

A Few Writing Tips (and More) Prepared for my Students

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- 1. Elements of a Ph.D. Research Project**
- 2. Elements of a Journal Paper**
- 3. Steps in the Publication of a Journal Paper**
- 4. Written Report Guidelines**

1. Elements of a Ph.D. Research Project

- (Parentheses contain knowledge that must be acquired by the student in course of research)
- Suggestion of a problem to be solved or a question to be answered (general knowledge in some area)
- Elucidation of importance of the problem or question (mature insight into that area)
- Development of a novel idea to solve the problem (design techniques)
- Exposition on the history of the problem and previous solutions (deep knowledge of the literature in the area)
- Development of a theoretical framework for the solution (theoretical techniques)
- Experimental exploration of the solution
- New fabrication techniques developed (new equipment development, equipment maintenance, laboratory techniques, experimental techniques)
- Measurements of fabrication results and solution results
- Demonstration of the solution in working prototype
- Theoretical modeling and explanation of results achieved (modeling techniques and software)
- Dissemination of research results by journal papers and conference presentations (writing skills, presentation skills, organizational skills)
- Suggestion of unexplored research directions (independent thinking)
- Preparation of dissertation and final defense (organizational skills, writing skills, presentation skills)

Note on selection of research topic: In engineering, nearly all projects are based on a grant or contract to perform some kind of investigation. This is usually defined, either broadly or narrowly, in a research proposal that has been funded. The investigator usually has considerable latitude for the work to be performed. It would be a disservice to the student for the advisor to provide every detail of the project to be performed. That is why the professor is referred to as the “advisor.” The student must become adequately familiar with the project to enter a phase of growth in which he/she may define many aspects of the project, thereby performing an original contribution to the field.

2. Elements of a Journal Paper

Before starting to write a paper, choose the target journal, look at several papers from it, and take careful note of its conventions. Model your paper, including references, after the examples. Also, when in doubt about how to do something, read over some papers to see how others do it. Don't rely on one paper, but take the average of several.

Make an outline of the paper before starting to write. What is the paper about? Your paper must have something new to offer. You can decide that only after a careful and lengthy review of the literature. Gather ALL of the papers on the topic that you can find. Make sure that you can identify what was the main point of every single paper that you have that relates to the topic. It helps over weeks to months to make a one-paragraph summary of the main points of every paper.

We will assume the general scheme of a paper: Abstract, Introduction, Experiment, Results and Discussion, and Summary and Conclusions. These are not the only section headings, and you can add others that clarify your paper, e.g. "Design Considerations," "Actuator Performance," "Mass Flow Rate," or some such things. These main sections are followed by Acknowledgments, References, Table Captions, Tables, Figure Captions, and Figures. Letter papers often have no sections, but follow the same overall form.

Abstract- this one paragraph is your whole paper in a microcosm. Few if any details are given, and it should summarize the problem addressed, basic procedure, and results. The style of an abstract is different from the main paper. Read many abstracts to pick a style that you like. Do not use any abbreviations unless they are used more than once in the abstract. Usually there are no references in an abstract, but not always.

Introduction- here you introduce the problem that you address by your work. Is it a new technique, a different range of operation, a variation of a device structure, a new simulation technique, etc. What is different about what you are doing compared to everyone else in the past, and why does anyone care, i.e. what is in your paper that is an improvement over the history of your field? Note: this can be written in the context of the literature review. For a Ph.D. dissertation, the literature review can be a whole chapter, maybe ten to twenty pages. For the paper, it should be a couple to several paragraphs depending on the length of the paper. Do not hesitate to reference your own work, when appropriate of course, but also include more, rather than fewer, references of other's works. That makes you look like an expert and gives recognition where it is deserved. People love to see their names in print in the references. When left out, they tend to feel neglected. Regardless, it is a service to the new reader (think "graduate student") to have access to a short discussion of the literature.

The theory underpinning your work can go in the introduction or another section after the introduction.

Experiment- This section says what you did: equipment used, sample preparation, substrate parameters, temperatures, times, thicknesses, etc. etc. Be detailed and specific.

Results and Discussion- Here you present your results. Discuss the experiments that were performed, why they were done the way they were, and what data you got. Figures are presented in order and each one is discussed in the body of the paper. One way to construct a paper is to lay out all the data you got, put it into some logical framework, and then work your way through all the figures until you get to the end. Here you can compare your calculations with your data.

Summary and Conclusions- try not to cut and paste from the introduction. Summarize the main points of the paper and what you learned. Try to be qualitative about what the outcomes of the paper were, and imagine that you are thinking about the ramifications of your work- what is significant (not to repeat why you addressed the problem in the first place), what were the shortcomings of the paper (did you feel there were any weaknesses that you don't apologize for, but acknowledge could be better) what work will follow in subsequent papers, etc.?

