So what is a (Diploma) Thesis? A few thoughts for first-timers.

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Abstract

This Document summarizes some thoughts regarding planing, doing, and writing a (Diploma) thesis. So what is a thesis? What is it good for? And how can people go more informed (and strategic) about it? Is there a collection of little tid-bit hints that can help me put together the actual thesis once its done?

The thoughts expressed in the document aren't any guidelines or detailed instructions, but thoughts, which are the result of reading many theses. So, please take them for the grain of salt—they are worth what you paid for them! ☺

Contents

1 Introduction

Since arriving here at the University of Zurich (back in the summer of '02) I read many (Diploma) theses. Some of them were really good, others weren't. What was most surprising is how many students entered the thesis stage with only little concepts what a thesis really is, apart from that thick bound document, which the advisor—professor or assistant—will (or will not) eventually read and generate a grade for. This limitation of the concept of a thesis is both a blessing and a curse. It is a blessing, as it doesn't carry a lot of misconceptions; it is a curse, as it oftentimes leads to a lack of orientation about doing the thesis.

In this document I will try to gather some thoughts that can offer some guidance about what a thesis is (and what it isn't), choosing a thesis topic (and the advisor that comes along with it), planning how to do the work (rather than only surfing the waves of intuition), and writing the thing in a disciplined manner. As pointed out this document gathers thoughts for guidance rather than instructions: the difference is that it is every person's free choosing whether to conform to those thoughts or whether to ignore them – after all I could only be a rambling professor... Binding instructions regarding the thesis can be found at the Departments web-site.[1] Furthermore, as the issues addressed here are personal thoughts, they might contradict some of the thoughts on the subject that my colleagues might have. Consequently, take all of the opinions raised in this document by the grain of salt – after all, they are just thoughts jolted down in bits and bytes and not commandments set in stone.

With this disclaimer in mind I will structure my ramblings as follows. First, I will philosophize about what a thesis is, and what it isn't. Second, I will spend some time on what types of theses there are. Next, we will cover some ground regarding doing the actual (research) work. Should one plan a project that long? Should I talk to my advisor or is doing the thesis more like a clandestine operation? When should I panic? The following section will summarize some guidelines on how to write the thesis. Note, that even though this section comes relatively late in the document it is absolutely central that you spend ample time thinking about the writing process. After all, the document is your major means of communication with the environment and, thus, your best (or worst) advertisement to entice a good grade and much more... I will close the document with some odd thoughts, that I couldn't fit anywhere else.

2 So what is a thesis?

There are many concepts about what a thesis is that float around the hallways of the department, and probably many student lunch discussions. While I found lots of information on the web regarding the task of writing a Ph.D. theses (some of which is linked to from our groups web-site), the information regarding Diploma (or M.Sc.) theses is not as rich. More importantly, while there seem to

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[1]At the time of writing, those instructions, any much more interesting information about the studies here at the University of Zurich could be found at http://www.ifi.unizh.ch/ifiadmin/staff/rofrei/Semesterarbeiten/MB_Ausarbeitung_DA_SA_SP.htm

be some documents, they don't always seem to be read. I will try to attack this problem from an angle that follows the different aspects (educational, research, etc.) of the thesis.

2.1   It's a masterpiece!

There is probably more truth to this statement that you would give it at a first glance. A masterpiece, in its original sense is not necessarily a piece of art, but the piece of craftsmanship that apprentices used to make to show the world that they had mastered what could be learned and could be trusted to do some work themselves.

This is very similar to what the thesis is for you, it marks the end of your phase as a student and the beginning of your life as a graduated computer scientist. Note the following important points, however:

- Even apprentices don't directly become masters after submitting their masterpiece. Usually, they first go on a journey, to learn more about their profession. You should think of it the same way. Your learning is not finished, but you can start doing it all by yourself whilst you are working as a productive member of society.

- The analogy to the masterpiece breaks down in when you think about the intended audience. While the carpenter generates something understandable by most members of society, your thesis doesn't need to be understood by everybody, but only by members of the craft, i.e., it should address the knowledgeable computer scientist. Specifically, it should be addressing me and/or your advising assistant.[2] So huge summaries of your general topic area might help my grandmother to understand the text, but aren't necessary and will not improve your grade.

