Part IV

RESEARCH WRITING

Scientific writing is characterised by conciseness, objectivity and consistency, as well as correct usage of technical terms and established formats. Most importantly, though, scientific writing is a communication—and, as with any communication, it should be clear and unambiguous.

In Chapter 12 we discuss scientific writing in general, in Chapter 13 we explain how to reference other people’s work, and in Chapter 14 we outline specific formats for theses and dissertations, research proposals and company reports.
12 Scientific Writing

In this chapter, we look at some aspects of scientific writing. We start with a list of useful tips to remember in scientific writing, and then discuss how finished documents should look.

This is not a grammar textbook, and so fundamental aspects of language usage are not discussed. This in no way implies that grammatical errors are acceptable in scientific writing, but rather demonstrates the expectation that people involved in postgraduate research will already have such skills.

12.1 FOURTEEN TIPS FOR BETTER COMMUNICATION

12.1.1 Make a plan

You wouldn’t begin a two-week trip to Malawi without some form of plan (itinerary, road-maps, visas), so why begin a report which could take up to several months (for theses) without one? Map out the order points will be discussed in, and ensure that your writing follows a logical progression from one point to the next, and from one section to the next. Occasional ‘road maps,’ which summarize the section ahead, can be useful to the reader.

12.1.2 Be objective

Scientific communication should be based on logical and rational discourse. A common error is to try to ‘sell’ one’s findings or research. As a scientist, you are supposed to objectively evaluate, not to advertise. Pointing out drawbacks or possible problems with your approach is good and, indeed, necessary; raving about how wonderful it is unscientific. You can still show how wonderful it is, but do this on the basis of comparison or rational arguments. Also, avoid emotive words such as ‘wonderful’, ‘ghastly’, and ‘horrid’.

12.1.3 Support your facts

Your writing can, and should, make statements of fact. Only a handful of statements can be made without support on the basis of universal acceptance (e.g. ‘most people have two legs’, ‘day alternates with night’). All other statements should be supported
by either a line of reasoning (based on your results and logical conclusions), or by a reference to the work of a previous researcher (for example ‘As shown by Naicker (1988), gweedledidgets are orthogonally centroid’). In the next chapter we discuss how to handle such references.

12.1.4 Be concise

Avoid woolly phrases and unnecessary words. Qualifiers such as ‘quite’, ‘really’, or ‘in fact’ can be omitted. ‘The reason that he went home was that it was raining’ could, for example, be revised to ‘He went home because it was raining’.

12.1.5 Be definite

Avoid unqualified terms such as ‘nice’, ‘good’, ‘big’ and ‘fast’. Rather use exact measures or comparisons (e.g. ‘it takes 7 milliseconds’, ‘it is the same size as a gweedledidget’).

12.1.6 One paragraph, one idea

A single paragraph should contain a single idea. Avoid overly long paragraphs (more than 500 words) if possible; your writing will be clearer and easier to read if the paragraphs are crisp and concise.

12.1.7 KISS

KISS (Keep It Simple, Stupid) is a good approach to any communication. Do not overelaborate.

12.1.8 Be active and use verbs

Where possible, prefer the active to the passive. ‘The workers consulted management’ rather than ‘Management was consulted by the workers’. Also try to use short verbs rather than long phrases. Avoid ‘The workers actioned a consultation with management’.
12.1.9 Eschew obfuscatory nomenclature

Don’t use big words! Some people believe that the most accurate word should always be used; some people just like fancy-sounding words such as ‘nascent’, ‘vitiate’, ‘opine’ or ‘symposiastic’. Extreme accuracy or fancy words might sound reasonable, but if most of your reading audience doesn’t understand such words, then you are hardly communicating effectively. Also confusing are TLAs that your reader is unfamiliar with. (Three-Letter-Acronyms, what else?)

12.1.10 Use appropriate terms

Use the technical terms appropriate to the field of research. This may seem to contradict the caution against ‘big words’, but again it’s a question of the audience—you have a right to expect readers of a paper on advanced calculus, for example, to be familiar with the terms and symbols of calculus. Having to define all basic terms at the beginning of reports would make the reports impractically long. At the same time, any terms which are not basic and could be misinterpreted by a fellow researcher in the field, should be defined.

