THESIS INFORMATION
a brief guide

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This guide is for those students (graduate and undergraduate) doing their theses under my supervision. If I am not your senior supervisor, then you are not required to follow these guidelines; however, I would still recommend them. My purpose in writing this document is to answer "off-line" the questions that frequently come up when one is in the throes of thesis preparation. Many of the points in here are similar to those in the *ENSC Communication Handbook* written by Susan Stevenson and Steve Whitmore; however, some of the more perverse items may be unique to me. The *ENSC Communication Handbook* also contains a good amount of information that will likely improve your writing style. Good references for style related questions are: Strunk and White's *Elements of Style*, Fowler's *Modern English Usage*, and *The Chicago Manual of Style*.

1 Generalities

A thesis is a major body of work, no matter whether it be at B.A.Sc., M.A.Sc. or Ph.D. level. If you have doubts about how a thesis is done or how much work is expected, I recommend that you look through some previously written theses – these are available from various sources around the department and more recent ones can be found on the Dept. website. It would be a good idea to ask around in order to find a good one.

The process of doing a thesis typically starts with an idea. At this point, an initial investigation should be done to see if the idea is really worthwhile. Only once this investigation has been carried out should the formal proposal be written. It is a good idea to start writing your thesis as soon as finishing the proposal. Waiting until all of your research/development is complete makes things take much longer. Also, it is amazing how explaining what you are doing in writing can clarify your ideas and identify wrong turns.

The following is a summary of what is expected for each kind of thesis. In all cases, the scope of the project should be well defined and the work should be of a high standard. You are expected to understand the material in your chosen area of work and you need to be able to justify the major technical decisions that you make.

Ph.D.

Normally, a Ph.D. thesis is required to contain *original* and *independent* research. As a result, the direct choice of thesis topic rests almost entirely with the student. Of course, it is necessary that their supervisor support the topic.

M.A.Sc.

The M.A.Sc. thesis does not have to be "original", but it should at least use known techniques in novel ways or combinations. The M.A.Sc. student should make a strong effort to define their own topic; however, at some stage the professor should assign a topic if the student has difficulty. An M.A.Sc. thesis is typically less than 100 pages in length.

B.A.Sc.

The B.A.Sc. thesis is expected to show that you are able to work independently on a problem of reasonably large scope and come up with a good solution. The work need not be original and, in fact, may be an implementation or an analysis of something that has been done elsewhere. A B.A.Sc. thesis is typically between 50–60 pages long and the technical work usually takes 2-3 months once the topic is defined and researched.

When your thesis is part of one of your workterms, it is important that you negotiate with your employer so that you are assigned a task "suitable" for turning into a thesis. This task should be a solid and cohesive body of work that requires a good amount of independent effort. In addition, the work must be at a senior year technical level. A series of unrelated tasks does not make a thesis no matter how useful they may be to the employer. The negotiation of what is a suitable project may be an iterative procedure between you, your boss and your SFU thesis supervisor. In some cases, it may be useful to draft up a pre-proposal to present your idea in a more comprehensive way and to ensure that your boss and your supervisor have the same understanding as to what you are planning to do. In this way, you can be fairly confident that you have a topic before you spend time writing a formal proposal.

2 The Proposal

It is necessary that you write a thesis proposal (indeed, Ph.D. students must defend their proposal in an oral presentation). The purpose of this exercise is not just to make you do more work! A proposal is, in fact, a mini-contract. Once I (and perhaps the other committee members) sign it off, it means that we have agreed that the proposed work is sufficient to form an acceptable thesis. This contract is not written in stone and you may change the thrust of your work midstream; however, this should only be done in consultation with your senior supervisor. Your thesis proposal also provides your committee with a chance to warn you off should you be attempting to solve all the problems of the world in a few (OK, tens of) pages. Note that it is dangerous to progress too far with your work before getting it okayed through the formal mechanism of the proposal. An oral indication from your supervisor is generally not a reliable indicator of approval, since professors have been known to forget and oral communication is never as precise as we would like.

