Improving your technical writing skills

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Abstract

This document describes the basic principles of good writing. It is primarily targeted at students and researchers writing technical and business reports, but the principles are relevant to any form of writing, including letters and memos. Therefore, the document contains valuable lessons for anybody wishing to improve their writing skills. The ideas described here are, apart from fairly minor exceptions, not original. They are drawn from a range of excellent books and have also been influenced by various outstanding authors I have worked with. Thus, the approach represents a kind of modern consensus. This approach is very different to the style that was promoted by the traditional English schools' system, which encouraged students to write in an unnecessarily complex and formal way. The approach described here emphasises simplicity ('plain English') and informality. For example, it encourages shorter sentences and use of the simplest words and phrases possible. It explains how you can achieve simplicity by using the active rather than the passive style, personal rather than impersonal style, and by avoiding noun constructs in favour of verbs. Crucially, this approach leads to better reports because they are much easier to read and understand.

Document change history

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1. Introduction

Compare the following two sentences that provide instructions to a set of employees (this Example is given in [Roy 2000]):

1. It is of considerable importance to ensure that under no circumstances should anyone fail to deactivate the overhead luminescent function at its local activation point on their departure to their place of residence, most notably immediately preceding the two day period at the termination of the standard working week.
2. Always turn the lights out when you go home, especially on a Friday.

The meaning of both sentences is, of course, equivalent. Which one was easier to read and understand? The objective of this document is to show people how to write as in the second sentence rather than the first. If you actually prefer the first, then there is little point in you reading the rest of this document. But please do not expect to win too many friends (or marks) from any writing that you produce.

Unfortunately, the great shame for anybody having to read lots of reports in their everyday life is that the schools' system continues to produce students who feel they *ought* to write more like in the first sentence than the second. Hence, the unnecessarily complex and formal style is still common. This document shows you that there is a better way to write, using simple, plain English.

One of the good things about technical writing is that you really can *learn* to improve. You should not believe people who say that being a good writer is a natural ability that you either have or do not have. We are talking here about presenting technical or business reports and not about writing novels. I speak from some experience in this respect, because in the last ten years I have learned these ideas and applied them to become a better writer. When I was writing my first book in 1989 an outstanding technical editor highlighted the many problems with my writing. I was guilty of many of the examples of bad practice that I will highlight throughout this document. You too can improve your writing significantly if you are aware of what these bad practices are and how to avoid them.

The document contains the following main sections:

- *Before you start writing* (Section 2): This is a simple checklist that stresses the importance of knowing your objective and audience.
- *Using plain English: style* (Section 3). This is the heart of the document because it explains how to write in the simplest and most effective way.
- *Using plain English: the mechanics* (Section 4). This covers vocabulary, spelling, and punctuation.
- *Basic structure for reports* (Section 5). This section explains how to organise your report into sections and how to lay it out.
- *Abstracts and executive summaries* (Section 6). This explains the difference between informative and descriptive abstracts. It tells you why you should always use informative abstracts and how to write them.
- *Writing that includes mathematics* (Section 7). This contains some simple rules you should follow if your writing includes mathematical symbols or formulas.

2. Before you start writing

Before you start producing your word-processed report you must make sure you do the following:

- *Decide what the objective of the report is.* This is critical. If you fail to do this you will almost certainly produce something that is unsatisfactory. Every report should have a single clear objective. Make the objective as specific as possible.
- *Write down the objective.* Ideally, this should be in one sentence. For example, the objective of this document is "to help students write well structured, easy-to-understand technical reports". The objective should then be stated at the beginning of the report. If you cannot write down the objective in one sentence, then you are not yet ready to start any writing.
- *Always have in mind a specific reader*. You should assume that the reader is intelligent but uninformed. It may be useful to state up front what the reader profile is. For example, the target readers for this document are primarily students and researchers with a good working knowledge of English. The document is not suitable for children under 13, or people who have yet to write documents in English. It is ideal for people who have written technical or business documents and wish to improve their writing skills.
- *Decide what information you need to include*. You should use the objective as your reference and list the areas you need to cover. Once you have collected the information make a note of each main point and then sort them into logical groups. Ultimately you have to make sure that every sentence makes a contribution to the objective. If material you write does not make a contribution to the objective remove it – if it is good you may even be able to reuse it in a different report with a different objective.
- *Have access to a good dictionary*. Before using a word that 'sounds good', but whose meaning you are not sure of, check it in the dictionary. Do the same for any word you are not sure how to spell.
- *Identify someone who can provide feedback*. Make sure you identify a friend, relative or colleague who can read at least one draft of your report *before* you submit it formally. Do not worry if the person does not understand the technical area – they can at least check the structure and style and it may even force you to write in the plain English style advocated here.

The following checklist should be applied before you give even an early draft of your document out for review:

- Check that the structure conforms to all the rules described in this document.
- Run the document through a spelling checker.
- Read it through carefully, trying to put yourself in the shoes of your potential readers.

3. Using plain English: style

When you are producing a technical or business report you want it to 'get results'. If you are a student this can mean literally getting a good grade. More generally we mean that you want to convince the reader that what you have to say is sensible so that they act accordingly. If the report is a proposal then you want the reader to accept your recommendations. If the report describes a piece of research then you want the reader to understand what you did and why it was important and valid. Trying to be 'clever' and 'cryptic' in the way you write will confuse and annoy your readers and have the opposite effect to what you wanted. In all cases you are more likely to get results if you present your ideas and information in the simplest possible way. This section describes how to do this.

The section is structured as follows:

- Sections 3.1 and 3.2 describe structural techniques for making your writing easier to understand. Specifically:
  - Sentence and paragraph length: keeping them short is the simplest first step to improved writing.
  - Bullet points and lists: using these makes things clearer and less cluttered.
- Sections 3.3 and 3.4 describe techniques for using fewer words. Specifically:
  - Using the simplest words and expressions available: this section also describes words and expressions to avoid.
  - Avoiding unnecessary words: this is about removing redundancy.
- Sections 3.5 to 3.7 describe techniques for avoiding common causes of poorly structured sentences. Specifically:
  - Using verbs instead of nouns
  - Using active rather than passive style
  - Using personal rather than impersonal style
- Section 3.8 describes how to explain new ideas clearly.
- Section 3.9 explains the importance of naming things consistently.
- Section 3.10 gives some rules on how to achieve political correctness in your writing without adding complexity.