12.1.11 I am not worthy

The words ‘I’ and ‘my’ should be used very sparingly (some would say not at all) in theses. If you present a valid argument, then you can make conclusions without using statements like ‘I think that...’, or ‘it is my view that...’. If you have to give a personal opinion which is not fully supported, then use of ‘the author’ is preferred.

12.1.12 Use only appropriate authorities

When you use the work of someone else to support a statement, ensure that the person is an authority. For example, a politician’s comment on a practical aspect of engineering is probably not of much academic worth; neither is a prince’s comment on architecture. Your references and support should come from those who are authorities in the particular field rather than just respected individuals.

12.1.13 Be careful with the ‘Truth’

Never state a particular religious, political, or humanistic world-view as a truth (fact). The fact that you believe, or even know something to be so, still does not allow you to
state it as a fact without reference or proof.

12.1.14 Avoid anecdotes

An anecdotal style is a sure way to get your writing ignored. ‘Little stories’ from personal experience to illustrate points do not belong in a scientific document.

12.2 WORDS INTO PRINT: TYPOGRAPHICAL CONSIDERATIONS

At some stage you will have to take your research and produce a document for the whole world to see. There is no such thing as a ‘right’ style for such a document. We list here some of the issues which you need to be concerned with. If you are uncertain whether a particular style is appropriate for your writing, consult your supervisor or promoter. What is extremely important, however, is that, having chosen a particular style, you use this style consistently.

12.2.1 Technology

A manuscript, thesis or dissertation should be typed using a wordprocessor. Apart from the extra features a wordprocessor provides (e.g. spell-checks), revisions can be performed easily and quickly, and the document can be electronically distributed. Letter-quality printers (laser, ink-jet or similar) should be used for final copies. (Although some dot-matrix printers advertise themselves as being ‘near letter-quality’ and produce fairly acceptable originals, photostatted copies lack legibility.)

12.2.2 Fonts

The font determines the shape of the letters you read. The font for the body text (as opposed to that for various headings, footnotes and so on) is normally a standard font. Avoid the use of ornate fonts—while they may look impressive, they are hard on the eye.

A font size of 12 points (‘normal’ typewriter size) is often used for body text. Spacing between lines should be between one and one and a half: both too little and too much white space between lines makes the text hard to read.
12.2.3 Headings

There are many options for headings and subheadings. Different fonts, font sizes, bold-face, text justification (left, right or centre) and (occasionally) underlining can all be effective. One possible scheme is to have chapter headings centred in large bold capitals, section headings left-justified in bold lowercase, and subheadings left-justified in lowercase italics. Pick a scheme you feel comfortable with.

12.2.4 Emphasis

If you want to stress a particular word or phrase, use *italics* or **bold**. *Underlining* is also an option, but it tends to cramp the surrounding text and distract the eye. Using exclamation marks to emphasise points can look **silly** and should be done very sparingly.

12.2.5 Quotes

Direct quotes should be surrounded by quote marks. The use of either single or double quote pairs is acceptable. (E.g. Le Roux stated "Nihilism is nothing to be worried about", or Zuma remarks ‘Mind over matter is a matter of the mind’), although a common rule is ‘singles first, double inside singles’. Obviously, direct quotes must be referenced. (Note that you must copy a quote exactly, even if it does contain errors. You can indicate that the source was in error, rather than it being your mistake, by inserting ‘[sic]’ where the error occurs.)

12.2.6 Widows and orphans

An **orphan** is the first line of a paragraph which sits by itself at the bottom of a page, and a **widow** is the last line of a paragraph which sits by itself at the top of a page. These should be avoided. In particular, a heading or subheading must be followed on the same page by at least two lines of the section it heads. Orphans are easily removed by inserting a page break before the paragraph; widows can take considerably more manipulation. Worry about this only when you are **absolutely** sure everything else is done—spending hours ‘prettying up’ a document and then remembering you have to insert one more paragraph, which of course plays havoc with all your ‘fixes’, is not a pleasant experience (sigh).
The interested reader is referred to any of the references Arn84, Bor78, Ber71, Cam90, Chi82, Day89, Jut94 and Por94 for more information on the art of scientific writing.

Discussion questions and exercises

1. Study the first two paragraphs of this chapter. Do you think these follow the guidelines (tips) for scientific writing? Rewrite them so that an audience of ten-year olds could understand them.