- Last but not least, masterpieces are supposed to show off an apprentice's capabilities. They do not have to include anything new, but have to show how well an apprentice masters known craftsmanship. I personally believe that a masters/diploma thesis at a university has to be more that "just" a showoff. There should be some novel element that is being explored, some sort of a delta produced to the current state of knowledge. For further elaboration please look at the sub-section 3.4 on the litmus test for theses on page 8.

So: yes, it is a masterpiece, but not in the usually attributed sense to this word...

2.2   It's my book!

Well, here comes one of the biggest misconceptions of the diploma/masters thesis. It is definitely not the goal of such a thesis to write a book. While your thesis might look like a book by the time it is finished it shouldn't be your goal to write a book. I think a little anecdote will explain the difference best:

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[2]Alternatively, if that addressing me seems to agonizing, then you can also address one of your colleagues, who visited the relevant classes... (Many thanks to Gerhard Schwabe to point out this alternative)

When I started writing my Ph.D. thesis I spoke to both my advisor and my committee members regarding the size of thesis. I also had a book in mind—after all this was to be my "chef-d'œvre." The answers I got where quite surprising. My advisor handed me his Ph.D. thesis, a beautifully executed experiment on the motivation of people in computer games: it was 69 pages long. One of my committee members told me that his advisor showed him a Ph.D. thesis that was exactly 2 pages long (including the cover page).

What these examples show you is that your thesis should not be a book but a "thesis". Essentially, a thesis is a statement in the ever-ongoing discussion of science. The statement typically includes an *introduction*, setting the stage for the statement, a *claim* of some sorts, the actual statement, and some sort of *support* for the statement. As hinted in the sub-section above: since the thesis is a statement in the ongoing scientific discussion its intended audience is the scientific community. Therefore, the text should be no longer (and no shorter) than it needs to be in order to fulfill this goal. In other words, paraphrasing Einstein: *make it as simple as possible but not simpler*!

2.3 It's a lots of cool coding surrounded by some boring text!

Many people, especially the ones who do want to code elaborately during their thesis, see it as the occasion to code like crazy and then add a brief description of the code as the actual thesis, maybe supplemented by a huge appendix containing code-examples and thousands of pages of `javadoc` files. The alert reader should realize that it can't be the goal of a statement in the scientific discussion to containing thousands of pages of code. While code is useful in our profession, many people can write it. It is the general design concepts and abstractions chosen, which differentiate one program from another. Hence, the focus of the thesis should be exactly those concepts, as they are going to survive to a point in time, when compilers to the programming language you chose have long since evolved to make gibberish out of your source code...

Note, however, that there are many styles of diploma/masters theses (see also below), some of which arrant a detailed description of the code. The description in itself (together with the code you wrote) cannot and should not be the essence of your thesis.

2.4 It's a research report! And my grandma is going to use it—at best—to kill some flies!

Yes, yes, and yes!

Finally, we are where we (or should I rather say I) wanted to be from the beginning. The goal of a thesis is to report on, and provide support for, a scientific statement. Hence, it is a research report—not more and not less. Those of you who are disappointed about this seemingly sombre conclusion should not despair for many reasons.

First, you are going to write a whole lot of such reports throughout the rest of your professional life. As a matter of fact, most of professional work contains the writing of some type of document to report on something; be it

on some investment, some new software-package, a case study, etc. All of these reports are some sorts of statements in a discussion. Usually the discussion they contribute to is not the ongoing scientific discussion, but the ongoing courting of a customer, the revelation of some finding in a newspaper, the highlighting of some problem in an engineering change request, etc... Statements, as we all know, are usually made to achieve some goal and should be customized to achieve to a form that they best achieve their intended goal. As you can see, thinking of things you write as a statement in an ongoing discussion is actually quite a helpful analogy and exercising to do so at the university is a good goal to have.

Second, reports can be exciting texts to read. There is no reason to make them be boring. Granted, some research reports have perfected the language of being boring in the name of sounding "objective," but there is no need to do so. As a matter of fact, most well written reports are quite fun to read.