3.1 Sentence and paragraph length

Contrary to what you may have learnt in school, there is nothing clever about writing long, complex sentences. For technical writing it is simply wrong. You must get used to the idea of writing sentences that are reasonably short and simple. In many cases shorter sentences can be achieved by sticking to the following principles:

1. A sentence should contain a single unit of information. Therefore, avoid compound sentences wherever possible. In particular, be on the lookout for words like *and*, *or* and *while* which are often used unnecessarily to build a compound sentence.

2. Check your sentences for faulty construction. Incorrect use of commas (see Section 4.3 for how to use commas correctly) is a common cause of poorly constructed and excessively long sentences.

   Example (this example fixes some other problems also that are dealt with below)

   > *Bad*: "Time division multiplexed systems are basically much simpler, the combination and separation of channels being affected by timing circuits rather than by filters and inter-channel interference is less dependent on system non-linearities, due to the fact that only one channel is using the common communication medium at any instant."
   >
   > *Good*: "Systems multiplexed by time division are basically much simpler. The channels are combined and separated by timing circuits, not by filters. Interference between channels depends less on non-linear features of the system, because only one channel is using the common communication medium at any time."

3. Use parentheses sparingly. Most uses are due to laziness and can be avoided by breaking up the sentence. ***Never*** use nested parentheses if you want to retain your reader.

Learning about some of the principles described below, especially using active rather than passive constructs, will go a long way toward helping you shorten your sentences.

Just as it is bad to write long sentences it is also bad to write long paragraphs. A paragraph should contain a single coherent idea. You should always keep paragraphs to less than half a page. On the other hand, successive paragraphs that are very short may also be difficult to read. Such an approach is often the result of poorly structured thinking. If you need to write a sequence of sentences that each express a different idea then it is usually best to use bullet points or enumerated lists to do so. We consider these next.

3.2 Bullet points and enumerated lists

If the sentences in a paragraph need to be written in sequence then this suggests that there is something that relates them and that they form some kind of a list. The idea that relates them should be used to introduce the list. For example, the following paragraph is a mess because the writer is trying to make what is clearly a list into one paragraph:

> Getting to university on time for a 9.00am lecture involves following a number of steps. First of all you have to set your alarm – you will need to do this before you go to bed the previous night. When the alarm goes off you will need to get out of bed. You should next take a shower and then get yourself dressed. After getting dressed you should have some breakfast. After breakfast you have to walk to the tube station, and then buy a ticket when you get there. Once you have your ticket you can catch the next train to Stepney Green. When the train arrives at Stepney Green you should get off and then finally walk to the University.

The following is much simpler and clearer:

> To get to university on time for a 9.00am lecture:
>
> 1. Set alarm before going to bed the previous night
> 2. Get out of bed when the alarm goes off
> 3. Take a shower
> 4. Get dressed
> 5. Have some breakfast

6. Walk to the tube station
7. Buy ticket
8. Catch next train to Stepney Green
9. Get out at Stepney Green
10. Walk to the University

The simple rule of thumb is: if what you are describing is a list then you should always display it as a list.

The above is an example of an enumerated list. The items need to be shown in numbered order. If there is no specific ordering of the items in the list then you should use bullet points instead. For example consider the following paragraph:

> Good software engineering is based on a number of key principles. One such principle is getting a good understanding of the customer requirements (possibly by prototyping). It is also important to deliver in regular increments, involving the customer/user as much as possible. Another principle it that it is necessary to do testing throughout, with unit testing being especially crucial. In addition to the previous principles, you need to be able to maintain good communication within the project team (and also with the customer).

The paragraph is much better when rewritten using bullet points:

> Good software engineering is based on the following key principles:
>
> - Get a good understanding of the customer requirements (possibly by prototyping).
> - Deliver in regular increments (involve the customer/user as much as possible).
> - Do testing throughout, (unit testing is especially crucial).
> - Maintain good communication within the project team (and also with the customer).

There are numerous examples throughout this report of bullet points and enumerated lists. You should never be sparing in your use of such lists. Also, note the following rule for punctuation in lists:

> If all the list items are very short, by which we normally mean less than one line long, then there is no need for any punctuation. Otherwise use a full stop at the end of each list item.

3.3 Using the simplest words and expressions possible

On a recent trip to Brussels by Eurostar the train manager made the following announcement: “Do not hesitate to contact us in the event that you are in need if assistance at this time”. What she meant was: “Please contact us if you need help now”, but she clearly did not use the simplest words and expressions possible. While this may be acceptable verbally, it is not acceptable in writing.

The golden rules on words and expressions to avoid are:

- Replace difficult words and phrases with simpler alternatives;
- Avoid stock phrases;
- Avoid legal words and pomposity;
- Avoid jargon.

We will deal with each of these in turn.

3.3.1 Replace difficult words and phrases with simpler alternatives

Table 1 lists a number of words and expressions that should generally be avoided in favour of the simple alternative.

Table 1 Words and expressions to avoid

Word/expression to avoid	Simple alternative	Word/expression to avoid	Simple alternative
utilise	use	endeavour	try
facilitate	help	terminate	end, stop
at this time	now	transmit	send
in respect of	about	demonstrate	show
commence	start	initiate	begin
terminate	end, stop	assist, assistance	help
ascertain	find out	necessitate	need
in the event of	if	in excess of	more than
in consequence	so	dwelling	house
enquire	ask		

Also, unless you are talking about building maintenance or computer graphics, never use the verb ‘render’ as in:

> The testing strategy rendered it impossible to find all the faults.

The ‘correct’ version of the above sentence is:

> The testing strategy made it impossible to find all the faults.

In other words, if you mean ‘make’ then just write ‘make’ not ‘render’.

3.3.2 Avoid stock phrases

Stock phrase like those shown in Table 2 should be avoided in favour of the simpler alternative. Such phrases are cumbersome and pompous.