2. Read a newspaper editorial. What features of the writing would you consider unscientific?

3. Write a half-page report on the Apollo 11 mission, using at least three sources of information. (You may need to visit your library!) Your intended audience should be your fellow students. Is your finished report an example of scientific writing?
13 Referencing

A requirement of scientific writing is that whenever you use results reported by other people, or directly quote their work, you inform your reader as to exactly where you obtained those results. This is known as referencing. Such information includes the name of the author(s) of the work, the title of the work, where it was published and the date of publication. In this chapter we discuss why referencing is important and also various schemes for referencing.

13.1 WHY REFERENCE?

There are a number of reasons why correct referencing is vital. The most important are:

➢ *Credibility:* Saying ‘I read somewhere that someone said that...’ is not as likely to be believed as saying ‘JA Tipworth stated in his 1990 text, *South African Fungi*, that ...’. More importantly, the reader who wishes to check whether something was in fact said, or if a result was in fact reported, can do so only if she has access to the details of the publication.

➢ *Credit:* If someone else’s work was useful for your work, surely that input deserves to be acknowledged. By referencing, you not only give credit where it is due, but you also avoid the risk of it being thought that you are falsely representing somebody else’s work as your own. (This form of scientific cheating is called ‘plagiarism’ and gets severely punished.)

➢ *Directing readers to related research:* If particular sources were useful to you, then they are likely to be of interest to your readers. References provide valuable pointers to further information. This is why extensive details are given of the source of the information.

13.2 REFERENCES AND REFERENCE LISTS

Giving full information on every occasion one makes a reference would lead to clumsy and awkward writing. An example follows:

‘A number of reports — *Diverse Ditches* by A.J. Fruit, M.E. Vegetable and I.C. Mineral, published in Cape Town in 1991 by Juta; *Deeper Digging* by

When one considers that scientific writing can contain as many as 20 references on a page, it is clear that the above style is not practical. Instead, one uses a form of ‘shorthand’. A short code is inserted in the text where the reference occurs (*the point of reference*), and a list of codes and their explanations (*the reference list*) is given at the end of the report. In the reference list, the full publishing information of the document concerned appears next to each code. Some common schemes for these codes are discussed later in this chapter.

### 13.2.1 Source lists, bibliographies and reference lists

A **source** is anything used in compiling one’s writing—books, journal papers, conference proceedings, personal communications, talks you’ve heard, newspaper articles and so forth. A **source list** lists all the sources used. The term ‘bibliography’ is often used as a synonym for source list; strictly speaking, though, a **bibliography** contains only books. **Reference lists** give only those sources which have been referenced (cited) in the text—if you’ve read something but haven’t referred to it in your own writing, it does not appear in a reference list.

Books can contain source lists, bibliographies, reference lists or combinations of the three; theses, dissertations and papers normally contain only reference lists.

### 13.3 SCHEMES FOR MAKING REFERENCES

A reference scheme specifies the format of the code used for the reference in the text, and how the reference list is constructed.

There are several reference schemes available, none of which is more ‘right’ than another. Many disciplines favour particular schemes, although two journals in the same discipline can still have totally different referencing schemes in their standard format. Three common schemes are discussed here.
13.3.1 The ‘Harvard’ scheme

This scheme, also known as the ‘Oxford scheme’, is the most widely used, and is the norm for the human sciences. Here the reference is in parentheses, and includes the author’s name, date of publication, and page number(s). For example, ‘(Foster, 1989:120)’ or ‘(Maharaj, 1992:15–19)’. Page numbers are omitted if reference is made to the work as a whole.

When the work referred to is by two authors, both names are given in the reference—for example, ‘(Masondo and Mills, 1993:10–12)’. When there are more than two authors, the first author’s name is given followed by the abbreviation ‘et al.’, which literally means ‘and others’. For example ‘(Einstein et al., 1955:42)’. Often, the code itself is sufficient for the reader to identify the source.

13.3.2 The ‘FTL’ (First Three Letters) scheme

This scheme tries to reduce the ‘clumsiness’ of references in the Harvard scheme while retaining the useful information in the reference. References consist of the first three letters of the (first) author’s name, followed by the last two digits of the year of publication. For example, a reference which in the Harvard scheme is written as ‘(Manning and Munsamy, 1952)’ is written in the FTL scheme as ‘(Man52)’.