A proposal is, in general, a short document – say 10 pages for a B.A.Sc. proposal to 20 pages for a Ph.D. proposal. Your intended audience is your supervisory committee, not your peers as in the thesis. This document should be written with as much precision as possible and should contain enough background material to show that you know what is involved. Typical sections for a B.A.Sc. proposal are as follows:

- Introduction
  - identify the problem/design-project and put it into context
  - identify your role if it is a team project
- Background
  - provide the technical details needed to understand the problem and its context
- Requirements
  - what does the project have to accomplish and how well does it have to work
  - what is the environment in which the project has to work
  - what are the constraints on the solution

- Plan of Attack
  - how are you planning to do the design or solve the problem
  - identify major risk areas and possible contingency plans
  - discuss how you are going to evaluate the success of your project
- Time Lines
  - break your project up into tasks and to estimate the completion time for each

M.A.Sc. and Ph.D. thesis proposals typically have greater technical depth, fuzzier goals and should include a reasonable thorough review of the literature in the area under investigation.

3 The Thesis

A thesis is not a project or a workterm report. It is a *formal* document in which you must demonstrate your command of the technical area under investigation. This means that you need to include enough background material so that your intended audience (students at a similar academic level to you, who may have no special training in your specific area of work) can understand and follow what you did. One of your peers should be able to duplicate your work using the information that you provide in your thesis. You should also be extra careful to fully justify and explain all major decisions that affected the direction of your investigation. Try to put your self in your readers shoes during the writing process and think about whether your text will be comprehensible or not. Remember, your reader does not know before hand what you have done and will likely become confused if contextual information is missing.

A thesis should be cohesive in that each part should be relevant to solving the problem in question. Conciseness is a virtue and makes your document easier to read and a more valuable reference. The thesis is NOT a story and you should avoid at all costs endless descriptions of each twist and turn of your investigation (these can be put in an appendix if you really can't bear to leave them out). Extraneous material such as program listings, circuit diagrams, complex derivations or material that does not directly relate to the thrust of your argument should be put into appendices.

3.1 Format and Style Issues

The format of a thesis is important and you must follow the University guidelines for your final copy to be acceptable. You must pay attention to the margins, the print quality and the format of the introductory pages.

Some common format errors are as follows:

- Your Introduction should motivate your work and define the scope of your study. If you are doing a design project, you should also layout the project specifications and discuss how you will test to see that these specifications are indeed met.
- Over use of the first person. The first person is generally not used in scientific work for several reasons:
  - Your work should be objective (to the extent possible) and sound reasoning should be used to justify courses of action. Use of the first person lends a subjective tone to your work that is best avoided.
  - There is a strong tendency to adopt a "story-telling" style when using the first person.

- No punctuation in equations – see some IEEE journal articles for details.
- Improper or missing citations. You should be sure and provide citations to the literature where appropriate. These are important both for giving credit where it is due and for guiding the reader to more detailed information. All of the items in your bibliography should be referred to at some point in the text.
- Material directly copied from elsewhere. Verbatim usage of text is permitted; however, the words should be put in quotes and cited. You must also cite the source when you use somebody else's figures and drawings!
- Improperly placed figures. Make sure that figures AND their captions stay on the same page. In addition, do not begin sections with figures: each section should be introduced with some text.
- Confusing line-breaks. You should also be sure to avoid line breaks in the middle of abbreviations or in-line equations (eg: "5 dB" should not be split across two lines at the hyphen).
- Punctuation. It is amazing how many people (myself included) have trouble with commas, colons and semi-colons. Please re-read a grammar/style book (or the *Communications Handbook* if you doubt yourself.
- The use of *which* instead of *that* in "defining" clauses. To paraphrase Strunk and White (1979)

  That is the defining, or restrictive pronoun, *which* the non-defining, or non-restrictive. For example

  > "The lawn mower that is broken is in the garage." In this case, *that* specifies which lawn mower from the class of all lawn movers and is thus defining.
  >
  > "The lawn mower, which is broken, is in the garage". In this case, the *which* clause adds a fact about a specific lawn mower.

