Writing a Master's Thesis

Many students carry out excellent projects, but they get too low grades considering the amount and quality of work they have produced. As an advisor that is a sad thing to see. This document is an attempt at providing some pieces of advice that may help.

Plan Your Work

You cannot just work. You need to have a clear goal and you need to make a plan for how to achieve that goal. It is not really useful to discuss the writing itself without discussing the work process.

You should, of course, have a clear idea about what problem you want to solve before you begin. You probably don't know precisely what goal you will pursue or how. The first step is to make a plan. Your plan could look about as follows

1. **Literature survey:** Read up on previous solutions to your problem and decide what precise goal you will pursue. The output from this phase is a goal and knowledge of previous work.
2. **Design:** Think about how you will reach your goal. Make a design for an implementation that should make you reach that goal. Your design should be based on previous work – and depart from previous work (if that is deemed useful) – in understood ways. The output is a plan for phase 3.
3. **Implement the design:** The output is a testable implementation.
4. **Test the implementation:** The output is a set of test results.
5. **Analyze the results from your test:** Based on the results you can now argue that the goal is reached.
6. **Write report:** Based on your statement on motivation and goals, literature survey, design notes, implementation notes, and analysis of test results you can now write the thesis.
7. **Revisit all phases:** Set aside some time to make changes to the design and implementation, new tests and changes to the report. In other words, set aside time to go through everything and improve where needed.

When you divide your work into these phases you should consider how much time to set aside for each phase. Also consider what precisely should be the output from each phase – and whether some of the phases should overlap. Write down precise dates for the completion of each phase. It is ok to change the plan, and if you do deviate you must change the plan – otherwise it becomes useless.

Of course, your plan should be discussed with your advisor.

Plan Your Thesis

Your project has a clear goal doesn't it? It should have since you followed the guidelines above. Your thesis could now be given a structure such as the following:

1. **Motivation:** Since you have a goal, there must be some problem that you are trying to solve. Explain this problem. What people in the real world are affected by the problem that concerns you? It is best if your grandmother understands this section.
2. **Goal (hypothesis):** After the motivation (why) explain in detail what the goal is. If your project contains an element of research (which is good) the goal is more like a hypothesis. In other words, your goal is to investigate some particular method to verify its usefulness for some particular purpose (verify the hypothesis).
3. **Related Work:** You will need to describe what has been done before and you will need to discuss the theory that your work is based upon. This is a slightly dangerous: Take care not to punish the reader with *hairy* theory without explaining why it is needed.
4. **Method:** Describe your own work (how you reached your goal) and take care to motivate your choices. Don't just describe all the things you did – tell us why.
5. **Results:** This section should write itself. Since you have a goal, the results section must document that you have reached this goal (or verified your hypothesis).
6. **Conclusion/Discussion/Future work:** You can conclude that you have reached your goal or discuss why not if that is the case. Also discuss hindsights: What things were even better or a little worse than expected regarding the methods you used to solve your problems. How could your project be improved by further work.

Of course, there is no need to have precisely the chapters shown above. You probably want to break your thesis into a few more chapters. You might also want to combine related work (3) and method (4) since it is easier to explain your own work in relation to the work it is built upon. Just make sure that your own contribution is not hidden. The reader will want to know what you did!

Anyways, if you have a **clear well-motivated goal**, the thesis is considerably easier to write than otherwise.

Start in Time

It is sad but true that many students wait for far too long before they start writing. You should set aside time for writing and **accept that it means you have less time for technical work**. You should also write down material needed for the report during your experiments. There is one particular danger, though. If you write your report piecemeal during the actual work, you may find that some sections are outdated because maybe your goals changed slightly or you decided to use other methods.

I think the best way to do it is to write up little pieces of text that can go into the report during the technical work.

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Near the end when you are sure about what goals and method you have been pursuing, you can start to put together these pieces and write the in-between parts to form the actual text.

Since you need to finish at a particular date, you cannot keep making changes and tests even if you update your plan. You have to stop and write the report. Therefore, it is a good idea to set aside a month (or so) at the end of your project. Use that month to improve your work. This is phase seven in the plan template above.

Know your audience

You will defend your thesis against a fearsome opponent. Well, he or she is really a nice person, but they have one disadvantage. The opponent has read your thesis, but may know **VERY LITTLE** about the topic that it concerns. Your advisor will know the literature, but perhaps the opponent does not, and it **is very very important that your opponent understands what you have been doing.**

He/she is not likely to know already about the problem you have solved or the method you have used. Hence, your are really the teacher trying to explain the problem and your solution to someone who doesn't know about either. Think of a fellow student who has followed many of the same courses which you have followed but decided to specialize in something different. That is your target audience.

Remember that it must be possible to reproduce your work based on the report.

Notation

Ok. So you shovel a lot of equations from a lot of papers into your report. They sure look good, but maybe the notation is a little different. Who will ever know? Or care? The opponent will! Make sure that all terms in your equations are explained in a precise fashion. Make sure your notation is consistent and easy to understand. It is a very good idea to make a table with symbols and other elements of your notation. Mostly to ensure that notation is consistent.

It should always be easy to understand all terms of any equation in your thesis.

Figures

Often figures are completely incomprehensible. Don't try to explain too many things in one illustration. Your figures should be clear, simple, and plenty. Also, they should be big enough. Remember that you will also need the figures for the final presentation.

Language

Most students at the Technical University of Denmark write only about as well as one would expect from a pupil in elementary school. The reports are riddled with simple errors – grammatical as well as spelling mistakes (what happened to spell check?). Try to get rid of these problems. In fact, it might not affect your grade much, but future employers may be put off if you write poorly. We don't care whether you write in English or Danish, but we do care about the quality!

Get someone to read your thesis in order to get rid of spelling mistakes and grammatical errors.

Chicken and Egg

There are these elements of some theory that your work is built upon. Since it is not well known, you decide to describe it. Since your work is based upon it, you describe it first in your report. The problem is that **at this point not a single reader knows why you are explaining this theory**. In other words, you need to describe your method in order to explain why you need the theory your method is based on ... nasty circular dependency.

The only viable solution is to explain things incrementally. You must discuss your method in a superficial fashion first. Give a general outline, then discuss some of the elements of the required theory and then go into details with the method. Alternatively, you might just get away with a precise discussion of how the theory is related to your work and a pointer to the section where it is used.

The golden rule is: **never let the reader wonder about why he or she is reading any given section.** If the reader thinks "why the hell am I reading this" your exposition is flawed and your grade will be lower than otherwise.

Bloat

Many students like to write long reports and put material such as descriptions of APIs (their own and other people's) inside the body of the report. Such material belongs in the appendix or should be omitted.

References

You may want to look at Fredo Durand's excellent advice on how to get papers rejected. Much of the same advice applies to getting low grades for a master's project:

http://people.csail.mit.edu/fredo/FredoBadWriting.pdf

You may also want to consult the Danish grade scale:

http://en.wikipedia.org/wiki/Grade_(education)#Denmark

See – to get an 11 or a 13 you have to be **independent** on top of everything else!

Andreas Bærentzen, 2006