Third, even though report sounds somewhat boring their subject matter can be very exciting. Think for example, of the reports of the first man landing on the moon, Churchill's report on his life in the second world war (a best seller), Cesar's report on the Gaelic wars (as well as Uderzo and Goschiny's alternative version we all prefer ☺), or of the Kinsey report, etc...

I could probably think of more reasons, but I think I made my point. Reports can be important and fun to be pieces of text, which contribute some sort of fact[3] or statement to an ongoing discussion of which the participants might be aware or not. Summarizing, a thesis is indeed a report of some sort and its role is to participate in a discussion of some sorts. Grandmothers should not be the addressee of the statement, but will in most cases be proud of the thesis, even when the use it mainly to show to their friends (and, occasionally, get rid of an insect).

2.5   It's yet another hurdle to graduation!

Well, that is certainly true. But it is also a central piece of your education. If used correctly, it can help you more to find a good job than some of the good grades you made. It will definitely survive your "Matur," which by the time you graduated from University nobody will ever want to see again (other than some random HR person who wants to have a complete file on you to bury in some archive).

2.6   For the hurried ones: The most important conclusions of the section in a handful lines

A thesis is a communicative act from you to the person who is grading it. In a research institution, such as the University of Zurich, this communicative act is graded as a statement in the ongoing discussion of science. Consequently, the person grading your thesis will have the mind set of such statements when evaluating your thesis. She/he will therefore look for the typical elements of

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[3] The use of the word "fact" is very dangerous, as it contains the connotation of universal truth—a concept usually shown to be wrong in most disciplines. I could write a document about this subject alone,but are going to refrain from a lengthy digression here. Should you be interested in the subject, then I propose that you visit my class on "Social and economic foundations of Information Systems" or catch me in the hallway for a chat.

such a statement, which should at least include an *introduction* (setting the stage for the statement), a *claim* of some sorts (i.e., the actual statement), and some sort of *support* for the statement.

3   Types of diploma/masters thesis

The zoo of theses contains different styles of assignments. I will try to summarize some of them. It will help you immensely, if you have an accurate idea of the type of thesis you are writing.

Note that all of the following structural hints are not instructions but give you an idea of the most important elements typically contained in a thesis. Thus, don't take it as a gospel to follow. But look at the following lists as necessary ingredients for a thesis, which can be included in other kinds of structures.

3.1   Hypothesis testing theses

The first type of thesis is the *hypothesis testing* thesis. This type of thesis follows the traditional paradigm of science: It states a hypothesis, which is then shown to be true (or false) throughout the rest of the work. A thesis of this format should contain an introduction setting the stage, a description of the hypothesis, an evaluation of the hypothesis (containing both a description of the hypothesis method as well as the actual evaluation), a discussion of the limitation of the evaluation, and some closing remarks. In slightly more detail, those sections can be described s follows:

- The *introduction* sets the stage. It motivates why the work presented is of any interest and introduces the structure of the rest of the thesis, which usually includes a succinct chapter by chapter overview of the thesis.

- The *hypothesis* section introduces and motivates the hypothesis.[4] Usually, the motivation is founded in the literature and the hypothesis is developed in the context of related work.

- The *evaluation* section explains in detail how the evaluation is designed and introduces the results. The evaluation usually takes the form of some type of statistical test or, even better, a formal proof. Essentially, the goal of this section is to present the reader with some sort of proof why the hypothesis should be believed.

  Note that the goal of the description of the evaluation design is to allow the interested (and resourceful) reader to repeat the evaluation, should (s)he want to.

- The *discussion* section puts the results in perspective discussing it in relationship with related work, possible effects, eventual limitations due to the evaluation, and, last but not least, personal opinion.

- The thesis typically closes with some *final remarks* offering some ideas about future work and maybe some sort of grand statement about the possible impact of the findings.

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[4]Note that the word thesis is contained in the word hypo*thesis*

Obviously, the structural elements above can show up under many different actual document structures and section headings.

3.2 Design science theses

A design science theses typically introduces a novel solution for an accepted problem. As such it follows the typical paradigm of engineering: after highlighting an important problem it introduces a novel (and hopefully advantageous) approach for its solution. A thesis of this type usually contains an introduction setting the stage, a description motivating the importance of the problem (possibly in the light of the literature), a detailed description of the proposed solution, an evaluation of the proposed solution in comparison with the state of art, a discussion section addressing the limitations of the solution as well as its advantages/disadvantages compared to other potential solutions, and some closing remarks. Again, in slightly more detail, those sections can be described s follows:

- The *introduction* sets the stage. It motivates why the work presented is of any interest and introduces the structure of the rest of the thesis, which usually includes a succinct chapter by chapter overview of the thesis.

