Earning a graduate degree

without the frustration, pain, irritation and annoyance!

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Graduate degree

- Is composed of 4 basic components:
  - Course work
  - Research work
  - Thesis
  - Making enough money to pay tuition and survive the duration of the degree
- Unfortunately, most graduate students do not realize that after passing classes, the MOST important component is the thesis; AND **this is not the same thing as working for their research advisor!**
- *Said a different way:* ***Your thesis and the means by which you manage to pay your bills MAY NOT BE RELATED!***

Graduate students

- All graduate students are not the same
  - Each has different gifts, skills, temperament and capabilities;
  - Each has different life circumstances and aspirations;
  - Each has different levels of motivation and drive to succeed.
- The ideal graduate student
  - Works 12 hours a day 7 days a week during their degree;
  - Writes and publishes several papers on their work with their advisor;
  - Finishes their degree in a year, with excellent results;
  - Mentors other students in the program, and more…
- How do you compare to the ideal?

Graduate advisors

- Ideally your advisor will be a tenured professor and an experienced researcher with:
  - Numerous papers, patents;
  - Books and chapters;
  - Research grants;
  - A track record of successfully matriculated graduate students.
- However just like students … not all professors are the same
  - Assistant professor –new to the job, recent PhD, non-tenured
  - Associate professor –has some experience, tenured
  - Professor –established, good at finding funding, publishing

Role of advisors, committee and the Dean

- There are usually two formal advisor slots in your graduate program
  - Research Advisor –guides you in your research decisions, ie the work you are doing for your thesis
  - Academic Advisor –guides you in your academic decisions, ie the courses you are taking.
  - These may be the same person!
  - ***Remember… they are advisors and you are a responsible adult… you can take or reject their advice!***
- You also have a committee, composed of other researchers; ideally they are interested or knowledgeable in the research area.
- Dean of Graduate Studies –tries to ensure that everyone plays together nicely, stays on task and on time, provides thesis templates, checking and approval!

The order of things

- Once you are enrolled in graduate school and in your FIRST SEMESTER
  - Select your advisor… someone with research interests in the area you want to do your thesis and that you can put up with for at least 2 years (MS), 5 years (PhD);
  - Select your committee members in consultation with YOUR advisor;
  - Select your research area, ideally a strong match with your advisor;
  - Select your entire course program ie all classes!
- In the first month of your SECOND SEMSTER have a committee meeting, present your planned research and course list as a formal document to give out to your committee!

Research and thesis

- There are two ways to do your research work leading to a thesis, either may work for you:
- <u>The wrong way:</u>
  - Your advisor gives you a project or a never ending list of task for you to complete, ***because you are paid to do tasks***;
  - When you have stayed long enough, and your advisor decides you can leave, you try to write up all the things you have done;
  - Since you have done everything asked, and everyone said it was okay, you will ***usually*** be able to complete your degree.
- <u>The right way:</u>
  - Use the scientific and engineering methods to develop questions, premise, experiments and answers to the proposed questions related to the work of your advisor;
  - Write the pieces up as a short paper, then write a thesis that you can **defend**.

Scientific method

- Is a method of inquiry and problem solving based on specific principles of scientific reasoning and is an ongoing process
  - **Formulate good questions** and select the one(s) that you intend to answer
  - **Develop a hypothesis**. This will become your thesis statement. This hypothesis must be falsifiable to be meaningfully tested.
  - **Make a prediction**. If A is true then the result of an experiment would should that B has the following form.
  - **Test and experiment**. Perform the test required to demonstrate the prediction. Gather the appropriate amount of data to get a statistically sound result.
  - **Analysis**. Evaluate the data set to demonstrate the hypothesis and use it to interpret the original questions.

