Thesis Writing Guidelines
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This short essay is intended for students who are considering me as a potential thesis advisor.

In my experience, my first meeting with a student follows almost always the same script: first the student tells me a little bit about their background and research interests, and then I explain my perspective on the roles and responsibilities in the thesis, what to expect, and how best to prepare for the journey ahead.

Although I remain intensely interested in the former, the latter of these is rather repetitive and inefficient. These guidelines represent an attempt to save some time for the more interesting parts of the conversation, and also to make sure that I never accidentally leave something out.

Why Are We Doing This?

The first question I ask a student is: *Why are you doing a thesis?* The answer inevitably involves one or more of the following:
[1] to graduate
[2] to solve a problem
- that I have experienced in the past
- that my command tells me is important
- that helps my service
[3] to advance the "state of the art"
- theoretical vs. practical research
[4] to learn a skill
- for my next assignment
- for life after I leave active duty
[5] to advance my career
- as a prelude to potential doctoral studies
- via professional recognition (e.g., MORS-Tisdale)

The key point here is that are many possible reasons for doing a thesis, and you (the student) should be clear about your own motivation and objectives. It should inform the topic that you choose and the type of thesis that you pursue. Knowing your own criteria for mission success is the first step toward achieving it.

Here's a question most students don't ask: *why am I (the faculty member) advising a thesis?* The answer to this inevitably involves one or more of the following:
[a] It's my job.
[b] I want to help you graduate.
[c] It will support a sponsored research project of mine.
[d] It's an interesting problem I would like to add to my research portfolio.

Although it is true that it my job to advise students and help them graduate, I am not required to advise any particular student. Moreover, I might be interested and willing to serve as an advisor even if it wasn't my job, in particular because of [c] and/or [d]. More often than not, my real motivation for working on a thesis with a student is the opportunity to collaborate on a research problem that is not only of mutual interest but which also helps to advance my own research objectives.

So a topic that falls within my existing research interests is more likely to grab my attention, but this is not always the case. One of the most rewarding parts of serving as an advisor is learning from students who lead me down unexpected and fascinating paths.

How Do We Get Started?

It is worth starting with the end in mind. At a minimum, you are going to write technical document that satisfies the requirements for graduation and is signed by me, the Chair of the OR Department, and others. *What will this document look like? The best way to get a sense of this is to read some of the theses that have been recently advised by me!* You can do this by either looking at my faculty website or by search the NPS library. *I recommend that you download and explore at least three recent theses.* Each of these documents was carefully and deliberately crafted to tell a story. Chances are that I am going to ask you to produce something similar.

The first formal stage of the thesis process is a written proposal that is formally approved by an advisor, second reader, and OR Department Chair. The proposal serves two purposes. The first is to clearly identify the research project itself. To do this, I require that you answer the following *Five Questions*, identified in "How To Write About Operations Research" by Distinguished Professor Gerald Brown (*PHALANX*, Vol. 37, No. 3, p. 7, 2004):
1) What is the problem?
2) Why is this problem important?
3) How will this problem be solved without your help?
4) What are you doing to solve this problem?
5) How will we know when you have succeeded?

The natural inclination by most folks is to focus exclusively on the answer to (4), but in fact we need answers to all of them. Expect that I will ask you to answer these questions! When we have answers to these Five Questions, then we have a thesis topic. The thesis proposal follows directly.

The second purpose of the proposal is an assertion to the Department that you have a topic and a willing advisor. By signing the thesis proposal, I am asserting that I agree to work with you on this topic and to guide you toward graduation.

The thesis proposal is not a binding contract. We are not obligated to perform the research exactly as stated in the proposal. Conducting research is an uncertain process, and it is common to deviate in one or more ways on the topic as we make our way. It is possible that we might narrow the effort to focus on a particular sub-problem of interest. Or we might recast the original problem according to some insight that we get along the way. Sometimes we even update personnel (e.g., we might replace a second reader). You also have the option to change advisors, but a change of this nature typically requires a new, signed proposal.

Outline Of Your Thesis

Each thesis is a unique document, but the vast majority of theses that I have advised follow a common organization, which is as follows.

I.   Introduction

This is often an extended version of the thesis proposal, answering each of the Five Questions, with emphasis on Questions (1), (2), and (5). The Introduction is typically 3-5 pages in length and should not be excessively long.