Table 2 Stock phrases to avoid

BAD	GOOD
There is a reasonable expectation that ...	Probably …
Owing to the situation that …	Because, since …
Should a situation arise where …	If …
Taking into consideration such factors as …	Considering …
Prior to the occasion when …	Before …
At this precise moment in time …	Now …
Do not hesitate to …	Please …
I am in receipt of …	I have …

3.3.3 Avoid legal words and pomposity

Lawyers seem to have a language of their own. This is primarily to ensure that their documents are so difficult to understand that only other lawyers can read them. This ensures more work and money for lawyers because it forces ordinary people to pay lawyers for work they could do themselves. For some strange reason ordinary people often think they are being very clever by using legal words and expressions in their own writing. Do not fall into this trap. Avoid legal words like the following:

forthwith	hereof	Of the (4th) inst.	thereof
henceforth	hereto	thereat	whereat
hereat	herewith	therein	whereon

Also avoid nonsensical legal references like the following:

> "The said software compiler…"

which should be changed to

> "The software compiler…"

and:

> "The aforementioned people have agreed …"

which should be changed to

> "A and B have agreed…"

3.3.4 Avoid jargon

Expressions like *MS/DOS*, *Poisson distribution*, and *distributor cap* are examples of jargon. In general, jargon refers to descriptions of specific things within a specialised field. The descriptions are often shorthand or abbreviations. If you are certain that every reader of your report understands the specialist field then it can be acceptable to use jargon. For example, if your only potential readers are computer specialists then it is probably OK to refer to *MS/DOS* without the need to explain what *MS/DOS* is or stands for. The same applies to *Poisson distribution* if your readers are all statisticians or *distributor cap* if your readers are car mechanics. In all other cases (which is almost always) jargon should be avoided. If you cannot avoid it by using alternative expressions then you should define the term the first time you use it and/or provide a glossary where it is defined.

3.4 Avoiding unnecessary words and repetition

Many sentences contain unnecessary words that repeat an idea already expressed in another word. This wastes space and blunts the message. In many cases unnecessary words are caused by 'abstract' words like *nature*, *position*, *character*, *condition* and *situation* as the following examples show:

BAD	GOOD
The product is not of a satisfactory nature	The product is unsatisfactory
The product is not of a satisfactory character	The product is unsatisfactory
After specification we are in a position to begin detailed design	After specification we can begin detailed design
We are now in the situation of being able to begin detailed design	We can now begin detailed design

In general, you should therefore use such abstract words sparingly, if at all.

Often writers use several words for ideas that can be expressed in one. This leads to unnecessarily complex sentences and genuine *redundancy* as the following examples show:

WITH REDUNDANCY	WITHOUT REDUNDANCY
The printer is located adjacent to the computer	The printer is adjacent to the computer
The printer is located in the immediate vicinity of the computer	The printer is near the computer
The user can visibly see the image moving	The user can see the image moving
He wore a shirt that was blue in colour	He wore a blue shirt
The input is suitably processed	The input is processed
This is done by means of inserting an artificial fault	This is done by inserting an artificial fault
The reason for the increase in number of faults found was due to an increase in testing	The increase in number of faults found was due to an increase in testing
It is likely that problems will arise with regards to the completion of the specification phase	You will probably have problems completing the specification phase
Within a comparatively short period we will be able to finish the design	Soon we will be able to finish the design

Another common cause of redundant words is when people use so-called *modifying* words. For example, the word *suitable* in the sentence "John left the building in suitable haste" is a modifying word. It is redundant because the sentence "John left the building in haste" has exactly the same meaning. Similarly, the other form of a modifying word – the one ending in 'y' as in *suitably* – is also usually redundant. For example, "John was suitably impressed" says nothing more than "John was impressed". Other examples are:

BAD	GOOD
absolute nonsense	nonsense
absolutely critical	critical
considerable difficulty	difficulty
considerably difficult	difficult

Modifying words can be fine when used with a concrete reference, as in the example "Jane set John a suitable task" but in many cases they are not and so are best avoided: Here are the most common modifying words to avoid:

appreciable	excessive	sufficient
approximate	fair	suitable
comparative	negligible	undue
definite	reasonable	utter
evident	relative	

Finally, one of the simplest ways to shorten and simplify your reports is to remove repetition. Poorly structured reports are often characterised by the same idea being described in different places. The only 'allowable' repetition is in introductions and summaries, as we shall see in Section 5.4. You can avoid repetition by checking through your report and jotting down a list of the key ideas as they appear. Where the same idea appears more than once, you have to decide once and for all the place where it should best go and then delete and/or merge the text accordingly.

3.5 Using verbs instead of nouns

Look at the following sentence:

"Half the team were involved in the development of system Y".

This sentence contains a classic example of a common cause of poor writing style. The sentence is using an abstract noun 'development' instead of the verb 'develop' from which it is derived. The simpler and more natural version of the sentence is:

"Half the team were involved in developing system Y".

Turning verbs into abstract nouns always results in longer sentences than necessary, so you should avoid doing it. The following examples show the improvements you can achieve by getting rid of nouns in favour of verbs:

BAD	**GOOD**
He used to help in the specification of new software	He used to help specify new software
Acid rain accounts for the destruction of ancient stone-work	Acid rain destroys ancient stone-work
When you take into consideration …	When you consider …
Clicking the icon causes the execution of the program	The program executes when the icon is clicked
Measurement of static software properties was performed by the tool	The tool measured static software properties
The analysis of the software was performed by Fred	Fred analysed the software
The testing of the software was carried out by Jane	Jane tested the software
It was reported by Jones that method x facilitated the utilisation of inspection techniques by the testing team	Jones reported that method x helped the testing team use inspection techniques

The last example is a particular favourite of mine (the bad version appeared in a published paper) since it manages to breach just about every principle of good writing style. It uses a noun construct instead of a verb and it includes two of the forbidden words (facilitated, utilisation). However, one of the worst features of this sentence is that it says "It was reported by Jones" instead of simply "Jones reported". This is a classic example of use of *passive* rather *active* constructs. We deal with this in the next section.

3.6 Using active rather than passive style

Consider the following two sentences:

1. Joe tested the software
2. The software was tested by Joe

Both sentences provide identical information. The first is said to be in the *active* style and the second is said to be *passive* style. In certain situations it can make sense to use the less natural passive style. For example, if you really want to stress that a thing was acted on, then it is reasonable to use the passive style as in "the city was destroyed by constant bombing". However, many writers routinely use the passive style simply because they believe it is more 'formal' and 'acceptable'. It is not. Using the passive style is the most common reason for poorly structured sentences and it *always* leads to longer sentences than are necessary. Unless you have a very good reason for the change in emphasis, you should always write in the active style.

The following examples show the improvements of switching from passive to active:

BAD	**GOOD**
The report was written by Bloggs, and was found to be excellent	Bloggs wrote the report, and it was excellent
The values were measured automatically by the control system	The control system measured the values automatically
It was reported by the manager that the project was in trouble	The manager reported that the project was in trouble
The precise mechanism responsible for this antagonism cannot be elucidated	We do not know what causes this antagonism
The stability of the process is enhanced by co-operation	Co-operation improves the stability of the process

3.7 Using personal rather than impersonal style

Saying

> "My results have shown…"

is an example of a sentence using the personal (also called *first person*) style. This contrasts with:

> "The author's results have shown…"

which is an example of the impersonal (also called *third person*) style.