- The *motivation* section introduces the problem addressed and emphasizes its importance in the light of the literature or some practical problem encountered in practice. Oftentimes this section also develops a list of requirements to be met by a solution.

- The *description* section introduces and motivates the proposed solution in the light of the problem, the requirements, other proposed solutions, and possibly the literature.

  Again, the goal of this section is to allow the resourceful and interested reader to repeat the solution implementation.

- The *evaluation* section discusses the proposed solution (and possible competing solutions) in the light of the requirements. Usually, it also provides some experimental evaluation which leads to some some type of statistical test or, even better, a formal proof. Essentially, the goal of this section is to present the reader with some sort of proof why the proposed solution should be good (or better than others).

- The *discussion* section puts the results in perspective discussing it in relationship with related work (as far as not yet covered in the evaluation section), possible effects (and side effects), eventual limitations of the solution, and, last but not least, personal opinion.

- The thesis typically closes with some *final remarks* offering some ideas about future work and maybe some sort of grand statement about the possible impact of the findings.

As with the hypothesis testing style the structural elements above can show up under many different actual document structures and section headings.

Note that the proposed structure above somewhat differs from the hypothesis style thesis, as oftentimes the related work is emphasized more towards the end

of the work, rather than at the introduction. Also, while the result of the hypothesis testing thesis is usually "knowledge," the result of design science research is typically a working solution as represented by a working prototype.

3.3 A quick word about evaluation

Both styles of theses included an evaluation of the claim—the hypothesis or the solution. But what is a sufficient evaluation?

In a Ph.D. thesis the answer would be: you have to establish formal, statistical, logical, or qualitative proof that your claim is correct. Note that this list of evaluation types is by no means complete. To make good and worthwhile evaluation is a time consuming tasks. Some Ph.D. candidates spend most of their time to come up and perform a suitable evaluation. So where does that leave us with a Diploma/masters thesis, where time limits the amount of work that can be done? Obviously, these time considerations limit our evaluation options and you might have to take some shortcuts. Nevertheless, you should keep in mind that finding an appropriate evaluation is absolutely crucial to the statement you are making with the thesis. If the evaluation is not sufficient, then the whole thesis looses believability.

Summarizing, I would say that you should talk early in your thesis to your (assistant) advisor about the evaluation issue. In some theses (in particular in the hypothesis testing ones), it will usually be almost obvious what to do. In others, we will need to talk about the subject and try to come up with an evaluation, which takes the existing time limitations of the Diploma/masters thesis sufficiently into account. Needless to say, that this goal is definitely achievable, as some Diploma theses that lead to scientific publications can prove.[5]

3.4 So what makes a thesis (a.k.a. the litmus test for a diploma/masters thesis)? Where I hid the "pure" implementation thesis

Some might be worried where the implementation thesis ended up. Well, in some sense it is there, hidden in the design science thesis. But it is hidden for a very specific reason: I don't think *pure* implementation assignments are really diploma theses on a University level. As mentioned in section 2.1, I personally believe that masters/diploma theses at a university have to be more than "just" a showoff, which in our domain would be an elegant implementation. There should be some novel element that is being explored, some sort of a delta produced to the current state of knowledge.

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[5]OK. So even though I was hoping to be silent about evaluation types, my silence was heard by to many people, and so I will speak about it (at least briefly). Essentially evaluation can be placed in three general categories: *formal*, *quantitative*, and *qualitative* (As usual, I probably forgot something. Hence, this is not a conclusive list). A formal evaluation essentially includes some type of proof, usually, within some type of mathematical or logical framework. You know this types of proofs best from math and/or theoretical informatics courses. A quantitative evaluation typically includes a benchmark test or experimental analysis, which typically result in some statistical statement about the confidence, at which the test/benchmark supports the hypothesis. Last but not least, a qualitative analysis provides some non-statistical evidence such as case-studies, ethnographic analyses, or expert assessments (e.g., interviews/focus groups), etc. Note that all three evaluation approaches require clear statements about their underlying assumptions and limitations.

