Generally, appendices are used to present large amounts of data that may not be essential to the overall discussion within the report but that provide additional information "for the interested reader" and/or provide detailed documentation of inputs, outputs, etc. that need to be preserved but do not require detailed discussion within the main body of the report. Or, an appendix may contain information that is simply too "bulky" to incorporate within the main report body. As an example, perhaps maps showing residential proportions for six occupation groups for four different census years have been generated. Twenty-four maps are a lot to include within the

main text. In this case it is probably best to put the twenty-four maps into an appendix and then perhaps include one or two of the more interesting (or most representative) of the maps in the main body and discuss these maps in greater detail. As with figures and tables, however, all appendices must be referenced somewhere in the main body of the report (e.g., "For further details, see Appendix C, which contains a full set of maps for all occupation groups and census years.").

6. SPELLING & WORD USAGE

American, British and Canadian English all use different spellings for many words. The three primary differences are:

- British English uses "our" for words such as "neighbour", "behaviour", "colour", etc. American English uses "or".
- British English uses "ll" in words such as "modelling" and "travelling". American English uses a single "l".
- British English uses "s" in words such as "maximise". American English uses "z" (and, of course also pronounces the letter as "zee" rather than the British "zed").

Canadian English, in a classic Canadian approach, is a mixture of British and American usage, although it primarily follows British usage. In particular, the correct Canadian spelling is "colour" and "modelling"; i.e., use "our" not "or" and "ll", not "l". With respect to "s" versus "z", either is considered acceptable (but call it "zed", not "zee"!); but whichever letter you use, always use the same letter (i.e., don't write "maximize" on one page and "minimise" on another).

It is important to use the appropriate spelling in a given context. If writing a paper for TRB or an American journal, use American spelling. Most international journals and conferences use British spelling. When writing your thesis, use Canadian spelling. MS Word's spell-checker is one of the most effective agents for American imperialism ever invented. Most students seem to have U.S. English as their default dictionary. As a result, far too many Canadian students generate "modeling" theses rather than "modelling" theses. This is <u>not</u> acceptable for a University of Toronto thesis! (At least in my view.)

With respect to word usage, a few general rules are:

- Generally do not use contractions in technical writing (i.e., the sentence "Generally don't use contractions" is not acceptable, over and above its paradoxical construction).
- Do not use "&" instead of "and" in the text body (note that use in titles is allowable as a "style feature").
- Generally use words for small numbers ("two points to note ..." rather than "2 points to note ..."), numerals for large numbers ("1,657 data points"), although "round numbers" can often be written either way ("one million", "1,000,000").
- Avoid slang or overly casual language.
- "Its" is the possessive form of "it". "It's" is the contraction of "it is". But since we are not using contractions (I almost wrote ("we're not" and then I almost wrote "we aren't"), "it's" really never should show up in a technical document.

• Since we're discussing possessives, the apostrophe goes before the "s" for a singular noun ("Ralph's dog"), after the "s" for plurals ("the stars' paths through the galaxy ..."), and after the "s" with no additional "s" if the word ends in s ("the Jones' dog").

Finally with respect to word usage, three personal "pet peeves" are the words "data", "methodology" and "parameter". "Data" is a <u>plural</u> word (its singular is "datum"). It has become almost universal usage however (at least in North America) to treat it as singular. Thus, for example, correct usage is "the data are ...", but most people today usually write "the data is ...". Harking back to the discussion of singular versus plural, every time you write "data is" think of the phrase "sticks is". One is as wrong as the other. It is probably a losing battle, but I would strongly encourage everyone to treat "data" as plural. But, whichever way you go, as always, be consistent in your usage.

An even more hopeless cause is the word "methodology". The Canadian Oxford Dictionary (2000) defines the word as:

- "1. a body of methods used in a particular branch of activity.
- "2. the branch of knowledge that deals with method and its application in a particular field."

In common usage, however, "methodology" has come to mean "method":

"1. a mode of procedure; a defined or systematic way of doing a thing." (Canadian Oxford Dictionary, 2000).

It is not enforceable, but I would strongly encourage anyone who cares about precision in language and who is not enamoured with using a fancy word incorrectly when a simpler word can be used correctly to consider using the word "method" to describe their logit model and to reserve the word "methodology" for discussing the body of work known as random utility theory.

Finally, a much more enforceable (and ultimately far more practically important) case is the word "parameter". In modelling terms, a parameter is a coefficient that is the weight attached to an explanatory variable. In the equation y = a + b*x, "a" and "b" are parameters (or coefficients) and "x" and "y" are variables (independent/explanatory and dependent, respectively). Variables define the *dimensions* of the system state of interest. Parameters define the sensitivity of the dependent variable to the independent variable(s). All of these definitions should be very clear to any University of Toronto Civil Engineering graduate student.

Unfortunately, in common usage (often even in technical or at least quasi-technical settings) "parameter" is used as synonymous with "dimension" or "variable" (e.g., "the important parameters of the problem are ...", with the speaker meaning "important dimensions" or "important variables"). This usage is <u>not</u> acceptable since it totally confuses the very real difference between a parameter (which is a characteristic of the system and can not in general be manipulated by the analyst – unless the analyst can reconfigure the system itself) and a variable (which either characterizes the system state or is a factor influencing the system state and in general can be manipulated – i.e., varied).

On the other hand, in my view at least, "parameter" and "coefficient" can generally be used interchangeably without doing excessive violence to either the English language or mathematical precision.

7. REFERENCING, FOOTNOTES & ACKNOWLEDGEMENTS

Correctly citing and referencing material from other documents is extremely important. Plagiarism is as serious an academic offense as exists. The University of Toronto Code of Behaviour on Academic Matters states that:

"It shall be an offence for a student knowingly:

(d) to represent as one's own any idea or expression of an idea or work of another in any academic examination or term test or in connection with any other form of academic work, i.e. to commit plagiarism.

Wherever in the Code an offence is described as depending on "knowing", the offence shall likewise be deemed to have been committed if the person ought reasonably to have known"

Footnotes (or, alternatively, endnotes) are used for at least two reasons. First, some disciplines routinely use footnotes or endnotes for citations. This is very common in the social sciences; however, it is almost never the done in engineering or the physical sciences, which prefer to use in-line (e.g., "Smith (1983)") referencing systems. Second, footnotes/endnotes are used to provide "parenthetical" comments that elaborate on a point made in the main text, but would provide an unacceptable "diversion" of the flow of the discussion. Footnotes are generally discouraged in technical writing, and some journals (e.g., TRR) do not permit them.

Acknowledgments recognize the contributions of non-authors to the ideas in the report, financial and moral support of sponsors, moral support from family and friends, etc. Students often seem to forget to include acknowledgements except in the case of theses, but, at a minimum, acknowledgements must occur in any document for which financial support, etc. have been provided. They usually occur at the end of journal papers and can appear either at the beginning or end of technical reports, etc. (I usually prefer the beginning).

8. SUMMARY

This document provides an over view discussion of various elements of good technical report writing.

REFERENCES

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