In the case of a clash (authors of two or more different works in the same year with the same first three letters of names), letters of the alphabet are added to distinguish between the works. For example, suppose Redfield and Reddy had both written 1988 works; then there would be two distinct references’ (Red88a)’ and ‘(Red88b)’ to avoid confusion.

13.3.3 The numerical scheme

Much beloved by engineering journals, this scheme ensures the ‘smoothest’ referencing, but at the cost of providing little information at the point of reference. References are given as numbers inside square brackets—e.g. [12]. In one version of this scheme, items are numbered in the order in which they are first referenced in the text; in another, the items are numbered alphabetically. Whichever version is used, a source only appears once in the reference list (just as with the other schemes described above); subsequent references use the same number as code.
13.4 THE REFERENCE LIST

The scheme you use does not affect the reference list apart from determining whether it is ordered alphabetically or numerically, and what the first item in a list entry is—this is identical to the reference itself, but often without brackets or page numbers. There are different approaches to the reference list. Suggested reference list entries for some common sources of information are given below:

13.4.1 Books

For a book, after the names and initials of all author(s) and date come the title, the city of publication and the publisher. E.g. a FTL-referenced list could include the entry:


You can (usually!) find the necessary information in the first few pages of a book, before the text begins. If you want to reference an article within a book written by someone other than the author just use the word ‘in’ before the book details. For example, using the numeric scheme and wishing to reference an article by Zappa which is inside a book edited by Kruger, one might have:


Note that the abbreviation (Ed.) indicates editor, and (Eds) indicates editors. The abbreviation ‘ed.’ in lowercase indicates edition (of a book).

13.4.2 Journals

A journal or magazine article is referenced as follows: Name of author(s), date, title of article, name of journal, volume number, issue number (if the volume is divided up into issues), pages where the article appears. The journal name is normally italicised. Three possible ways of making a reference list entry for an article appearing on pages 108 to 112 of the journal Diseases of the Nervous System are:


The third example above makes use of an approved standard abbreviation for the journal name—you should never make up your own abbreviations. In some fields the use of standard abbreviations is common, in others these sometimes cryptic abbreviations are avoided. Whatever method you choose to employ, be consistent.

### 13.4.3 Conference proceedings

If the paper has been published in the conference proceedings, the reference is of the form:


If the paper has not been published as part of the conference proceedings, then the following form is common:


### 13.4.4 Theses/Dissertations

One can also reference other these or dissertations (T/Ds). It does not matter what level the T/D is. A typical entry is:


### 13.4.5 People

When referring to a communication or correspondence with someone (normally only referenced if the individual is an authority in the field), the individual’s name, the date of
the communication, the individual’s affiliation, and the word ‘personal communication’ are often given as the reference entry. For example (using the FTL scheme):

Kha01 Khan, M.I., 2001, University of Nairobi, pers. comm.

An alternative style is not to include personal communications in the reference list, but to give all the information at the point of reference instead.

13.4.6 The Internet

The rules for referencing a website are still being formulated. One reasonable approach is to provide the most natural but general URL, e.g. www.tug.org. Being very specific can be a problem, as people tend to restructure and revise their website on a regular basis.

There are many types of sources; those mentioned above are just the more commonly-used ones. If unsure how to reference a particular item, check with your advisor. Examples of the reference schemes described in this chapter can be found in Appendix A.

Discussion questions and exercises

1. Which of the three schemes above do you prefer? Why?

2. Journal papers typically have more references per page than books do. Why should this be so?

3. One of the problems in the previous chapter was to write a half-page report using at least three sources. Reference this report using any of the three schemes described above.

4. Say you read an article by Mey in which she quotes (and references) Edwards as saying ‘The real answer is 42’. You wish to use this quotation yourself. How would you reference it? How would someone obtaining the quote from your report reference it?
14 Standard Report Formats

This chapter describes common formats for theses and dissertations, proposals to conduct research and company reports. Formats are used as a standard style of presenting information, but by themselves do not guarantee effective communication—this is still your job.