Whether to use personal or impersonal style is a subject that still causes fierce debate. Some writers feel that a report is not truly scientific if it is written in the personal style, and they back up this claim by pointing to prestigious scientific journals that insist on third person writing. In fact, it is hard to find any reputable journal that continues with such a policy.

The most important justification for using first person style is that it is more natural and results in simpler sentences. Many examples of the kind of poor sentence structure that we have seen in the previous two sections (using passive rather than active style and using nouns rather than verbs) are caused when authors are forced to write in the third person. Consider the following examples:

BAD	**GOOD**
The current research work of the author of this report is also described	I also describe my current research work
In the previous report of the authors the rationale for the proposed method was discussed in detail	In our previous report we discussed in detail the rationale for the proposed method
However, it is the writer's belief that this situation should not have occurred	However, I believe this situation should not have occurred
Examination and discussion of the results obtained, are necessary before a decision can be taken	We must examine and discuss the results before we decide

In many cases you have to include excruciating diversions to make what you are trying to say unambiguous if you insist on the impersonal style. For example:

"The author's results have shown …"

may actually be ambiguous because it is no longer clear which author you are really referring to. This leads to the contorted refinement:

"The results by the author of this report show …"

which sounds pompous and unnatural. It certainly compares poorly with

"My results have shown…"

In the following example:

"Recent experiments involving formal inspections have resulted in ..."

it is not clear whether the writer is referring to their own experiments, other researchers' experiments, or a combination of the two.

Even worse than ambiguity is where use of impersonal rather than personal style introduces genuine uncertainty. For example, consider the following:

"It is not possible to state the exact mode of operation of the drug".

This leaves serious doubts in readers' minds. It might mean that the authors do not know how the drug works, but it might also mean that the operation of the drug is impossible.

Finally, many authors who are reluctant to use the personal style, but realise that they cannot write a sentence naturally without it, opt to use the expression 'one' as in "One can conclude from the experiment ...". You should avoid this, as it sounds pompous. If you feel uneasy about saying "I" then say "we". In other words the 'royal' we is better than the royal 'one'.

3.8 Explain new ideas clearly

If you are trying to introduce or explain a new idea or abstract concept then there are three techniques you can use to help your readers and improve your message:

- *Use examples*: In Section 3.6 I described the concepts of active and passive constructs. Before attempting a formal definition I provided some examples. Take a look back at how I did this and apply the same approach in your own reports. The general rule is to try to provide an example before providing an abstract definition or generalisation.
- *Use analogies*: Suppose you wanted to explain what email was to somebody who had just woken from a 20-year coma. You could try telling them that email was much like sending a letter, but without having to physically use a stamp and find a letterbox. This is an example of an analogy.
- *Use a diagram*: If you can provide a simple diagram that captures an abstract concept then you are effectively providing a pictorial analogy. This can be very effective if done well.

3.9 Use consistent naming of the same 'things'

Many generations of schoolchildren have been indoctrinated with the rule: "Never use the same word twice". So, we get writers who feel that they must always use a different word to describe the same thing. In technical and business writing exactly the opposite rule applies: You should *always* use the same word to refer to the same thing. Anything else causes confusion and annoyance to readers.

Consider, for example, the following paragraph that was written in a group project final report:

> In the first three weeks of the project we wrote a project plan for the system. We were ambitious in our requirements because we wanted the group project to be a success and we wanted the software to be of high quality. In fact we were determined that our software would win the prize. By the end of term we realised there were major problems with the project. The first increment of the project we delivered was inconsistent with the requirements specification and it was clear the final code would not be the best system as there were clearly better groups than ours.

The problem with this paragraph is that there are three key 'things' that are referred to in different and inconsistent ways. The 'things' are:

- *The project*: This refers to the entirety of the group experience.
- *The plan*: This refers to a document describing the requirements and schedule for implementing them.
- *The system*: This refers to the software system that the group project is supposed to deliver.

Unfortunately, we find that these things are referred to at different parts of the paragraph as:

- The project: *project*; *group project*; *group*.
- The plan: *project plan*; *requirements*; *requirements specification*.
- The system: *system; software*; *project*; *code*; *final code.*

Not only is there inconsistent naming of the same 'things' but we also find genuine ambiguity because the same words are used to refer to different 'things'. There appear to be two distinct reasons why students write in this way:

1. They have been brainwashed by the 'never use the same word twice' rule at school.
2. They are genuinely confused in their own minds and therefore hide their confusion by deliberate ambiguity.

In situations such as this it is important to identify each *different* 'thing' first and decide once and for all how it should be named. Once you have made this decision be consistent and use the same name throughout when you refer to that 'thing'. In the above example this would lead to the following improved text:

> In the first three weeks of the project we wrote a plan for the system. Our plan was ambitious because we wanted the project to be a success and we wanted the system to be high quality. In fact we were determined that our project would win the prize. By the end of term we realised there were major problems with the project. The first increment of the system we delivered was inconsistent with the plan and it was clear the final system would not be the best system as there were clearly better projects than ours.

3.10 Painless political correctness

If you were writing a manual on 'how to impress the boss' where the manual is supposed to be relevant for any boss/employee relationship, you would probably want to avoid the following kind of statements:

> If you find yourself with little to do ask your boss if he wants you to help him.

The use of 'he', 'she', 'him', 'her', when referring to non-specific people can in fact be avoided, without having to resort to the awful 'he/she', 'him/her' alternative. You can use the following methods:

- Use plural pronouns instead of singular. Thus, use 'they' in place of 'he' or 'she', use the pronoun 'them' in place of 'him' or 'her', and use the pronoun 'their' in place of 'his' and 'her'. So the above text could be rewritten as '…ask your boss if they want you to help them'. And you could write 'the programmer should test his own code' as 'the programmer should test their own code'.
- Rewrite the sentence in the plural. Thus, instead of 'England expects every man to do his duty' write 'England expects everyone to do their duty'.
- Use 'you' or 'your'. Thus, instead of saying 'every employee should leave his desk tidy' say 'leave your desk tidy'.
- Rewrite the sentence to avoid any reference to awkward pronouns. Often, such an alternative is simpler anyway. For example, you could write 'If you find yourself with little to do ask if the boss wants some help'.