I know that this is a rather vague definition but you might want to think of it as follows: A university is, among other things, in the business of (a) teaching students and (b) producing new knowledge. On the graduate level, which is what all studies after a bachelors (or, vaguely speaking, in the "Hauptstudium") are, those two tasks start to merge. Our task is not only to teach students to absorb existing knowledge, but how to synthesize new knowledge in the form of either new scientific knowledge (as exemplified by the hypothesis testing thesis) or new solutions (as exemplified by the design science thesis).

At this point you might think: "Good four you guys, the university gets my services to do its job, but what's in for me?" Well, what's in for you is that you learn how to develop new knowledge, which is a heavily sough after capability in the market place. Just think about it: Financial services companies entertain whole research departments, Companies like ABB thrive on novel solutions to (mostly) known problems, and consulting companies will essentially make their living on analyzing existing problems and finding and/or constructing good solutions to them. This goes so far, that some rather well known business schools (i.e., Harvard) completely place their whole educational philosophy on teaching everything through problem solving of specific situations, an approach they call the case-based method.

Summarizing, I believe that there should be some novel element in a diploma or masters thesis on the university level. Thus, pure implementation theses are, in my personal view, problematic. *Nevertheless, theses can have a substantial implementation part either to implement some type of test for the hypothesis or to implement a prototype, which evaluates a new solution approach.*

3.5 Fast food menu

The fast food menu of theses contains both a hypothesis testing thesis—the stronghold of science—and a design science thesis—engineering at its best proposing a solution to a known problem. Both approaches answer the following questions in their respective styles:

- Why should I care (to read the rest of the thesis)?

- So what is your proposition?

- Why should I believe the whole shebang?

- Why isn't everybody calling you like hell to give you the Nobel price and/or the Turing award?

- Any grand statements for humanity to finish?

4 Writing the thesis – Let's get to the beef

So far we have covered quite a bit of ground to discuss what a thesis is and types of theses there are. In this section I will discuss some practical considerations regarding the actual writing of the thesis. The issues discussed in this section are even more practical than the almost foundational and structural ones covered so far. I will divide them into project planning issues, stylistic questions, and general hints regarding a thesis.

4.1 The thesis project

Writing a thesis is like planing and doing a project. So everything you learned about project planing can and should be applied. While I am not a project planning Guru myself, here are a few hints that I think are really useful to think about:

Plan your thesis! As mentioned your thesis is a project, and projects should be planned. I know that six months sound like being really long, but once you start time flies by! Trust me, been there, done that! If you don't trust me, talk to people who are approaching the end of the six months. Thus:

- Think how long different tasks are likely to take.

- Plan some milestones and adapt your plan should your schedule start to slip.

- Discuss your plan with others to sanity check it. If your schedule slips strongly, then consider talking to your advisor.

- Think exactly about what elements belong in your thesis that are not directly connected with the work like:

  - Meeting with the advisors (professor and research assistant) *before and after* you get the assignment to clarify your wishes about the thesis and their expectations.
  - Think about external deadlines that are not imposed by the advisors but are of logistical nature (such as the time needed for printing and binding the thesis).
  - I usually like to have students report on their thesis in an oral presentation in front of my research group. This presentation is not part of the official thesis requirement but is a great occasion or you to show off your thesis and train giving presentations.

Talk to your customers! Just like any project you have a "customer" or "audience." You should talk to them to find out what their expectations are and manage them appropriately.

I oftentimes tell people of an analogy I have with different communication styles that students entertain with me and/or the advising assistant. Here there are:

- **The tunnel thesis.** This specific thesis style *is usually a recipe for disaster.* I, usually, see the student when we first discuss the thesis, then I write the assignment. Next I hear from the student is when the written and bound thesis is dropped off at my office. Usually, the arrival of the thesis is followed by an email around 24 hours later what the grade might be. While some people are capable of producing great results like that most theses of this format are a disappointment to all parties involved. After reading and grading it (within a reasonable time – usually a month – after all I have many theses to read at any given time) the student usually contacts me frustrated as (s)he thinks that the grade is way to bad for the

submitted masterpiece. The following conversation usually unearths that the work performed is better than what I could extract from the text, but since I didn't know it at the time of grading it is too late to fix things...

