

Hints to good technical writing

For some people good writing comes naturally. But for the rest of us, it need not be difficult to write reasonably well with the help of some rules or guidelines. In this paper I outline some of the rules I use when writing. These help me to save time and to be as effective as possible.

1. The right attitude

It is essential that we have the right attitude with regard to the question “for whom are we writing?”. On one hand you are obviously writing for the benefit of the person who will read what you write. You have something to say, and your reader needs to hear your message. But on the other hand you are also writing for your own benefits. Because you have a message, you need people to read about it. Without getting into the complex psychology of our motivations, we can all identify with the sense that when you have something to say you want people to hear it. So as a first guess we can say that the beneficiaries of your words are 50:50 your reader and you as the writer. Put another way, who is most privileged to have someone read what we write? Is it your reader, or is it you as the writer? I am sure that part of the search for success in writing is to realise how much of the privilege is the writer’s.

Golden rule – you are writing for the benefit of your reader. Make sure that you always aim to help your reader as much as you can.

If you are writing for the benefit of the reader, you need to make sure that you help your reader as much as possible. One way to help the reader is to make reading your work as easy as possible, in both the fine detail and the larger picture. Allow your reader to sit back and enjoy your work, and take away from your reader as much of the effort as possible.

2. Preparation in the mind

Golden rule – Be very clear about what you want to write before you start.

You have a story to tell, but you need to be very clear in your mind exactly what this story is. And you only become clear by detailed rehearsal. Different people have different ways of rehearsing their story. Some people need to sit and write detailed notes, whereas others are able to rehearse their story as they walk home, or whilst they sit in the bath, or as they do the gardening. Whichever is more appropriate, you should not begin to write until you have a very clear idea of what you want to say.

Part of this rehearsal is to get excited about your story. What you are about to put into your reader’s hands is something that is very precious to you – it has absorbed time and effort, and you have some satisfaction in the main outcome. Telling the story should not be yet another effort, but should be something that excites you. You are about to take your reader on a journey through territory you have explored before anyone else has been there, and now you have explored it you want to show it to people. As you dwell on your story it will become exciting to you, and you should not think of taking anyone on your journey until you are excited about it. Your story is a treasure chest for which you have the key. Your initial exploration was exciting for you, and now you should be equally as enthused about sharing this excitement with you readers.

3. Guide your reader through your work

It is wholly inappropriate to assume that your reader will be able to put as much effort into reading your work as you put into preparing it. It is likely that your reader will be picking up your work late at night, with a mug of cocoa to help relax. Or else your reader will be on a train with time to kill, but with half an anxious mind on the stations flashing by and the meeting at the other end. It is unlikely that your reader will have devoted a large part of the best time of the day to sit and study your words in a quiet atmosphere. Because of this, your reader will not be able to keep in mind complex arguments, or be able to cross-reference one part of your work with another. Your reader will not be able to look at a diagram or table and form the deduction you are hoping for. Worse than this, the chances are that if your reader is not able to make sense of what you are saying he or she will simply give up. Remember, your reader's time is precious, and if your work does not immediately entertain and inform your reader will instead choose something that does!

Golden rule – Make your work as easy to read as possible, in both the overall layout and in the way you construct the text.

So how can you make your reader's task as easy as possible? Some simple rules are

1. Careful use of sections and subsections with proper headings, effectively separating different parts of your story into self-contained compartments.
2. Use short sentences instead of complex ones, and in particular avoid too many qualifications within single sentences. On the other hand, it is nice to have variety, and a long series of short sentences can be dull. The spirit of this rule is that short sentences are to be preferred where possible, but do not feel constrained when a long sentence would be appropriate.
3. Avoid all forward referencing unless you are simply aiming to whet the appetite for what is coming up.
4. If you direct the reader to a diagram, table or equation, explain in plain words in the text what you want the reader to take from this. Do not expect the reader to draw the conclusions you want them to draw.
5. Begin each paragraph with a sentence that anticipates both the content and purpose of the paragraph. And do not use a single paragraph to make several separate points.

Remember, you are not tangling a complex web for your reader to untangle as a challenge!

4. Use a careful layout

Golden rule – use headings, subheadings, and first sentences of paragraphs carefully in order to guide your reader through your work.