Acknowledgments- Find out what grant paid for the work and mention the agency and grant number precisely. Acknowledge people that you spoke with, gave you some hints and ideas, etc. Be specific if you are really grateful. Again, read many of these to get an idea how to form this section.

References- be extremely precise. Make a strong effort not to take a citation from another paper without having a copy of the reference for yourself. There are often errors in other papers and you will just propagate it. Also, don't take someone else's word for what the paper contains. Make sure it is exactly the right format, and make sure they all follow a precise and common format.

Table captions- are not the same as figure captions. Look up a bunch of these to see how they differ. Number them in order on a page. Note now that a manuscript is not a paper – it is configured for easier formatting. As you will see next, tables and figures each go on a separate page, unless the paper is requested to be publication-ready.

Put the tables in here, one per page. At the top, put "Table I" etc.

Put the figure captions on a page or pages. Note very carefully from examples how figure captions are constructed. They usually start with a fragment of a sentence. Subsequent pieces are full sentences. You'll get the idea from reading many of them.

Put the figures each on a page. Print them as large as is reasonable. Note the fonts and styles of graphs etc. They should match what is commonly used in the journal. Put the figure number at the tops of the pages. Do not use color unless absolutely necessary. Use the best possible printer that you can find, or make high quality pdf's. Make all originals when several copies are requested. You don't want a reviewer struggling to see the figures.

That finishes it. Again, read lots of papers for examples. I could not possibly include all the details. Absolutely never submit a sloppy paper with typographical errors, poor figures, etc. I guarantee that you will get sick of your work well before it is submitted. Still, read it and reread it several times to work out all of the bugs. It shows a lack of respect to your advisor and the reviewers to do less than that.

3. Steps in the Publication of a Journal Paper

1. You do the work.
2. The work has to be unique, interesting and useful.
3. You must do a complete literature search for papers that may have related information or prior results.
4. Look up the target journal for specific rules on length, font size, references, format, etc.
5. You write a first draft including some background of the literature, why it's an important problem, and what is new. It must be well written.
6. You edit the document.
7. Advisor edits document.
8. You revise the document.
9. Advisor checks document.
10. Co-authors edit the document.
11. You and advisor decide changes.
12. You make changes.
13. Advisor checks document over.
14. Write cover letter and submit online. It must be in the format of the journal, all forms filled out, cover letter, etc. Ask advisor who, if anyone, will pay page charges.
15. Get reviews back. Mourn if not accepted. Fix and submit to other journal.
16. You make changes to paper.
17. Advisor checks changes.
18. You make final revisions to paper.
19. You prepare a copy of paper highlighting all changes
20. You write cover letter explaining the changes.
21. Advisor reviews and edits cover letter.
22. You make final changes to cover letter and resubmit.
23. You fill out all forms indicating changes and copyrights.
24. When it is accepted, you prepare purchase requisition to pay page charges, if any.
25. You and advisor read the galley proofs, make corrections and resubmit. **THERE WILL BE ERRORS AT THIS POINT! READ THE GALLEYS!**
26. Your advisor congratulates you for your accomplishment.
27. You put it on your resume. Keep it updated.

4. Written Report Guidelines

When I give you an edited document, I expect each item to be carefully paid attention to. I want each item marked in yellow marker as you correct your documents. Return my edited copy with your revised paper so I can check the changes.

NOTE: If I correct something once, it is your responsibility to go through the entire document and correct it everywhere.

Do not submit anything to me that has typos in it, or has not been suitably proof read by you twice looking for errors to be corrected. I don't want to do your work in addition to my own.

If you are writing a thesis or dissertation, it is your responsibility to know the formatting rules perfectly. In all cases, the university formatting rules take precedence over my guidelines presented here. When you submit a document to me, it should already be in the final format.

Plagiarism

There is no such thing as "just a report." Copying text from another document is plagiarism and is highly unethical, even if you provide a reference for their work, and regardless of the application. Even if your intentions are not to defraud the other author and to cheat on your document, this practice could destroy your career and damage mine if I don't recognize that you have copied the work of another. DON'T DO IT.

You may be tempted to paraphrase and slightly change the words of others so that you are not strictly copying, again providing a reference. This is also not allowed because you are using the other's work too closely here as well. By doing this, you are becoming merely an editor of others rather than an author of your own work. Besides this, it can certainly be construed as plagiarism as well. When using another work for a reference you should read, think, close the book, and write in your own words, regardless of how difficult this may be for you. Anything short of this is plagiarism. In any case, always cite the source of your material.