14.1 THE THESIS OR DISSERTATION

14.1.1 Layout

A typical thesis or dissertation (T/D) is presented in A4-size format and has the following elements, in the order as given:

1. Title page: This normally contains the title of the T/D, the full name of the author, and a statement along the lines of ‘Submitted in partial fulfilment of the requirements for the (degree name) in the Department of (department name), (institution).’ At the bottom of the title page might appear the city and date of the T/D’s acceptance, and copyright.

2. Preface: This details where the work was carried out (e.g. Department of Computer Studies, ML Sultan Technikon), under whose supervision it was done, and over what period it was conducted. A statement of originality should also appear, along the lines of ‘These studies represent original work by the author and have not been submitted in any form to any other tertiary institution. Where use has been made of the work of others it has been duly acknowledged in the text.’

3. Acknowledgements: This page allows the author to acknowledge contributions to the T/D by others. It is normal to acknowledge the work of one’s mentors, any institutions or organisations which have provided funding or assistance, and the active help of anyone directly involved with the T/D (research colleagues and assistants, typists, proofreaders). Acknowledgements of a personal nature (e.g. to parents, spouses) are common but should be brief.

4. Abstract: The abstract should give, in as concise a way as possible, an outline or summary of the T/D. It should be short and exact—an abstract of longer than 25 lines is unusual. The abstract should be the last piece of the thesis that is finalised.
5. **Table of contents**: See early pages of this book for an example of a table of contents. There is also sometimes a list of figures or tables.

6. **Body**: The chapters in the T/D now follow. The first chapter is generally an **introduction**. This highlights what the subsequent chapters contain, includes a brief overview of previous work in the field and gives definitions of important terms. The last chapter is normally a **conclusion** which summarises the previous chapters, in a far more detailed manner than the abstract, and includes indications of what future research is necessary in the field and why. The chapters in between contain the report on the actual research conducted.

7. **Reference list**: See the previous chapter for details.

8. **Appendices**: These are often numbered A, B, C etc, and contain anything which the T/D uses which is not in its chapters. Computer listings, derivations of formulae, the raw data from which information used in the T/D was derived, etc., are often contained in appendices rather than in the body of the T/D.

### 14.1.2 Page numbering, headers and footers

Page numbers must be included. These normally appear at either the bottom centre or the top right of the page. Headers (at the top of the page) or footers (at the bottom) giving the T/D or chapter title are sometimes included.

Note that the pages comprising items 1 to 5 above are normally numbered using roman numerals (i, ii, iii, etc). At the start of the body of the T/D, the page number is reset to 1 and numbering from this point on uses arabic numerals (1, 2, 3, etc.).

### 14.1.3 Length

There is no correct length for a T/D. It is possible for a 20 page T/D to be too long and for a 500 page T/D to be too short. The length of the T/D is determined by the problem, the discipline, and the ease or difficulty of reporting on the research. Whether you have ‘done enough’ is a question you should address together with your supervisor, but remember that enough here refers to enough research and an effective write-up of this research, not to any set number of pages.

### 14.1.4 Figures, tables and equations

Figures should be clear and preferably printed. If not printed they should be drawn using India ink. If a figure is needed that cannot be easily produced on an A4 page,
then it should be folded to A4 size and pasted onto a blank A4 page so the reader can unfold it.

All figures and tables should be numbered (e.g. Figure 1, Table 2) so that they can be referred to in the text. (If they are not referred to in the text, then they shouldn’t be in the T/D!) Figure/table numbers normally appear centred below the figure/table, followed by a brief but useful description of the figure/table. For example, ‘Table 1: Cumulative carbon readings (1960–1980)’ or ‘Figure 3: Internal structure of a glockenspiel’.

Equations can be numbered. If so, equation numbers often appear next to the equation in parentheses without any description, such as:

\[ e = mc^2 \]  \hspace{1cm} (5)

14.1.5 Footnotes

Use footnotes sparingly; they tend to break the concentration of the reader. Many writers maintain that if something is worth mentioning at all then it is worth mentioning in the text itself (i.e. there should be no footnotes). Some disciplines, however, are wedded to footnotes (and use them for references).

14.1.6 Margins

A typical margin size on A4 paper is 25 mm for all four margins (top, bottom, right and left). Avoid margins a lot narrower than this (causes text to seem very cramped) or a lot wider than this (causes text to look ‘lost in space’). Check with printers/binders whether you need to leave extra space on the left margin for binding.

