Report Writing Anatomy

Associate Professor Sam Zhang (msyzhang@ntu.edu.sg)
School of Mechanical and Production Engineering, Nanyang Technological University
March 2004

Foreword

Frequently we face the question of how to a technical report: Lab report (spreading over all years of students), Final Year Project (FYP) report (graduating undergraduate students in the final year), First Year Report (for Master students or PhD students' candidature confirmation), Master or PhD thesis…

Frequently I find myself correcting same kind of mistakes again and again in those reports. Finally I decided to give my student a lecture on how to write technical report by highlighting the mistakes I have collected over the years. I call it a "Report Writing Anatomy". This document is a result of this lecture. Hope the students could benefit through making fewer mistakes and reviewers could benefit because they don't have to correct the same old mistakes again and again.

Comments and suggestion are always welcome

Structure:

A technical report always has a more or less fixed structure. The following is a good example:

1. **Abstract**
2. **Acknowledgements**
3. **List of Figures (if necessary)**
4. **List of Tables (if necessary)**
5. **List of Abbreviations (if necessary)**
6. **Introduction**
7. **Literature Review**
8. **Experimental Procedure**
9. **Results, Discussion**
10. **Conclusions**
11. **Future Work**
12. **Reference**
13. **Appendix (if any)**

I will elaborate each of these items and point out do and don'ts in the following section:

- **Abstract:**

An abstract is the overview of the entire report where you summarize *motive*, *methods*, *key results* and *conclusions*. Be brief and avoid waffle and spurious details. Usually I find myself writing or revising the abstract AFTER writing the whole thesis especially after writing the conclusions.

- **Acknowledgements:**

This is the place where you express your gratitude to organizations or people who have helped with ideas, technical assistant, materials or finance. Keep it simple, give full names and affiliation, and avoid getting too sentimental.

- **Introduction:**

A good introduction starts with ordinary things that the reader can easily relate to his/her existing knowledge, and immediately catches reader's attention thus making the reader wanting to read on. Then it outlines the problem and why it is worth tackling. Briefly give an account of the *main contributors*, summarize the *status of the field* when the research was started, provide any specialized information that the reader might need if he is to understand what follows; State what will be done that has not been done before *(new experimental approach? new data? new model? new interpretation?);* Keep it as brief as possible whilst still doing all the above mentioned

- **Literature Review:**

This is where you establish the foundation of your project: In the topic of the research you proposed, what has been accomplished and what is still lacking? It is a piece of *discursive prose*, not a list describing or summarizing one piece of literature after another, not a pile of arguments or sections copied from textbook or research papers. You must read extensively, digest, analyze and find the logic among different researchers' views on a topic or topics surrounding the problem or issue concerned. Organize the chapter into sections that present themes or identify trends, including relevant theories. Based on this, your topic is put up to be addressed.

If you write a good literature review, you will find that in your discussion, you frequently refer the reader to the literature review chapter (particular section or formulation, diagram, etc.).

- **Experimental Procedure:**

The three major elements for this chapter are *equipments*, *materials* and *method*. This chapter should exclusively cover what YOU do and use to carry out YOUR study for YOUR project. Description on the characterization techniques or principles should not be in this chapter but in a dedicated section in the "literature review". Experimental parameters (e.g. deposition conditions) should be in a format that allows comparison, *e.g. target power in terms of power density (watts/effective target area)*. Results should not be here. This chapter should dedicated to "What I use and how I'm going to measure" a particular property under what kind of conditions. Remember to put in details of equipment used, such as Model, Make, year together with detailed testing or measurement conditions, such as speed of loading, sampling frequency, voltage, current, step size, number of measurements, how the data will be obtained (mean value of 10 measurements? Fitted into straight line? etc)

- **Results:**

In this chapter you present the output of the experiments, model or computations. The "output" should treated output, analyzed output, not simply the machine printout (which, in necessary, should be placed in appendix). The data should be reported without opinion or interpretations at this stage. Define all symbols and units. Give emphasis in the text the most important aspects of the figures and tables. Give error-bars or confidence-limits for numerical or graphical data. Text should always come before a plot or diagram or micrograph is put out. Plots, tables, diagrams, micrographs should also be called for, not just pop out from nowhere and out of blue.

- **Discussion:**

Here you discuss your results, extract principles, relationships, or generalizations from the results. The function of "discussion" is to describe the analysis, mechanism, models and theories and lead the reader through a comparison of these experimental or computational results. Put forward the most significant conclusions first; develop subsidiary conclusions after that. Be clear and concise, and do not waffle. Keep in mind, this is where you express YOUR opinion, YOUR argument or YOUR explanation of what is going on based on the results you presented. Therefore, combining discussion and the results you will draw conclusions in the conclusion section. The result chapter provides the basis and the discussion chapter is the argument for the conclusions you will draw.

- **Conclusions:**

Based on the results and discussion, here you draw the most important results and their consequences; List any reservations or limitations. Only be *conclusive* when concluding anything. "Horses have four legs" is conclusive.

In the conclusion section, don't start discuss again. You have done that in the "Discussion" section. Likewise, "future work" should not be mentioned in the conclusion section. Dedicate the conclusion section to concluding remarks.

It is acceptable to present "conclusions" as a bullet-pointed list or numbered list. When concluding, be precise, accurate, and brief (don't start arguing).