The use of headings to divide your work into manageable chunks is self-evidently of value in making your work easier to read. But the use of headings should extend well below the level of main headings, and in this section we will explore the use of actual and virtual headings.

The main headings, which are often called *Level A headings*, are used to separate your work into distinct compartments, with the headings giving an

indication of the content and purpose of the compartments. For example, for a simple paper that reports a new experimental measurement, one can imagine the following set of headings:

Introduction This section contains descriptions of the state of the field, the specific issues that will be tackled in the paper, and the approach that will be taken to tackle these issues. The introduction should usefully contain an indication of how the paper is structured in order to set your reader on a well-lit path. Some people think that many members of their readership will not have time to read beyond the introduction, and therefore aim to “spill the beans” of the story within the introduction. There is a fine line between anticipating the rest of the paper and merely duplicating later materials, and so this approach should be taken with care.

Methods The methods used in the investigation should be systematically described and discussed in this section. It should be appreciated that your reader may want to gloss over this section, so it should be viewed as a reference section for readers who are particularly interested in the details. Because of this, it is best to avoid discussion of extra issues (for example, matters of science or interpretation) that you need your reader to appreciate. This section can contain details about the initial treatment of the experimental data as well as about the experiment, and if your entire data analysis uses standard analysis methods to extract the main results you can describe these here also.

Results You will use this section to present your main results, having dispensed with your intermediate results in the methods section. Remember, you need to avoid overwhelming your reader with too many results, so you should aim to present only the final results and not a whole swathe of intermediate results. The latter may be better placed in your methods section. You should aim to interpret the results as you present them. It is unreasonable to expect your reader to keep in mind all your results until you reach the next section. You should also aim to present your results in a logical sequence, allowing one set of results to build upon another.

Discussion This section is perhaps the most difficult to anticipate. In some cases, particularly when you are presenting a single result that the reader will readily understand, it may be almost entirely superfluous and could therefore be dropped. On the other hand, if you have presented a number of results in the previous section, the discussion section can be used to bring everything together in order to complete the story.

Once you have defined the set of main headings, you may want to improve further the structure of your work by breaking some or all of your sections into subsections. For example, your methods section may contain subsections on sample preparation, sample characterisation, descriptions of main experimental techniques, data reduction, and preliminary treatment of analysis of experimental data. Again, the subsection headings (often called *Level B headings*) should tell your reader exactly what to expect in each subsection.

You can use further subdivisions with headings, called Level C headings, but these should only be used if necessary. Too many levels of headings create too much of a web, and it is not reasonable to expect your reader to go down too many levels and keep hold of your main purpose. Level C headings should really only be used to separate sets of paragraphs that present different facets of a single idea, such as different examples of a main point, or repetitions of a set of procedures.

Different headings should be differentiated by different type faces, and numbers with points (e.g. 1.1, 1.2, ...) can be used to good effect. You should also consider spacings before headings, with larger spacings before Level A headings than before Level C headings.

You should view your paragraphs as mini-sections in their own right, and the careful use of paragraphs will play a large part in helping your reader through your work. A paragraph should contain a single idea, perhaps one that is expanded, or illustrated, or contrasted with other ideas. The first sentence of each paragraph should tell your reader what to anticipate in the following sentences. Much thought should go into the choice of first sentence.

5. Careful preparation

No-one would argue against careful preparation, but nevertheless many people embark on a venture without adequate preparation. Preparation achieves two purposes. First, it maximises the prospect of success. Second, it minimises the wastage of time and effort.

Golden rule – Careful planning saves time and helps you achieve your purpose in writing.

There are two ways in which the writer can be fully prepared. The first is to ensure that all the material is at hand and the story to tell is complete. It is easy to start writing a section before all the data have been analysed, and figures prepared. But it may later turn out that you don't have time to complete your data analysis, and then your story will have changed.