3.11 Summary

The main points you should have learnt from this section (in order of importance) are:

- Keep sentences and paragraphs short.
- Never use a complicated word or phrase when there is a simpler alternative.
- Remove and unnecessary words and repetition.
- Use active rather than passive style.
- Use active verbs rather than abstract nouns.
- Use personal rather than impersonal style.
- Explain new ideas clearly by using examples, analogies, and diagrams.
- If what you are describing is a list then use an enumerated list or bullet points.
- Avoid stock phrases, legal words and pomposity.
- For each abstract 'thing' referred to in your report, use a consistent name to refer to the 'thing'. In other words ignore the 'rule' that says you should never use the same word twice.
- Use of 'he' or 'she' to refer to non-specific people is regarded as politically incorrect and is easy to avoid.
- Never use the words *utilise* or *facilitate* since these are respectively the most useless and pompous words in the English language.

4. Using plain English: the mechanics

Section 3 explained the most important principles for improving the style of your writing. However, it is also important (and actually easier) to improve the mechanics. We have already looked at the mechanics of structuring reports in Section 2. In this section we look at the mechanics of using plain English. We focus on:

- Avoiding common vocabulary and spelling errors (Section 4.1)
- Abbreviations (Section 4.2)
- Punctuation (Section 4.3)

4.1 Avoiding common vocabulary and spelling errors

Beyond having a good dictionary available, there is no simple guideline to follow to make sure you always use and spell words correctly. However, there are a number of examples of words that are frequently misused in place of a similar sounding word with a different meaning. These examples are given in Table 3.

Table 3: Commonly confused words

affect: verb meaning to influence	***effect***: noun meaning result or verb meaning to bring about
adverse: adjective meaning unfavourable	***averse***: adjective meaning opposed to or disinclined
principle: noun meaning a standard or rule of conduct	***principal***: adjective or noun meaning most important
stationery: noun meaning writing materials	***stationary***: adjective meaning not moving
illicit: adjective meaning illegal	***elicit***: verb meaning to give rise to
flaunt: verb meaning to show off	***flout***: verb meaning to show contempt
allusion: noun meaning a passing reference as in "were you making an allusion to my wife?"	***illusion***: noun meaning a false impression
complement: noun meaning something that completes, or verb meaning to make complete	***compliment***: noun meaning praise or verb meaning to praise
council: noun meaning an assembly	***counsel***: verb meaning to recommend or noun meaning recommendation
ensure: verb meaning to make certain	***insure***: verb meaning to protect against risk
mitigate: verb meaning to moderate	***militate***: verb meaning to influence (for or against)
practice: noun as in "put my ideas into practice"	***practise***: verb
advice: noun meaning recommendation	***advise***: verb

Similarly, Table 4 lists some of the most commonly misspelt words.

Table 4: Commonly misspelt words

accommodate	embarrass	necessary
commemorate	gauge	parallel
commitment	harass	privilege
committee	mileage	questionnaire

The final class of vocabulary problems you should avoid is using American spelling (unless you are submitting your report to an American audience). This means in particular:

- Verbs should end in 'ise' rather than 'ize' as in 'generalise' rather than 'generalize' and 'formalise' rather than 'formalize'.
- Words like 'colour' and 'flavour' should not be written as 'color' and 'flavor'.

4.2 Abbreviations

The rules you should follow on abbreviations are:

- Always avoid abbreviating words out of laziness. For example:

  Never write 'approx.' for 'approximately' (it may be better to write 'about');

  Never write 'e.g.' for 'for example'.

  An exception, but misused example, is 'etc.'. In most case where 'etc.' is used it can be avoided. For example, people usually use it in the following way:

  "He eats lots of fruit, such as apples, oranges, bananas, etc."

  The 'etc.' here is redundant because of the 'such as'. If you are using 'etc.' then the correct way to write the above sentence would be:

  "He eats lots of fruit: apples, oranges, bananas, etc."

- A long title, such as Tottenham Hotspur Football Club, should not be abbreviated if it is used only once in a document. However, if it is used more than once then it can be abbreviated to its initials THFC providing that the first time it is used you write the full title with the initials in brackets.
- Where initials such as THFC are used as above it is useful to provide a glossary.

4.3 Punctuation

This subsection covers the rules for using:

- Capital letters
- Apostrophes
- Commas
- Exclamation marks

4.3.1 Capital letters

People use capital letters far more frequently than they should. Apart from at the beginning of sentences, and proper names, the only other times you need to use capitals are for:

- Organisations and places (for example, the House of Commons);
- Acts of Parliament (for example, the Act of Union);
- Label formed from a proper name (hence Marxist, but not communist);
- North, South, East and West when they form part of a country name but not otherwise (hence South Africa, but not south London);
- Titles when used with the name but not otherwise (hence the Duke of York, but not the duke);
- Certain periods of history (for example, the Black Death, Renaissance);
- God.

4.3.2 Apostrophes

Apostrophes have two purposes only:

1. ***To show that a letter has been missed out***: For example, isn't (is not), can't (cannot), it's (it is).
2. ***To show possession***: For example, *the snake's eyes*, *the children's shoes*. If the thing doing the possessing already has an *s* at the end then do not add an *s*. For example, if we are talking about the eyes of several snakes then we write: *the snakes' eyes*. The only exception to this last rule is if:
   - it is a proper noun (Mr Jones's daughter);
   - the word ends in a double *ss* (the boss's office).

   You never use an apostrophe with a possessive pronoun like her, its, theirs, ours.

If you learn these two simple rules then you should know immediately that the following examples are ***wrong*** (yet they are extremely common):

- I gave the cat it's food
- I like tomatoe's
- In the 1960's
- All the department's were represented.

In each case the apostrophe should not be there. A related mistake, which is appalling in its stupidity yet incredibly common, is:

- I should of done my homework

instead of

- I should've done my homework (short for *should have*).