  Note: a non-restrictive clause is always parenthetic and should be preceeded by a comma.

Citations should be in the format discussed in chapter 7 of the *ENSC Communication Handbook*; i.e.,

- Recent research (Aardvark 1992) shows that ...
- Previously published work (Aardvark and Sloth 1989) indicates ...
- Previously published work (Aardvark, Giraffe and Sloth 1989) indicates ...
- Previously published work (Aardvark et al. 1985) indicates ... (> 3 authors)
- Aardvark (1992) has shown that ...
- Previous methods (Aardvark 1980a, 1980b; Grizzley 1809) ...

This method is endorsed by the *Chicago Manual of Style* and in my opinion is superior to the standard paper numbering used in IEEE journals, since it saves the reader a lot of paging back to the reference list – an important feature when there are many references. In addition, should your word processor not automatically number citations (and generate a reference list), you will find that the above system saves you a great deal of typing by allowing you to add references without changing what has been formatted already.

Your bibliography should be presented in alphabetical order with the last name of the author first (only the first author should be in reverse order). This method allows you to quickly identify a reference. For example,

Aardvark, A., and B. Sloth (1989, August). A comparison between two gourmet delicacies: ants and leaves. *Journal of Good Taste 44*, 555–565.

Some styles put quotes around article titles and the date at the end. It is not critical which style you choose as long as you are consistent.

Although you are free to use any word processor to compose your thesis; however, I recommend the use of LaTeX or `Word`. Each of these packages has advantages and disadvantages. For example, LaTeX generally produces a superior looking document; however, it is not WYSIWYG, takes a while to learn, and dealing with tables and graphics is a bit painful. `Word`, on the other hand generally produces inferior equations and has a hard time "floating" figure and tables to sensible places. `Word` also lacks a free bibliography database package for doing easy citations. On the plus side, however, `Word`, has useful features such as a WYSIWIG interface, the ability to add notes, track changes and simple inclusion of graphics. A `Word` macro package is available from the ACS to help you with items like a table of contents and general formatting

For those of you with home PC's, a free version of LaTeX is available from http://www.miktex.org.
The software installs very easily and can be used to produce a "pdf" output. Also, by using the ensc_thesis.sty style file, LaTeX can automatically arrange your document in the correct way (margins, line spacing, chapter headings, approval page ...) for an SFU thesis. The style file itself is located in ~vaisey/tex/macros on the research net, but I can also email it to you.

4 The Defense

In ENSC, thesis defenses are organized into 3 sections: a presentation to a general audience; a question and answer period involving the entire audience (where most questions are targeted towards what was talked about in the presentation); and a private question period with only you and your examining committee present. The private session generally focuses on material from the written thesis and usually contains the more difficult and probing questions. Once the last questions are over, you will be asked to leave the room and your committee will come to a consensus on the grade you will be given. There are four possible outcomes: pass; pass with minor revisions; pass with major revisions; and fail. The second outcome is by far the most popular.

No matter what level of thesis you are defending, it is important that you spend a significant amount of time polishing up your presentation. Your talk should define what the problem is and then summarize how you attacked the solution and what results were obtained. There is no need to go into each and every point discussed in your thesis! The objective is to show your command of the material and to explain to the audience (who may not have read your thesis) the main results of your work.

Questions from any area of your thesis work are fair game; however, the major types are:

- clarifications
- questions probing your understanding of the technical issues underlying your work
- questions about the validity of your assumptions
- questions asking you to explain why you took a certain approach
- questions asking you to explain what would happen if something were changed
- questions about possible extensions to your work

It can be a big help to prepare answers to what you think are the most likely areas for questions.

Finally, if you don't know the answer to a question it is far better to admit it than to attempt to "bullshit" your way out, which just tends to dig you into a deeper hole. Limiting the scope of your work in both the thesis and the presentation will help avoid this kind of difficulty.