The second way in which the writer can be prepared is to carefully sort your story into a detailed layout before you start writing detailed text. My way is to follow the following steps:

1. Decide on what your story contains, and exclude sub plots that are superfluous
2. Decide on your main headings and the content and purpose of each section
3. Decide on the set of Level B headings you may want to use within each section
4. Select the diagrams and tables you will need for each section or subsection
5. Order the points of each section or subsection, and write the first sentence of each paragraph
6. Once you can see how each subsection is panning out, decide whether the flow of ideas could benefit from the use of Level C headings.
7. Finally write the text within each paragraph

Contrary to the advice given in many manuals on writing, I would argue that with careful preparation your first draft should be very close to your draft. There is no point writing

something twice. The corollary to this is that you should make it a rule not to write anything unless you know where you are heading. It is very tempting when you are stuck to just write anything with the view of editing it later. This is most wasteful of time, and may actually divert you away from the best path in your telling of your story. It is better to write nothing at all than write something that is not well-planned and carefully constructed.

6. Some short points about style

Some short rules on style

1. Use type styles carefully
2. Use variety in your sentences
3. Be explicit
4. Be careful in your use of the first person
5. Be careful to describe the main message from diagrams and tables
6. Be careful to explain equations

1. Use an attractive and consistent type style. Use a consistent margin justification throughout. Use a line spacing within paragraphs that is slightly larger than the font size (such as 14–16 point spacing with 12 point type face), and set up your word processor to force this line spacing (without this you may get variable line spacing if you use subscripts and superscripts or some special fonts). Use different fonts or font size/style for headings, but avoid making your headings too brash. You are not the owner of a McDonald's restaurant trying to attract passing motorists! Never use underlining – it simply tells the reader that you don't know how to use the range of facilities offered by a modern word processor

(underlining used to be the only flashy thing a typewriter could manage, but you will never see underlining in a book or journal).

2. Use variety in your choice of phrases, and in your sentence construction. Not too much variety so that your story becomes an eclectic collection of styles, but enough to retain the interest of your reader.
3. Be explicit in your choice of phrases. If you want to tell the reader something as an aside, begin your sentence with “As an aside ...”, or “In passing we can also note that ...”. If you want to make a contrast between something you have said and another idea you may want to raise, use appropriate sentence beginnings such as “On the other hand”, or “However, we can also make the opposite point that ...”. If, after a complex argument, you want to summarise or reinforce the point, you can begin the sentence with “To summarise, we see that ...”, or “The point is that ...”. Do not hide your message behind subtle turns of phrase.
4. I like the use of the first person, but this needs to be used with care. You are not telling the story of your holiday, and even if you did, you would achieve better effect by mixing first and third person. You should aim to use the third person as much as possible, with appropriate sprinkling of the first person for variety. The use of “we” can take on several meanings: you and your co-authors, you and the reader, you and the rest of the community, or simply the “Royal We”. You should aim not to mix up these usages.
5. Describe the main message from a diagram or table within the text so that the reader can continue without having to actually look at the diagram or table. Do not expect the reader to be able to break away from the text, interpret the data in the diagram or table, and then come back to the point you were making in the text without having forgotten what you

were saying. A diagram or table should be viewed as supporting evidence or a helpful recasting of your arguments, to which the reader can refer if they need convincing.

6. Similarly, do not expect your reader to understand an equation. Instead, in the sentence before an equation tell the reader what the equation is doing, and in the sentence after the equation summarise what the equation has done. That way the reader will be able to read the text without having to fully understand the mathematics of the equation. The equation therefore act as reference material, to which the reader can turn if needing to use your work for something else.

Appendix: Project reports

The methods of writing outlined in this paper apply equally as well to Part II/III project reports as to any other form of science writing. Here I outline how a good project report might be constructed. The headings I suggest here provide a guide, but different projects may call for different structures. Invariably the borders between sections are not always clearly defined, and this guide should be interpreted in the context of your own project. This outline is not designed to be proscriptive.

I have outlined some of the sections that could be included in the project. It is often useful to break these sections into subsections, with each subsection devoted to one aspect.