Figures and Figure Captions

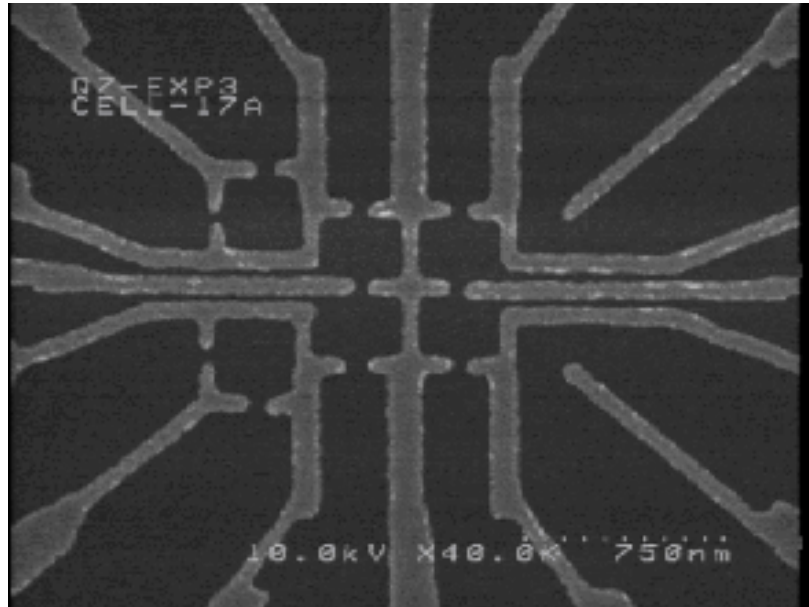


Fig. 3. Scanning electron micrograph of 6-dot QCA cell fabricated on AlGaAs/GaAs substrate. The bright areas are gold electrodes formed by electron beam lithography and lift-off. The larger dots on left are for purposes of charge detection. The four contiguous cells in the center ideally hold a total of two electrons. The two angular electrodes are intended for biasing the 4-dot cell.

Notice the figure caption. The form should be a smaller font, like 10 if you use 12. It should start as Fig. X. then two spaces. Then the first sentence is a partial sentence with a short description. After that, the sentences are all complete sentences. You may have no description or some description. I feel that you should include enough description that the figure can be understood at least a little bit without reading the paper.

All figures must be referred to in the text. The figure must be mentioned first, followed further in the paper by the figure itself. If the figure has several parts, such as a) b) etc., then every part must be mentioned in the text separately.

In general, don't have any white space on the page that is not necessary for some purpose.

Section headings should be bold-faced as in this paper, or may be numbered, e.g.

- I. Introduction
- II. Progress in last three weeks

Never start a sentence with a numeral. Find some way around it.

Paragraphs

Start a new paragraph when you start a new thought or idea.

Paragraphs should contain at least two sentences.

Paragraphs should either be indented by five spaces, with no blank lines between paragraphs, or not indented with a blank line between paragraphs. Your choice.

Abstracts

Abstracts do not get reference numbers.

Comments on Common Errors (and Some of my Preferences)

Ensure/insure

His life was insured for one million dollars.

Good writing will ensure a good career.

Use 2 spaces **after a period**.

Capitalize the first word after a **colon**.

“Can not” should be “**cannot**”

Punctuation marks always go inside **quotes**, as in:

The last thing he said to me was, “Good luck with your talk.”

Electronics based on molecules is called "molecular electronics."

Semicolons improperly used.

No: “*The designers most likely did not want to exceed a certain weight and size so as to allow easier transportation and placement; yet they wanted to give this design a long lifetime.*”

Yes: “*The device overall would have to be bigger; the keyboard pad is too small to type on.*”

There is no plural of **research**. “All of his research was performed at Notre Dame.” Not “researches.”

Parallel structure.

“...*to ski, to surf, and playing piano.*” Should be “I like to ski, to surf, and to play piano.”

Lists of **authors**.

When only two or one author, write them out, “Hong and Mirkin [7] report the development...”

If more than two authors, “Mirkin *et al.* [7] have investigated...” Note the period and the italics.

Misplaced modifier.

“...*will only hold up to 96 characters.*”

to

“... *will hold only up to 96 characters.*”

...*only purchase a handful of washing machines.*

to

“...*purchase only a handful of washing machines.*”

Informal writing.

“*Would affect the price a lot*” (considerably). Should be “Would affect the price considerably.”

Effect and affect are not the same.

To effect a change in a situation. (cause)

To achieve the proper effect. (noun)

To affect the health of the system. (verb)

Use approximately instead of around or about, but about is fairly okay.

