

Advice for Writing Theses

Over the past twelve years, I have sat in on a number of theses defenses, either as observer, defender, or examiner. The most informative ones are the ones where the candidate is having some difficulties. Often in these cases, the examiners are explicit about the shortcomings of the thesis and make a list of recommendations. I have found many of the recommendations are applicable to all theses, so I have compiled them together here.

Organization

The usual high level organization is

- Introduction, where you state your problem or hypothesis,
- Background Research, where you tell what has already been done by others to address this or similar problems,
- Method you have used to address the problem or hypothesis,
- Observations and Data you have made or gathered as you worked through your method,
- Discussion of your data and observations, and
- Conclusions about what you have found.

Introduction also includes a road map through your thesis, giving a chapter-by-chapter tour. The Conclusions should have a list of your contributions (anything you have done that is different from those that have gone before you) to the related area of research and a list of future research questions.

My supervisor told me repeatedly (and others where he was examiner on the thesis defense) to follow the simple rule: Say what you are going to say, Say it, and Say what you've said. One of my committee members put it another way: You are not writing a mystery novel! In other words, you state up-front what is coming, explain it, then reiterate the important ideas. This means you state your main contributions in the Introduction, you end each chapter with a summary of what was presented, and you make it clear at the beginning of each section what you are going to discuss next. Once you set up these expectations, then make sure you deliver.

All through your thesis, make sure you are bringing your reader along with you. At every point in the thesis, you have to get your head out of the weeds and ask yourself, am I making sense? The point of the thesis is to transfer your knowledge and what you have learned to others, including those outside (within reason) your area.

Abstract

The Abstract is the entire thesis in a microcosm, about 200 to 300 words. I always wrote it last. In a paragraph that is concise, precise, and understandable, you have to state the

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problem you are solving, give your motivation for your research, and finish with your conclusions and accomplishments.

Thesis Statement or Hypothesis

One interesting omission I've seen from a couple of theses that I've examined is a thesis statement, or hypothesis. It leaves the examiner guessing what the point of this whole thing was. Sometimes the examiners can winkle it out. It's much better that you tell them. You should specifically announce, *this is the question I am answering*. What is special about *this is the question I am answering* is that the statement must be refutable. You must be able to state in your conclusions, I have shown this statement to be true, or even, this statement to be false. Your examiners, and general audience, then can then judge if the path you took indeed shows that.

Writing Style

A thesis is written in a formal style, preferably in a passive voice. When I started technical writing in industry, my supervisor handed me a small book called "The Elements of Style" (William Strunk and E.B. White, 1979, MacMillan Publishing). It is concise, readable, and provides a good start for any technical writing.

In writing a thesis, there are a lot of details that, if paid attention to, reduce distractions (and irritations) for your readers.

Clean up all spelling errors, typos, and grammatical errors. If your grammar is shaky, ask a friend, relative, colleague or technical writer for help.

Do not use contractions such as isn't or you're.

Generally, write numbers out in words; exceptions are dates (2004), numbers with multiple digits (2.789), labels (serial number X12345), sections of your thesis (see Chapter 2), references (Brown et al [6]), etc.

Write in present tense. Your thesis (everything except possibly the background research) is a recipe for others to follow your research. It's not a story narration, particularly not a mystery novel! If you think of recipes, you don't say, "the flour will be added" or "the cake was baked". You say, the flour is added and the cake is baked.

The only time you change to a simple past tense is when you describe an event in the past that is completed. If you are describing a specific task you completed, you say "we found that ..." If you are describing a task that you can repeat in the future, you say, "we find that ...".

Background Research

This should be a set of papers that give background and motivation for what you are doing. Your research is building on previous research. That previous research needs to be explained so the reader can follow where you are going. You should clearly explain

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where the background research (usually drawn from journal papers) provides a basis for your research or where it is different from your research (motivating the different thing you are doing). Make it very clear that you have read and understood the background papers, and that it doesn't look like you are just rewording a few sentences from the abstract.

References

Be sure your references are complete, accurate, and consistently presented. Follow a prescribed standard for listing your resources. There are many. Choose one commonly used in your field.

Also be sure you reference *everything* you used from sources other than your own work. The internet has opened up a can of worms for plagiarism.