4.3.3 Commas

If you follow the principles described in Section 3 you will find that you need to use fewer commas because you are writing shorter sentences. This is a bonus, because the fewer commas you can use the better. Apart from the case where a sentence would be too long otherwise, there are just four reasons for using a comma:

1. ***Where you are writing a list***. For example: 'I like apples, oranges, peaches and bananas.' However, note that in technical reports it is usually better to use enumerated lists or bullet points. Where the items in the list include commas themselves you should use semi-colons rather than commas to separate the list items as in: "Government departments such as health; agriculture, food and fisheries; the foreign office and employment."
2. ***Where you are using a qualifying word or expression at the beginning of a sentence***, such as:
    - 'However, it is best..'
    - 'For example, we can see …
    - 'Unfortunately, you should know..
    - 'Firstly, it is unlikely ..
3. ***Where the sentence would be ambiguous without it***. For example: "I decided on an alteration of course" means that you changed your course, whereas: "I decided on an alteration, of course" means that, naturally, you decided to make an alteration.
4. ***To show where you have inserted a phrase***. For example: "Teddy, who is normally the best in the team, had a very poor match." In any such case the sentence should still make sense if you remove the part between the commas.

4.3.4 Exclamation marks

There are only two reasons ever to use an exclamation mark:

1. ***Where there is an exclamation*** as in "Do it now!", "Help!"
2. ***As the mathematical notation for the factorial function***, as in "the number 4! is equal to the number 24"

You should never use an exclamation mark at the end of a sentence to indicate that the sentence was supposed to be funny. Many people do this and it is both stupid and annoying. If the sentence was funny, the reader should have found it funny without having to be told to laugh. If the sentence was not funny the exclamation mark will have simply confirmed to the reader that you are a poor writer. Either way you lose in the eyes of the reader.

4.4 Summary

- The only certain way to avoid spelling errors and incorrect vocabulary is to use a dictionary whenever you are unsure of anything. However, there are common examples of words that cause errors and you can learn these.
- Use English rather than American spelling unless you are targeting an American audience.
- Abbreviations should be used only where necessary.
- Apostrophes should only be used to show possession or to show that a letter has been missed out. All other uses (especially when used before the ‘s’ in plurals) are wrong.
- There are simple rules to learn for when to use commas. In general, however, writing shorter sentences means using fewer commas.
- Apart from its special use in mathematics you should only use an exclamation mark in an exclamation. Never use it to tell the reader that a sentence was supposed to be funny.

5. Basic structure for reports

Although this document is primarily about improving the content of your writing (by understanding principles of good style) it is important that you first learn what is the required structure of a technical or business document. The section covers the following:

- What every report should contain (Section 5.1)
- General layout (Section 5.2)
- Sections and section numbering (Section 5.3)
- The role of introductions (Section 5.4)
- Figures and tables (Section 5.5)
- Special section about student project reports (Section 5.6)

5.1 What every report should contain

Make sure every report contains the following basic information:

- Title
- Author name(s), affiliation and contact details
- Date
- Version number
- Abstract (if more than 5 pages), which is essentially an executive summary
- Page numbers
- Table of contents (if more than 10 pages)
- Conclusions (if more than 5 pages)

It is incredible how many reports fail to contain this basic information. Many students, for example, often even fail to put their *name* on their reports.

The first four items above must appear on the front page. The abstract can appear on the front page or before the table of contents.

Ideally, each page should have a header and a footer (in Microsoft Word you create headers and footers from the *View* menu). The header should contain the author, title, and version number. The footer should contain the date and page number.

Page numbers should appear preferably in the form "Page n/m" where m is total number of pages. In MS Word it is easy to generate the number corresponding to total number of pages automatically – just insert the field "NUMPAGES" (click on Insert/Field menu and then just select NUMPAGES).

Assuming you are using a word-processing system you should generate the table of contents automatically. In Microsoft Word the menu option *Insert→Indexes and Tables* brings you to the required functionality. An automatically generated table of contents will pick up headings that you have nominated as sections and subsections etc.

Any report that is subject to a review procedure should also contain a 'change history' page, where the version numbers and dates are listed with the main changes that were made.

5.2 General layout

You should obviously try to make your report attractive to look at. However, this does *not* mean adding meaningless frills such as decorative borders or unnecessary graphics, which actually detract from your message. Figures and tables (see Section 5.5) are excellent for breaking up text, providing that they are genuinely helpful in clarifying your argument or better still if they are used instead of a long-winded textual description. You should also break the report up with sections and headings, as described here in Section 5.3.

One of the simplest ways to make your report attractive is by sticking to the following principles about fonts, spacing and margins:

- *Fonts*: Apart from headings and caption labels, you should generally use the same font and font size throughout. The *Times New Roman* font at 11pt or 12pt is a good choice.
- *Spacing*: It is good to have plenty of white space on a page. However, double-spacing throughout is overkill, unless you are producing a draft that you want somebody to annotate. Using a font like Times New Roman with the spacing set as *single* in MS Word looks fine (that is how this document is set up). However, what is crucial is that you should always leave spaces between paragraphs. In this document the space between paragraphs is defined by setting *Format → Paragraph → Spacing After* to 6pt in Microsoft Word. That way when you start a new paragraph the correct space is automatically inserted. You should avoid using the carriage return to create space between paragraphs.
- *Margins*: Leave wide margins (1.25in is good). For formal reports it is also best to use the 'right justify'.

5.3 Sections and section numbering

Any report longer than four pages should be broken up into sections using the following principles:

- Sections should be numbered (preferably using numerals. 1, 2, 3, ..). Whatever numbering convention you use you must be consistent.
- Each section should have a proper heading that accurately reflects the material contained within it.
- Long sections should be broken up into subsections, which should be numbered *n*.1, *n*.2, etc. where *n* is the section number.
- Long subsections should be broken up into subsubsections which should be numbered *n.m*.1, *n.m*.2, etc where *n* is the section number, *m* is the subsection number.
- Never use numbered decomposition smaller than subsubsections. Instead, use bullet points, itemised lists, numbered lists, numbered examples, etc. instead (see Section 3.2 for more on these).

In what follows we will use the word *component* as the general term for a section, subsection or subsubsection. Thus components are the building blocks of the document.

There are no hard and fast rules about 'how long' a component should be. It is more important that each numbered component contains a coherent content that is accurately summarised by its heading. However, in each document, component lengths at the same level should not be drastically different. For example, a document of 20 pages that contains 3 sections, one of 18 pages and the others with one page each, is an indication of poorly structured thinking.

At every level of decomposition there must always be AT LEAST TWO components. Thus, for example, a section can contain either no subsections or at least two subsections, but must *never* contain a solitary subsection. So, the following structure is NOT allowed:

1. Part One
2. Part Two
    2. 1 Part TwoPointOne
3. Part Three

Here Section 2.1 is called a 'hanging' subsection. There must never be hanging components.