II.   Literature Review

Academic papers on a particular topic can be understood in terms of a broader conversation that is going on in print between many researchers. Your thesis will become a part of this conversation, but you are the new entrant. Consider the situation where you enter a room to find a group of people already talking; if you do not want to look foolish, it is wise to make sure you know what has already been said. In essence, the Literature Review is your summary of the conversation up to this point. It has two purposes. First, by demonstrating your understanding

of the conversation, you establish credit to anyone who already knows what has been said. Second, for the reader who is new to the topic you essentially say, "here is what you need to know about what has already been said in order to understand what I am about to tell you."

The length of the Literature Review can vary greatly depending on the topic and the author. It is common for students to struggle initially with the level of detail to use in summarizing past work. Just as in live conversation, it does not make sense to try to repeat everything that was said (that's an easy way to lose a reader). At the same time, the reader is going to need some context in order to understand and appreciate the contribution you are going to make. As a general rule of thumb, my recommendation is that you "write the Literature Review that you wish someone had written for you." If you think certain details are interesting, include them. If details are a distraction to the point you are trying to make, leave them out.

The Literature Review essentially answers Question (3) in detail, and it is typically anywhere from 5-15 pages in length. While there are always exceptions to the rule, anything shorter than five pages suggests you haven't done your homework in understanding the conversation to this point, and anything more than 15 pages risks losing the interest of the reader.

I often recommend that the Literature Review end with a short restatement of where the new research fits into this conversation. This typically should not be more than a paragraph. The intent is to tell the reader, "now that you know what's been said, here's how what I am about to tell fits into the broader conversation."

III. Model

The "meat" of the thesis typically begins with this chapter. Here is your chance to answer Question (4) in detail. If the thesis involves an optimization model, this is where the mathematics is introduced in gory detail and following "NPS format." All the details describing your assumptions and analysis process should be presented here. Essentially you introduce the machinery that you use in conducting your analysis.

This chapter is usually the first one to be formally written. We start by writing our problem in its mathematical form. We need to define a lexicon of terms that we will use precisely and consistently throughout the document. It is important that we are clear in our mathematics and modeling (our intent) before we write any code to implement it. Thus, we are forced to write this portion before we get too far down the path of our work.

This chapter is typically 10 or more pages in length.

IV. Analysis, Results

This can be one or more chapters, depending on the nature of the problem and the type of analysis. In this chapter, you explain what "happened" when you exercised your model for the problem of interest. Here is where graphical displays will help to describe the output of your model, and you will explain the implications of what you learn.

The length of this chapter can vary greatly. If it gets excessively long, we sometimes split it into multiple chapters.

V. Summary and Conclusions

This final chapter should be short and sweet. Summarize the investigation. Summarize and interpret what you learned. And don't forget to discuss opportunities for additional work (i.e., Where are the gaps? If you had more time, what would you do?); future students will be most appreciative of this. This chapter should typically be no more than five pages.

Citation Style

We use the INFORMS reference style, which essentially uses inline (Author, Year) citations. See my research webpage for links to style guides and examples. We do not use footnotes in our writing.

Keys to Success

Be patient, but diligent. In the beginning, you are likely to feel like you are wading through mud, or worse yet, quicksand. It might not be obvious what to "do" and you might get frustrated at your ability to "be productive." This is normal, particularly in the early going as we work toward a clear and concise problem statement. Formulating the problem is honestly half the challenge. Once we get a clear formulation, it will be obvious what to do.

Write early and often. In the beginning, one of the best things that you can do is search the literature for articles that are related and will become part of the conversation summary in chapter II. For each article you read, take notes and then try summarizing them in a single paragraph. If you are successful, your Literature Review can be constructed largely from these summaries. More broadly, consider keeping a journal of the questions, statements, and ideas that you have as you go. As these ideas start to take shape, try writing in complete sentences, then paragraphs, etc. You will thank yourself for doing this.

Aim for short, but frequent iterations. We can meet as often as makes sense for the project, but my experience is that it is desirable to have more frequent but shorter meetings (we typically should not need to meet for more than 30 minutes at a time). It is better to get together for frequent updates that allow me to provide "rudder guidance" than for you to disappear for months and then resurface, only to discover that you have gone down the wrong path.

Recognize that writing is hard and will take a lot of time. Most students do not have any experience with formal, technical writing. It is really hard, and requires considerable dedication and perseverance. We will do this together. You should expect that we will edit and rewrite things several times before anything becomes final. It is not uncommon that each chapter will go through 5-10 revisions. Given that each revision can take days to complete, it becomes obvious that timely completion means that we need to start writing early. Typically, we try to have Chapters I-III written in their near-final form by the end of your penultimate academic term (and earlier if possible). Working backward, we need to be iterating on these first few chapters at the T-minus-6-month mark.

Tell a story. In the end, every reader wants a story. We will talk about what this means and how to do it as we make our way.