Using the scientific method

- Before you start any research endeavor you need to get *up-to-speed* on the topic. You do this by:
  - Relevant class work! … *I want to take a class because…. = FAIL*
  - Literature review / survey – this is the most important!
- Develop several questions related to your research interest
  - Hierarchically organize the questions based on your interests
  - Pull hot topics out of the literature review
  - Look at funding calls from organizations
- Select an overarching question and use it to develop a thesis statement
  - Develop experiments to investigate the thesis statement
  - Proving the thesis statement true gives you the answer to your original question

Thesis as a research tool

- You can't do research without being an expert in the area and have good questions you are trying to answer.
  - ***Children make noise all the time and constantly ask questions***
- Doing work for an advisor is no guarantee you are working on your thesis, it is more usual that you are working on something they are interested in and may not be usable or suitable for a thesis.
  - ***You may be able to take one small piece of this work and with additional independent effort make it into a thesis.***
- You need to take command and control of YOUR research activities. Its not a job, its part of YOUR degree! The value YOU get from your degree is developing and honing your research skills.
- ***The take away from your graduate degree IS becoming a researcher, not the work or tasks you completed.***

Thesis document

- The thesis is a means to describe, document and explain a complete research experience
- A thesis can be outlined by chapters as:
  - **C1: Introduction**
    - Describes the motivation for the research work
    - Describes the driving questions for the work
    - Defines a thesis statement that can be proven in the remainder of the work
    - A description of the remaining chapters
    - No figures, equations, tables are needed in this chapter
  - **C2: Background**
    - Literature survey
    - Techniques and mathematics to understand work
    - Statistical analysis approach used
    - Other useful things you didn't develop

The thesis (cont)

- **C3: Research and Analysis**
  - Describe your method and approach
  - Present your data
  - Analyze your data
  - Interpret your data
  - Explain the value and importance of your finding
- **C4: Summary and/or Conclusion**
  - Highlight your results
  - Demonstrate that your thesis statement has been answered
  - Show how the answer to the thesis statement answers your key questions
- **References**
- Appendices as needed to document computer code, mathematical derivations etc.

The short paper "thesis"

- A thesis is long, time consuming to write and harder to read; **speed up the process** by developing a short paper following the model of a thesis
  - No more than 4 pages in length
  - Only needs introduction, background, results and discussion sections; include needed summary headings and sub=sections
  - You should be able to write 1 – 3 paragraphs under each major heading
  - **Identify the important data plots, including a guess of what the data would look like; tell the story in pictures**
  - Places where you can't fill in information are the areas you need to work on to complete the research effort.
- ***This document while in draft form becomes the focus of your first committee meeting with the planned course work.***
- *Once your committee approves, it is up to you to complete the work.*

Start writing the thesis NOW

- Prepare your reference list by finding and reading:
  - The standard textbooks and papers;
  - Recent review papers on the topic;
  - Check papers in the reference list of the review papers;
  - Your advisors papers, even the off topic papers (learn how to read!).
- **Start today writing Chapter 2 Background:**
  - Identify the main contributions of each reference
  - Summarize each paper's potential contribution to the field
  - Identify key concepts that will be used in your work and describe these topics
- **Develop your list of questions to be answered and morph these into a thesis statement.**
- **Write chapter 1, Introduction.**
- Now you are ready to design experiments and record work.

Wait a minute

- I have:
  - been in the lab every day working on research!
  - Googled stuff!
  - Read papers!
  - got stuff accomplished, got something like results!
  - Everyone else uses the word research around me!
- How come I am not doing research?
  - Research comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge ***ON THE PLANET***… ie answer relevant questions.
  - ***But they have to be worthy questions…. Not just … I don't know what I am doing… I will go ask someone….***

Moving forward

- The key to completing your degree is making sure your advisor and committee members understand your timeline and dedication to meeting the timeline!
- The longer the degree takes the greater the risk of not completing the degree.
- The requirement is on you the graduate student to become an expert in: the course catalog; the requirements of the thesis work; the scientific or engineering topical area.

Other questions

- Whatcha got?

- Thanks!