If you are defining terminology, state where you got the definitions. If the definitions are yours, then make that claim. Otherwise, provide a reference.

Terminology

Careful use of terminology can make an enormous difference to the clarity of your thesis.

Be consistent. Choose the terminology you need as early as possible in the thesis process and use it consistently throughout. If at some point, your choice fails you, change it, then go back and make all the necessary changes to keep it consistent.

Don't be creative. You may be bored with using the same word over and over again, but your reader will quickly get lost if you suddenly switch. Using an example from a thesis I recently examined, the author used the terms "marketing optimizing host", "advertising server", "marketing host", "advertising agency", and "marketing companies" all swirling around one concept, all within two paragraphs of explanation.

Precisely define your terminology the first time you use each one. Define short forms and acronyms on first use. Repeat the definition if there is a large gap between uses in the thesis.

Provide a glossary if appropriate.

In some fields, such as software engineering, there are several problems with terminology. One is multiple definitions for the same term. Another is multiple terms for the same concept. A third is usurping (hijacking?) words in common use and applying very specific meanings for a narrow context. Address the first two problems by choosing one particular term or definition to use throughout your thesis. Use judgment on how many of the alternatives you want to acknowledge in your thesis. The third problem is trickier to handle. If you have to use the hijacked word in its specific context, then you will have to find synonyms to take over its usual meaning in its broader context. An

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example of this is the word 'entity'. It has a specific meaning in relational database design. If I want to talk about some 'distinct thing' in another context, I have to find another word.

Another problem crops up when describing someone else's work. Other authors may use different terminology than you have chosen. Make sure you reword the other author's concepts into the terminology you have chosen to use. If you directly quote the other author (meaning you can't change his/her words), then provide a brief explanation in your own words, if the meaning may be unclear.

Diagrams, Graphics, and Charts

A visual summary of pieces of your work is extremely useful. Several cautions are in order. Make sure that the visual

- is consistent with your data presented in the thesis
- doesn't imply something you don't mean
- has meaningful titles, labels, and/or captions
- uses titles, labels, and /or captions that are consistent with terms in the text
- uses notation that has been explained or is otherwise clear
- details don't become too complicated
- actually is useful

Explaining and Justifying Your Work

Mary Shaw wrote an interesting paper, "Writing Good Software Engineering Research Papers: Minitutorial" (Proceedings ICSE 2003, pp.726-736, available through ACM Portal) based on analyzing papers submitted to ICSE 2002. A thesis is a really big paper and a conference program committee is a version of a thesis examining committee. Shaw's paper captures much of what thesis authors should be considering when they start their task.

Along with Shaw's recommendations, I'll provide my own list, gleaned from examiners at these defenses.

- What value comes from your work? What is the intended use? Why would someone care about your work? Be explicit about what you have achieved.
- Do you provide enough detail or is your method systematic enough for others to objectively evaluate or reproduce your work? Draw clear boundaries around your work.
- How does your work relate to other similar work? Explain differences and similarities. Justify the direction you took in your research.
- Justify major choices and decisions made in your research work – include a discussion of thought processes leading up to those decisions.
- Be careful of unsubstantiated claims. If you say your work is "useful for practitioners", then you better have proof or careful reasoning behind your claim.

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- Demonstrate a good knowledge of popular flavours and preferences of techniques, notations, and methods. If you choose one technique (including developing your own) over another, explain why. Explain what weaknesses/strengths exist in each technique. What differences are there amongst them?
- How did you test your hypothesis? Be careful demonstrating your techniques or methods with toy examples. Discuss the limitations of your examples and extrapolate what needs to be done for a 'real' example.
- Tie claims and conclusions tightly back to what you have demonstrated with your data and observations. There must be evidence of reasoning for the conclusion you have drawn.
- Make sure background research is up-to-date. You must demonstrate knowledge of related and current literature. You should discuss the literature in terms of your work.

Final Thoughts

Start organizing your thesis early. Putting thoughts to paper and contending with this linear organization of material often introduces new demands on your plans.

Be prepared to do several rewrites of your first few chapters. Keep focused on your hypothesis or thesis statement and be draconian about tossing pieces of your writing that don't contribute directly to describing what you have accomplished.

Lay down your hypothesis and thesis outline as soon as possible. This will provide your road map into writing your thesis and eventually the road map for your readers.