- **Future Work:**

This chapter should only list the work to be done, and should not include or further elaborate on work that are already accomplished

- **Appendix:**

Appendix is not a place you dump all experimental data regardless of whether it is used or not used in the main chapters. Appendix should house *tedious but essential* derivations, data tables etc., that would disrupt the flow of ideas in the main text if not put away. All appendices should be mentioned in the main text. If not, they should not be there in the first place.

That concludes the main structures. Next I will highlight some important aspect where mistakes always appear:

- **Abbreviations:**
  - All abbreviations should be spelled out for the first time when they appear, including that in the abstract. However, if a term is not used the second time in the abstract, that term should not be abbreviated in the abstract. If it is used in the main text more than once, then define the abbreviation there, not in the abstract.
  - Use abbreviations prudently. Try not to use them if possible (don't run wild using abbreviations)
  - A list or table of symbols and abbreviations should be included for bigger size reports

- **Figures and Tables:**
  - Table should be arranged such that the title of the table *precedes* the table itself, not at the bottom of the table.
  - Figures should be arranged such that the title and figure caption *come after* the figure itself, i.e., at the bottom of the figure.
  - All figures and tables should come in *only after* they have been mentioned or call upon in the text
  - In figure caption, it helps to elaborate or highlight the points to be made; always consider the *purpose* of putting the figure there *(e.g. what do the figures prove or illustrate?)(What do you want your reader to learn from this figure?)* In research papers (journal papers) it is not common to highlight this in figure caption because of the page length concern. But in reports, it is usually good to put it in. This helps the authors in deciding whether it is necessary even to include that figure or not. It also helps to lead the reader to the point you want to make.
  - Keys and legends should be presented such that they can be easily differentiated and recognized (On screen, one can see colors, but printed copy is usually black and white. Be considerate of this)
  - When presenting micrographs, make the scale bar prominent, and drop the use of magnification (1000X, etc). It makes no sense to give a magnification (and maybe wrong) because the presentation may be on a piece of A4 sized paper or maybe on a large projection screen. In the original photo, make the scale bar according to its magnification and group it with the photo, thus enlargement or shrinkage of the photo will enlarge or shrink the scale together.
  - When presenting photos or figures copied from reference materials, ensure that the quality is good; note that the quality of the photos will be compromised when being save as *.jpeg format (due to the compression method), but this can be rectified by using a suitable image processor to improve the quality before saving
  - Note also the file-size of photos and figures will be large if they are save as *.bmp or improved quality *.jpeg.
  - If you directly copy a photo directly from the screen and paste into word document, the file is bmp type and it results in big files. Save the photos in jpg file and then use the <*insert picture*> function in the word processor to insert the photos and figures. This way, the file-size of the report will be reduced drastically.

- **Referencing:**
  - It is a conventional courtesy to reference the originators of key ideas, theories or models. In fact, I would not just consider referencing as a mere "courtesy". It is a must, a demonstration of integrity: in way of recognizing other's work and contribution. Also, proper referencing provides support to your work and also the leads for your reader to follow should he wants to.
  - By-chapter listing of references is not advised (though it is okay sometimes), put all references in the end of the report.
  - DO NOT cite references at the section heading--- that is very silly and demonstrate that you do not know what is all about referencing! References should be cited immediately after the specific statements, data or equations extracted
  - Cite the references at caption when the figures or tables are from other people's work
  - Ensure statements extracted from the references of relevancy and significance, *e.g. "sintering is one of the most important technological processes in the powder metallurgy and ceramic industry"* does not seems to require a reference
  - Make sure all cited references are indispensable
  - Citing references dated many years back (e.g. 1977) should be carefully considered for their relevancy at the present time

- **Language:**
  - Essence of technical writings is *communications*
  - The quality that precedes all others is *clarity*
  - Use simple language and simple concise construction: short words rather than long; familiar words, not obscure
  - Do not waffle; writing evasively on points that are already clearly known is a waste of the readers' time
  - Avoid clichés and weak qualifiers *(e.g. rather, somewhat, quite)*
  - Do not overstate or over-emphasize
  - Never apologize, *e.g. unfortunately, there was insufficient time to complete the last sets of tests* (suggests bad planning and incompetence)
  - Do not patronized: *the amazing perceptive comment by Lu . . .*
  - Do not be condescending: *readers familiar with my work will know . . .*
  - Interjections are strictly prohibited in technical writings
  - Special attention should be paid to avoid mixing of tenses
  - Do not rely on the word or syntax correcting function of the word processor
  - Always be wary of broken and incomprehensible sentences, grammatical and syntax errors
  - Write in a way that draws attention to the sense and substance of the writing, not to the mood of the author

- **Others:**
  - A holistic treatment with good logic and fluency of the entire report is of great importance; Stand-alone chapter beginning with its own introduction, literature

review, etc., should be avoided. (That is usually resulted from ineffective integration of several published papers from the author)

- Equations will need derivation, reference or justification
- Always use *S.I. units*
- The emphasis (e.g. doping or synthesis parameters) of the proposed work should be made clear from the beginning and be consistent till the end. Avoid switching of emphasis of your work.

In compiling this document, reference has been made and some points picked from "How to Write a Paper", 3rd Edition, by Mike Ashby, Engineering Department, Cambridge University, UK, 2004. I strongly recommend that all students download and read that write-up.