Use much and not “a lot of”

When describing a continuous **quantity**, use “less.” When describing a discrete quantity, use “fewer.” Less water, fewer jelly beans.

Incorrect comma usage.

wrong: “*In addition this greater vacuum power...*”

correct: “In addition, this greater....”

and “Also, within the limits of...”

Change “We would go to the movie, however, dinner does not end until”
to “We would go to the movie, however dinner does not...”

Here the commas are correct:

Indirect measurement is any method, however, that does not directly observe the topology of a contamination line.

Lack of **brevity**

“A designer usually concerns himself or herself with...”

Could be, *“A designer is usually concerned with...”*

“By changing the design of the skate, the in-line skate can be used...”

to

“By changing its design, the in-line skate can be used...”

Lack of **hyphens** for compound modifiers:

“all lace system” should be *“all-lace system”*

A **list** of two things does not use a comma.

“... such as molecular circuits and quantum devices.”

Three things does:

“... such as molecular circuits, integrated circuits, and quantum devices.”

Which versus That

“Which” introduces a nonrestrictive clause, and “that” introduces a restrictive clause.

Which one you choose to use will change the meaning of the sentence. Even if others don’t use those two words correctly, you should. Rather than repeat a great explanation, read about it on Grammar Girl:

<http://www.quickanddirtytips.com/education/grammar/which-versus-that-0>

Headings

Decide on a system of capitalization for headings, and stick to it throughout the document.

Wrong: 1.2 Electron Beam Lithography system

This is wrong because either all of the words are capitalized, or only the first word is. See the next section.

Capitalization in the text: Don’t capitalize things that are not proper nouns. Period.

Electron Beam Lithography System is not capitalized. Why should it be?

The Department of Electrical Engineering should be.

“I would like to major in electrical engineering.” is correct.

The rule here is that just because a phrase impresses or intimidates you is not a reason to capitalize it. It must be a proper noun.

Acronyms

All acronyms, no matter how trivial to us experts, should be expanded the first time they are presented. Acronyms are allowed in headings before they are expanded.

Do not use an acronym if the expression is used only once or the acronym itself is not used in the paper. Don't use an acronym in the abstract unless it appears again in the abstract.

Acronyms are intended to shorten the overall text and hence for defining itself for future use in either the paper or the abstract. Consider the abstract to be a separate document, so if you do use an acronym, start over again in the paper.

“We used a scanning electron microscope (SEM) for observing our sample. The SEM in our laboratory is an....”

We use two 16-bit digital-to-analog converters (DACs).

Don't start a sentence with “But.” Use “However,...”
I don't like the word “but” in technical writing, so at least use it sparingly.

Units

Always leave a space after a number before the units. “50 kV” or “20 nm”

References

Use periods at the end of references.

Use whatever is the appropriate format for what you are writing. If no format is required, I want you to use one that contains the title of the paper, as in the IEEE format. Also, I prefer you use the names of all of the authors, and not “et al.”

Contractions

Don't ever use any contractions for any technical writing. This is not technical writing.

Articles

For you non-native English writers, use “a” before any word that sounds like it starts with a consonant. Use “an” before any word that sounds like it starts with a vowel. The British use “an” before an “h” but we don't do that in the U.S.

There are exceptions. Here are some examples of various applications:

an apple
a carrot
a Hitachi SEM
an SEM
a wish
an example
a 40 mile long road
an 800 mile long road
an IBM model 30/286
a user interface (a hard “y” sound)

Numbers

This is often a matter of taste. If it’s not technical, spell out the number. When a number in a sentence is short, spell it out.

“We used six lines.”
“Each sample had 64 lines in it.”
“Each sample lasted 6.3 hours.”

Numbers that start with a decimal point should instead start with a zero:

.1 micron should be 0.1 micron

Commas in Lists of Modifiers

Use commas in lists of modifiers.
.... modern, highly complex chips.

The first word of a sentence should not be abbreviated. The following is incorrect:
“Fig. 3 shows the relationship...” should be “Figure 3 shows the ...”

After using a colon: Use two spaces and a capital letter.

Use of the word "only"

Put it in the right order:

“In this figure we only show the...” should be: “In this figure we show only the...”

Titles

Short words in titles are generally not capitalized. Example:

2.5.1 Methods of Measuring the Width of Contamination Lines

References

All references in the document should be in some format chosen by you or the requirements of the publication. You may not use the formats provided by whatever source you use to get the reference. I prefer including the journal title, if it is not specified by the rules.

All journal abbreviations should be consistent in the document. It is best to find the official abbreviations for journals.

Slang words

Use *obtain* instead of *get*.

Use *must* instead of *have to*.

Do not use *till* when you mean *until*.