- **The U-boot thesis**. This interaction style is very similar to the tunnel type. The difference is that U-boot theses writers contact me or the advising assistant in random intervals with seemingly unconnected questions. The result is usually the same as in the tunnel thesis: frustrating to all parties involved.

- **The help I am drowning thesis.** People working like this go into panic mode somewhere between getting the actual assignment and the end of the first month and never leave it. They come by constantly seeking advice. The result is that we sometimes wonder who actually developed the ideas in the thesis – the student or the advising assistant.

- **The healthy thesis.** All of the above cases are overdrawn extremes. Nonetheless, I have experienced them all in my career in some form or another. You should, therefore, strive to talk to your advisors at healthy intervals—how long those exactly are can usually be found by talking to your advisors. In most cases frequent (e.g., weekly) interaction with the research assistant advisor automatically helps to establish what is good for you. Note, however, that the onus of establishing contact lies with you. It is your responsibility to ensure that the communication is well on track. After all, it's your thesis!

Remember, the advisors are interested in your work and want you to succeed. When they advertised the thesis subject they had a specific goal in mind, which would help them in some way (e.g., simplifying their work or provding and improtant building block for their research). If you don't talk to them, then the chance is high that your thesis will not meet the expectations (not necessaririly because its is not good enough). So talk to your advisor(s) – often. In most cases it helps both you to succeed.

Get the related work early in the game! This suggestion sounds very commonsensical, but you wouldn't believe how many people delay the searching for related work until its to late. Also, finding related work is not easy. Oftentimes, people present (and publish) things differently than you would go about it. So finding the right articles is not an easy task. Here are a couple of hints of how to go about it:

- Look whether you can find *a good survey paper* (e.g., in the ACM Computing Surveys) or good textbooks to get a feel for the area in which you write the area.

- Usually the *research assistants know the important papers.*

- *Go to different information sources to find the papers.* Try the following sources:

  - The ACM digital library (http://www.acm.org/dl/)
  - The IEEE Computer society digital library

- The INFORMS Digital library. Informs published first class more business oriented journals. ISR (Information Systems Research) and Management Science are definitely excellent sources.
- JSTOR (http://www.jstor.org) is an on-line library of some excellent older journals.
- CiteCeer (http://citeseer.ch) is an excellent spider for computer science based papers. It also allows you to do citation analyses!
- The publishers digital libraries such as Springerlink, etc. Some of them are accessible when you are at the university.
- Commercial databases such as the web of science (everything science), INSPEC (mainly engineering literature), ABI-Inform (largely business related literature). Some of them are accessible when you are at the university and usually allow citation analyses.
- Check other resources at: http://www.hbz.unizh.ch

- When you find a good paper use *breadth search in both directions.* In other words, look at what related work that paper is citing (and find them) and look for papers that cite the paper you liked (e.g., using CiteSeer, Web of Science).

Very importantly, though, don't forget to stop reviewing the literature! It is not unusual for a PhD student to learn about the literature for about a year. In a six month thesis project you should seriously think about your investment of time if it looks like you are investing more than $1\frac{1}{2}$ months...

4.2 The writing action

Writing is difficult work. It does take more time than most people think it does. Usually, you can't really be sure that you know something until you are able to explain it either in writing or in a talk – the latter being less of a proof than the former. So you have to take your time to do so and establish a good discipline to get the text together before 2 o'clock in the morning of the last day, when nobody is going to proof-read the whole thing. I will try to outline some ideas that may help you to write your thesis, going from self-discipline to practical issues.

Writing Discipline One of the most important things you will have to develop is an ample writing discipline. If you look at it as a the task of writing 100 pages, then the task is rather daunting. If you think of it as a page a day, then it looks rather simple things. Some of the most successful theses writers always had a draft of what they did by the end of the week. Essentially they followed the 4 days work, one day write approach, which can be very efficient once you are passed the initial material gathering phase.