14.1.7 Binding

Final copies of a T/D should be professionally bound. In some institutions it is usual to submit the thesis to the examiners unbound, so that any revisions the examiners suggest can be incorporated into final copies. Check your own institution’s policy.

14.1.8 Concluding remarks

This section has discussed style points that must be considered when writing a thesis or dissertation, and given examples of various acceptable styles, formats and techniques.
Remember that these serve only as guidelines; if the particular circumstances of your T/D call for a different format, then use that format. Always check with your supervisor to ensure that the style you use will be acceptable. Above all, after you have made a particular choice, stick with it throughout the T/D. Consistency is essential in scientific writing, and will be appreciated by all your readers—some of whom will be your examiners.

14.2 PROPOSALS TO CONDUCT RESEARCH

There are two areas in which research proposals are necessary. One is when you draw up a research proposal for a Masters or Doctoral thesis, the other is when you draw up a proposal as part of an application for funding. The former document will be studied by the Faculty Research Committee and (possibly) the institutional Research Committee; the latter document will be studied by potential funders such as funding bodies (e.g. NRF or MRC) or industry. Although both types of proposal cover much the same ground, they will be addressed to different audiences and should be compiled with this in mind.

Many research proposals are drawn up according to a set format devised by the institution or the funding body. *Use that format.* It might be awkward, clumsy and unfriendly, but those who judge the proposal are certain to react unfavourably if you ignore a format that they have specified.

Funding bodies often provide actual forms which you have to complete. A common error in filling out such proposal forms is to write something like ‘see attached document’ in response to a specific question. Rather summarise your attached document in answer to the question, and then put ‘see attached document for greater detail’. Review committees often have many applications before them, and forcing the members to scratch around to find material can have a negative effect (and there is no guarantee that your attached documents have all been copied and distributed).

Proposals for research funding must include a **budget**. Budgets should be inclusive and realistic. Include all items that will cost money, down to stationery and computer disks. Sometimes you will be unsure of the cost of a particular item—for example, the cost of a hotel room in New York for the conference you plan to attend. In these cases justify your budget cost on some basis—for the example above, you might use the daily subsistence allowance recommended by your institution. It is a mistake to artificially inflate a budget—some people do this on grounds that ‘all budgets get cut, so if I ask for double what I need I’ll wind up getting the right amount.’ Not only is this dishonest, there is a good chance you will be refused any grant.
A check-list of items you should include in a research proposal appears below—remember, though, that if a specific format is provided you should stick to it:

- Proposed title of research
- Researcher’s name
- Researcher’s co-workers/supervisors
- Statement of the research problem
- Brief background to the problem
- Brief description of the research methods to be employed
- Possible outcomes of the research (why it is useful)
- Description of proposed reporting of research—for example papers, company reports and/or a thesis. (Some institutions require a rough chapter outline for thesis proposals.)

14.3 COMPANY REPORTS

Commissioned research, where a company pays you to do research in order to solve a particular problem, has some distinct reporting features. These include:

- Be considerate to top management. Executives are busy people, and while the R & D (Research and Development) workers in an organisation may welcome the opportunity to read through every line of your 300-page report, most executives will not have the time or the inclination. Company reports should thus begin with an Executive Summary—a page or at most two—which summarises the most important aspects of the problem involved and the solution that was found.

- Agree to agree. In any commissioned research you should agree to (and sign) exact specifications of what is to be researched and how this is to be done, before commencing the work. This prevents disagreements as to whether you have done what you undertook to do, and precludes people from ‘shifting the goalposts’ as work progresses. These exact specifications should appear as the first section of your report (after the executive summary and table of contents).

- They name the child. Don’t create your own title for the research report—companies have their own systems for classifying and filing their reports, and so you must obtain the title of your report (which could be something on the lines of CA712-14-X) from the company.
Discussion questions and exercises

1. Get a copy of a thesis (any thesis) from your library. Does the format conform to the specifications given above?

2. Find out what format is used for research proposals at your institution.

3. Consider what the different audiences would be for research proposals, theses and company reports. Would this affect the words you could use in the reports? How?

4. Get a paper from a journal. Cover up the abstract. Read the paper. Write an appropriate abstract. Compare your effort with the actual abstract (uncover it!).