However, the following is OK:

1. Part One
2. Part Two
    2.1 Part TwoPointOne
    2.2 Part TwoPointTwo
3. Part Three

So it is perfectly acceptable to have some sections without any subsections.

5.4 The crucial role of 'introductions' and summaries

The following rules explain the nature of 'introductions' at different levels of decomposition:

- The first section of any report should be an introduction and overview of the entire report. It should end by giving a walkthrough of the subsequent sections. Look at Section 1 of this report for an example.
- Where a section is broken into subsections the text immediately before the first subsection should be an introduction and overview of the entire section. It should end by giving a walkthrough of the subsequent subsections. Look at Section 3 of this report for an example. Note that Section 2 is not an example because it has no subsections.
- Where a subsection is broken into subsubsections the text immediately before the first subsubsection should be an introduction and overview of the entire subsection. It should end by giving a walkthrough of the subsequent subsubsections.

In other words, at each level of decomposition, preceding the first main component at that level there should be an introduction and overview of the set of components at that level. This introductory text should say what is contained in each of the components. Thus:

1. Section One (Introduction)

This is the introduction to the entire report. This report is about blah blah blah.

This report contains two main sections. Section 2 covers …. Section 3 covers …..

2. First main section

Since this section is broken into two subsections, the text here should just state what the purpose of this section is and what is covered in Section 2.1 and Section 2.2

2.1 Section TwoPointOne

The text for section 2.1 goes here

2.2 Section TwoPointTwo

Since this subsection is broken into two subsubsections, the text here should just state what the purpose of this subsection is and what is covered in Section 2.2.1 and Section 2.2.2

2.2.1 Section TwoPointTwoPointOne

The text for section 2.2.1 goes here

2.2.2 Section TwoPointTwoPointTwo

The text for section 2.2.2 goes here

Section Three

The text for section 3 goes here. No need for introduction as it has no subsections.

Where a section has more than one section it is also useful to include a summary at the end that reminds readers of the main points. In other words, each main section is structured as follows:

1. Tell readers what you are going to tell them.
2. Tell them it.
3. Tell them what you have told them.

The same is true at the top level, because the first section of the report is the introduction to the whole report and the final section is the report summary.

5.5 Figures and tables

It is good to include figures and tables in your document because they break up the text and make it more readable. When using figures and tables you should stick to the following the rules:

- Every figure and table in your document should be numbered and labelled, as in Figure 1 (Microsoft Word has very good features for handling numbering automatically – you should learn these.)

Figure 1: A very fine footballer

- Every reference to a figure or table should use the number of the figure or table. Thus, never write something like "the figure above shows a footballer", but write "Figure 1 shows a footballer". Spatial references to figures without numbering are nearly always ambiguous. Moreover, when you reformat your document you may find that the figure that was once 'above' actually appears on the top of the next page.
- Every figure or table that appears in the document must be cited at some point in the document (this is a consistency requirement).

5.6 A structure for student project reports

The following is an indication of the kind of structure that should be used in the write-up of a student project. In this example I will assume the project is about building a Bayesian network tool for predicting software faults.

- *Abstract* (see Section 6) - less than one page
- *Table of Contents*
- Chapter 1. *Introduction* (see Section 5.4)
- Chapter 2. *Background/motivation*. Should set out the context for the work - why the chosen topic is important/interesting. In the example this would address the issues of why people are interested in predicting software faults and why a Bayesian network approach might be useful. This chapter could also provide an overview of previous work in software fault prediction and why it is lacking.
- Chapter 3. *Research*. This chapter should describe your own research into the topics (if it covers more than one key topic then there should be a chapter for each), with full references. In the example, there are actually two topics you would need to investigate: software fault prediction and Bayesian networks, but the former could go in Chapter 2. For Bayesian networks you would be expected to provide an overview of what they are, how they are used, the tools that support them, and other similar BN applications.
- Chapter 4. *Requirements*. This chapter should describe the requirements for the system you have built, together with how the requirements were captured. You should use UML notation of use cases.

- Chapter 5. *Design*. This chapter should describe the high-level design of the system, preferably using class diagrams.
- Chapter 6. *Implementation*. This chapter should provide an overview of the implementation, providing information about low-level design decisions not covered in the previous chapter. You should include screen shots. You should not include the full source code, but you should include code fragments that illustrate key points or algorithms in your implementation.
- Chapter 7. *Testing*. Describe what your test plans were and how you carried them out. At the very least you should explain how you tested against the use cases.
- Chapter 8. *Conclusions and recommendations.* Include the personal stuff (what you have learnt, what was good/bad, what worked/didn't, what you would do differently next time etc.) and general recommendations (in the example this would be about building BN applications and software fault prediction).
- *References.*
- *Appendices* (Log of meeting, work plan, detailed class diagrams etc).

5.7 Summary and checklist for when you finish writing

The following checklist should be applied before you give even an early draft of your document out for review:

- Check that the structure conforms to all the rules described above.
- Read it through carefully, trying to put yourself in the shoes of your potential readers.
- Run the document through a spelling checker.
- Make sure you generate an up to date table of contents and references to figure and table numbers (selecting all the text and pressing the F9 key in MS Word should do all of this for you).

6. Abstracts and executive summaries

There are two types of abstracts: *descriptive* and *informative*. A simple example of the difference is:

> *Descriptive*
>
> This report describes the advantages and disadvantages of each of the options available for dealing with the problem of increased air passenger traffic to Newtown and provides a recommendation for a way forward.

> *Informative*
>
> This report describes the four options available for dealing with the problem of increased air passenger traffic to Newtown. The options are
>
> 1. Build a new runway at the existing airport
> 2. Build a new airport in Newtown West
> 3. Build a new airport 30 miles north
> 4. Do nothing
>
> The first three options will all provide a short-term boost to the local employment market, while options 2 and 3 will provide long-term economic benefits. Option 1 is relatively cheap, but will only provide a short-term solution. Option 2 is expensive and unpopular with local Newtown residents. Option 3 is more popular, but just as expensive. However, there is a possibility of a higher government subsidy for option 3. Option 4 is likely to be ruled out after the result of the next local elections. We recommend option 3.

A descriptive abstract says what you do in the report without providing any of the information or results. An informative abstract says what the report contains, including summarising the main results. An informative abstract is also called an *executive summary*. You should always write informative abstracts rather than descriptive abstracts. Since informative abstracts are generally longer, this recommendation may come as a surprise to you. Elsewhere in this document I have emphasised the need to write as few words as possible. The difference here is that descriptive abstracts provide no sensible information at all (beyond what you might find in the document title and table of contents). Hence, they are a complete waste of time and space. They are not an alternative to an informative abstract.