Also, remember that it is always important to get feedback from others. The fact that you wrote it doesn't mean that others understand it. Hence, having a friend and/or colleague reading it and giving you feedback is crucial. In order to make it possible for a friend to read things you will have to deliver draft versions of your chapters early. Last, don't forget the research assistant advisors! They

will usually be prepared to go through the document outline with you (so will I) and even read the document to give you feedback.

Summarizing one can say:

- Try to *write as early as possible.* Think of it as: "A page a day keeps the horror away!". A different way of thinking of it is the "4 days work, one day write" metaphor (also known as the always be done writing approach).

- *The more feedback you get and the earlier get it the better.* Ask your friends, assistant advisors, and myself, for feed-back early in the game. We usually try to help as much as we can!

Stylistic issues   There are a number of stylistic questions that arise when writing the thesis. To complement the usual sources [Strunk and White, 1979]. I have made a list of the most important issues I could think of:

- **The "I" versus "we" question.** One of the most often asked Questions is whether to use the anonymous "we" or "one" form when writing the thesis. I propose the following rule of thumb: When you write what you personally think, then state it appropriately (e.g., as "My personal opinion is") and then you can most definitely use the first person. Everything else, which is supposed to be as objective as possible should be in a neutral form (e.g., third person or in the passive voice).

- **Citations.** Citations should deserve a full section by themselves. They are a very strongly discussed issue. In particular, when different tastes collide. I strongly dislike the German Informatics citation format, which puts found letters and the publication year in brackets (e.g., [BeKK2004]). It doesn't really help me to remember what reference is talked about and more or less forces me to read the text with a constant flipping back and forth between the text and the citation format. I also strongly dislike the ACM and IEEE format (a number in brackets) for the same reason. Therefore I suggest you take the following advice to heart to help you:

  1. If you have lots of citations, use a bibliography program such as EndNote™for Word or BibTeX for LaTeX.

  2. Please use some "normal" format that includes the full name of the author and the publication year (e.g., [Bernstein 2000]). Should there be one co-author then refer to the reference Autor-1 and Author-2 and the publication year (e.g., as [Bernstein and Kaufmann 2004]). With more authors use the *et al* notation (e.g., [Bernstein *et al.* 2005]). EndNote™or BibTeX have multiple formats ready (e.g., the APA-format, IEEE Transactions format, etc.).

- *Tell them what you are going to tell them, tell them, and tell them what you told them!* This is the most important stylistic tip you are going to get in almost any writing course. It holds unless you are intending to write a thriller where some things should only be revealed at the last page. But theses aren't thrillers. Hence, you should tell people at every section (just as you are doing it in the first section of the overall theses, what they should expect to read in the section. Then tell the reader the details, and

end the section with a short summary. This approach is, by the way, a good approach to fill the space between the section heading and the first sub heading ☺.

- **Read though the text, spell check, and (if possible) grammar check the text.** It just makes a better impression, if you spend the day to try to remove the most obvious errors. Take the time, it's worth it.

- **The role of the abstract** is to advertise the content of the thesis to its readers. It should be giving an interesting overview that entices the reader to dive into your text. Note, it is not a movie trailer with cliff-hangers!

Formatting issues. There are just a few formatting rules to follow. These will help to ensure the readability of your document. If your aesthetic view of formatting gets insulted of the following then please forgive me:

- Please use at least $1\frac{1}{2}$ space. Double space would be better, as it allows me to write into your thesis without using micro-type.

- Please use a font ≥ 11 points. I don't get younger and being able to read a text without a raster-tunnel microscope is really helpful.

- Please use ample margins and headings. It helps structure the text.

5 Conclusions

We have started quite some ground (and killed a couple of trees) since the onset of this paper. The hints collected here might make an impression that writing a thesis is a pain in the butt. Well, this is not true. Writing a thesis (or should I say the whole process including doing the research) is usually a lot of fun. Unless you will decide to get a Ph.D. your career will ***never*** give you the opportunity again to exclusively focus for an extended period of time on a subject that you actually chose. Therefore: Have fun! If you don't you are doing something wrong. I had some of the best days of my (professional) life during my theses.

I will close with my best wishes for your time at the thesis.

Good Luck!

Abraham Bernstein

References

[Strunk and White, 1979] Strunk, Jr., W. and White, E. B. (1979). *The Elements of Style.* Macmillan, third edition.