Abstract

This is a concise summary of the main themes of the report, which typically is of one paragraph only and will be of around 1/2 to one page in length. It should not exceed one page in length. The purpose of the abstract is alert the reader as to what will be found in the report. The abstract may include the following:

- One sentence summary of the objective of project
- Main results, either a few numbers if appropriate, or brief description of main results
- One sentence summary of main finding

Introduction

The introduction will serve a number of roles, which *may* include the following:

- Clear explanation of objective of project
- Science context of project (what was previously know, what activity is going on in the science community in the area of the project, what are the open questions, with appropriate references)
- Clear and concise explanation of the route taken in the investigation, without the details (which will be in the methods section)
- Indication of what the reader may expect to learn through reading the report (e.g. brief summary of what the main finding will be)

Methods

Clearly this section should be devoted to discussing the technical issues of the work, whether experimental or computational. This section *may* include

- Details of experimental equipment and procedures

- Details of calculations performed, including details of programs
- Data correction and data reduction
- Sample plots of spectra, diffraction patterns etc, with quality of any data fitting shown on the plot (e.g. diffraction pattern with Rietveld fitted pattern superimposed)
- Preliminary results that come from data reduction but which are not primary results for the science investigation (e.g. results of Rietveld refinements when such results are to be used rather than as the end result)
- Discussion of problems in the methods that lead to limitations or constraints on the results that emerge (e.g. values of parameters in data analysis may be correlated and impossible to resolve)

The methods section *should not* include

- Discussion of scientific importance of results
- Results from the analysis of data (e.g. temperature dependence of an important parameter)
- Results that are close to the science objective of the project (e.g.
- Piles of data – appendices can be used when there are many similar sets of data to be presented

Results

This section is devoted to presenting the hard facts that have been uncovered in this project. The results section *may* include the following

- Collation of data, e.g. as plot of some measurement or calculation against temperature
- Analysis of data leading to new results, e.g. temperature dependence leading to an activation energy
- Interpretation of data by some formalism that leads to a new result, e.g. fitting a Landau free-energy function to data leading to determination of parameters
- Results that form the end-product of the investigation

The results section *should not* include

- Discussion of scientific importance of results
- Piles of results that are similar – appendices can be used when there are many similar sets of results to be presented

Discussion

The discussion section is where the main results are interpreted and placed into the overall context. This section *may* include

- Discussion of scientific importance of results
- Discussion of constraints on the results that arise from limitations of the methods
- Discussion of new insights or understanding that arise from the results
- Placing results into a broader context, flagging any new contribution that arises from this work
- Suggesting ways forward

The discussion section *should not* include

- Discussion of methods or data analysis, except when these are new and form part of the focus of the report (after all, some projects do include significant developments of new methods)

Summary

Summary sections should be used with caution. This section *should not* simply reproduce parts of the discussion section. The summary section is useful when there are several points that have been made in the project, and it would be useful to bring these together to demonstrate the breadth of the report. The summary section *may* be used to

- Highlighting new techniques developed in the work
- Highlighting the important results
- Highlighting new insights or new understanding
- Flagging any new issues that have emerged

The summary section *should not* be used to

- Provide a discussion of the results
- Provide a discussion of what can be done next
- Repeat other aspects of the discussion section

Appendices

Appendices are useful when you need somewhere to place data, results, methods etc. when the description is likely to make the main project report harder to read. A project report may need to document too many sets of data or data analyses for these to be included in the main body of the report, but they do need to be documented somewhere. For example, you may have performed Rietveld analyses on diffraction patterns from a range of compositions of a

material. It is important that the results from all these analyses are included in the report, but their inclusion in the main body of the report may seem inappropriate. This is a problem that can be solved by an appendix. As a guide, use an appendix when you suspect that the reader will simply gloss over several pages in the main text. The reader can then look up the appendix when needed. You can have several appendices, and one appendix *should not* cover more than one theme. Topics for appendices *may* include

- Background theory, particularly when not original
- Tables of data that need to be documented for reference, but where the tables themselves do not contribute to the main flow of the report (a sample table can be included in the main text)
- Plots from the analysis of the data that need to be documented for reference, but which interrupt the main flow of the report (a sample plot can be included in the main text)
- Details of methods, where the details are not of direct interest to the reader but which ought to be documented for reference
- Details of any computer programs written for the project
- Discussion of any side point that may have arisen but which would be a distraction in the main body of the text

References

The references *should* be listed in a separate section after the end of the report. It is useful to give the titles of the articles included. Unpublished data made available to you should be referenced as such. Information communicated to you verbally, but which is not contained in any publication, should be referenced as “personnel communication”. This could include suggestions of how to do something, or ideas of interpretation.