As a further, more comprehensive example, compare the following two abstracts describing the same case study:

> Version A (descriptive)
>
> This report describes a major case study to evaluate the effectiveness of using a formal method during software development. We describe the background of the method used and discuss the claims made in favour of these kinds of methods. We describe the experimental set-up and the particular software under investigation. We present a range of results indicating the circumstances under which formal methods may be effective. We explain the measurements that were used, along with the

rationale for using them. We compare the results of the measurements at different life-cycle phases. We consider the different uses of the system. Finally, we present a number of strong recommendations.

Version B (informative)

VDM is one of the best-known formal methods used in software development. We describe a case study to evaluate whether higher quality code results from the use of VDM.

The case study involved an air traffic control system developed over three years. Some of the modules in the system were developed using VDM (160 modules making approximately 400 KLOC) while the rest of the modules (300 making approximately 700 KLOC) were developed informally.

We found that, prior to release, the fault density of formally developed modules was not significantly different to the informally developed modules (4 faults per KLOC being typical). However, the fault density in the 6 months post-release was significantly lower for formally developed modules (on average 0.6 faults per KLOC compared to 1.4 faults per KLOC). More faults were found during the early development phases in the formally developed modules. This favourable evidence to support formal methods is countered by the following observations:

1. the formally developed modules generally took 25% longer to complete than similar sized informal modules.
2. the formally developed modules were those concerned with the critical functions and were developed by more experienced and better qualified staff with a strong mathematical background.
3. the non-formally developed modules included all of the interface code so faults discovered in the first 6 months post-release were inevitably more likely to be in this part of the system.

Despite these reservations we believe that the post release fault-density for the formally developed modules was very low. We therefore recommend that companies should consider using formal methods such as VDM for the most critical components, providing that they have well trained staff with a very good mathematical background.

As in the previous example, Version A actually tells the reader *nothing* about the case study. This writer is challenging the reader to read through the entire report in order to find out the basic results. Version B, on the other hand tells us all the key information about the case study without including anything superfluous. Even if we do not have time to read the paper (and most readers never get further than the abstract) it tells us what we really need to know. It even makes us more likely to read the paper because it will identify and target key readers.

Since informative abstracts are so obviously superior to descriptive ones why do the majority of scientific writers still insist on providing descriptive abstracts that infuriate us and insult our intelligence? Normally, the reason is laziness, although in some cases it may be due to the fact that the author really has nothing to say. Descriptive abstracts are often written *before* the work has even been carried out. In other words, the abstract is merely a plan for the author. Plans are fine and necessary in order to complete a piece of work; but if you were delivering any product you would not use your original project plan as a replacement for the product description. So never use a descriptive abstract.

7. Writing that includes mathematics

This section provides three of the most important rules to follow when your writing includes mathematical symbols and formulas. If you follow these rules your report will be easier to read and understand.

Rule 1: All variables should be in italics to distinguish them from normal text:

Incorrect: The value of a increases when a is less than 100.

Correct: The value of *a* increases when *a* is less than 100.

Rule 2: When including equations in your work these should be set out on a separate line, and preferably labelled. The dangers of not doing so are that:

- The equation may end up stretching onto the next line;
- Readers may find it difficult to understand where the text is separated from the equation;
- It is generally much harder to follow.

Here is an example:

Incorrect:

The value of x can be computed as $x = 1/y + f(z)$. In this equation $f(z)$ represents a particular function of z.

Correct

The value of x can be computed as:

$$x = 1/y + f(z) \qquad \text{Equation (1)}$$

In Equation (1) $f(z)$ represents a particular function of z.

The only exceptions to rule 2 are when the equation involves just 2 variables separated by an operator, such as $x=y$ or $x>2y$. In these cases you do not need to leave a space between the symbols, so there is no chance the equation will run over the line.

Rule 3: Never start a sentence with a mathematical symbol of any kind, since this can create genuine ambiguity as well as just being hard to read. For example:

Incorrect: We have computed the value of x in terms of y and z. z is in turn expressed as a function of another variable.

Correct: We have computed the value of x in terms of y and z. The variable z is in turn expressed as a function of another variable.

8. Summary and conclusions

No matter how poor you think your writing skills are, you really can learn how to improve them. Good technical writing is about using plain English. This is much easier than the writing style many of you will have been taught at school. You do not have to know and use long words and complicated phrases. You do not have to make your writing more 'interesting' by thinking of different ways to describe the same thing. In fact, the simpler and shorter you make things, the more likely you are to produce technical reports that get results.

This document has provided a number of easy-to-use guidelines to help you improve the reports you write. The crucial points are:

- Have a clear objective in mind before you start writing and make sure that everything you write is geared towards that objective alone.
- Keep things as simple as possible by using language that is concrete and familiar.
- Keep sentences and paragraphs short.
- Avoid long, pompous words and phrases when there is a short simple alternative (especially avoid the words: utilise, facilitate, endeavour, necessitate, render).
- Avoid unnecessary words, clichés and legal words.
- Avoid repetition.
- Use active rather than passive style.
- Do not turn verbs into nouns.
- Use personal rather than impersonal style.
- Always refer to the same 'thing' in exactly the same way.
- Make sure all reports conform to the basic structure described (title page with appropriate details, page numbers, appropriate section numbering, and introductions and summaries where appropriate).
- Use examples and analogies before introducing abstract concepts.
- Use a dictionary, and make sure you learn the words that are commonly miss-spelt or misused;
- Write informative (rather than descriptive) abstracts.
- If your writing includes mathematical symbols and formulas follow the rules about how these should be displayed.

Finally, once you have checked that your report conforms to the principles described here, have a friend whom you trust read through your report before you submit it. Act on their recommendations, because they are likely to find the same problems that your intended audience would.

9. References

You should try to get hold of a copy of at least one of the following books, all of which provide a far more comprehensive treatment than I can cover in these pages:

- Jay R, 'How to Write proposals & reports that get results', Pearson Education Ltd 2000, ISBN 0 273 64497 1
- Kirkman J, 'Good ttyle; writing for science and technology', E & FN Spon, London 1992
- O'Connor M, 'Writing successfully in science', Chapman and Hall, London 1991
- Turk C, and Kirkman J, 'Effective writing: improving scientific, technical and business communication', E & FN Spon, London 1989