SOME THOUGHTS ON WHAT IT TAKES TO PRODUCE A GOOD PH.D. THESIS

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DIFFERENT PHASES OF PH.D. RESEARCH

- finding a good problem
- staying on top of the literature
- getting plugged into the broader research community
- communication of research results through oral presentations and writing

FINDING A GOOD PROBLEM

This is probably the most stress inducing phase of the whole program.

How does one go about finding a good problem?

1. Ask your major professor

2. Ask your office mate

3. Ask your mom

4. .....

In my mind, the correct answer is: None of the above.

To appreciate my answer, you have to get to the bottom of what engineering research is fundamentally about.

Basically, engineering research is about

..... observing and understanding the world around you with regard to how things work now and how they could be made to work better

..... discovering the current best practice in your area and pushing that to a higher level of performance

..... bringing together two hitherto disparate threads of engineering knowledge and creating a new thread for study and analysis

In order to discover a good problem .....

..... you have to first push yourself to the current state of the art, before you can advance the state of the art.

Are there any strategies for rapidly pushing oneself to the current state of the art?

In the kinds of areas that most of us here are interesting in, I think the best strategy is to actually try to do a state-of-the-art experiment.

For example, if you want to discover a good problem in the area of computer vision for video tracking, there is not a faster way to get to the state of the art than to try to implement a tracker.

There are probably 500 papers now that have been published on the subject of computer vision algorithms for video tracking. These range from histogram based methods, to Kalman filtering based methods, to HMM based methods, to ....

You could spend a couple of years trying to read all these papers, but by the time you are done, there would be another 100 papers to read.

It is probably more efficient if the problem discovery phase is experiment-driven as opposed to literature-driven. What you read in the literature should be dictated by your current experimental obsession, as opposed to the other way around.

STAYING ON TOP OF THE LITERATURE

This is probably the most traumatic phase of the whole program.

Much technical literature is poorly written, designed more to hide than to reveal, designed more to obfuscate than to clarify, designed to gain short term recognition, etc.

In other words, much technical literature is written with motives that are less than noble.

How does one cope?

My strategies for coping with the literature glut:

Every engineering contribution is based on assumptions about the real world. When I look at a new paper, my first attempt is to quickly extract those assumptions. If I find those assumptions excessively unrealistic, I do not pay much further attention to the paper.

I read papers to seek out their limitations. But some authors do a great job of hiding the limitations.

Sometimes I discount papers if I have already written off the authors in my mind.

To get to the bottom of what's in a research paper...

> In a face-to-face interaction (even by e-mail sometimes), people are more likely to tell you about the limitations of their work, limitations that they did not mention in their written papers.

GETTING PLUGGED INTO THE BROADER RESEARCH COMMUNITY

This is probably the most frustrating phase of the whole program.

Every research area has its in-group. People who are already on the inside make it difficult for people from the outside to break in.

But break in you must, because the research program of the funding agencies is determined to a great extent by the collective debate that takes place within research communities. So you want to become a part of that debate.

Moreover, everyone needs recommendation letters when you are trying to get a new job, or when you come up for tenure, promotion, etc.

Progressive steps for breaking into a new research community:

Actively participating in conferences and workshops in order to become noticed.

Expressing verbal interest in other people's work at conferences and workshops and following that up with e-mail interaction.

Forming friendships and collaboration with researchers from other institutions.

Volunteering to help out with workshops.

Volunteering to organize workshops.

Volunteering to help out with conferences.

Volunteering to organize conferences.

Volunteering to help out with journal refereeing.

etc.

As a rule of thumb for those Ph.D candidates who want to work in universities:

> During the last third of a Ph.D program, about a third of your mental focus should be on the research world outside.

During this period a lot of your energy has to go into forming friendships (they will be your future collaborators) with people on the outside.

COMMUNICATING RESEARCH RESULTS THROUGH ORAL PRESENTATIONS AND WRITING

Ability to express ideas precisely and unambiguously is a key to success in all human endeavors, particularly so in research.

Writing is central to good research.

A Ph.D. is, as the degree says, a doctorate in philosophy, a doctorate in ideas, a degree that requires that the chosen ideas be articulated precisely and with rigor.

Moreover, writing imposes a discipline on thinking. Every time you write something down, you are committing yourself to a position. The act of making that commitment forces you to examine with care what it is that you are writing.

Post Ph.D. life in industry

Post Ph.D. life in a research university

Post Ph.D life in a non-research university

There is world of a difference between these three lifestyles. This is not to say that any one particular post Ph.D existence is better than the other two.

If you are not sufficiently self-aware to know where you belong among these three possibilities, you could end up frustrated and with a lot of emotional and other problems down the road.

The 30 Ph.D.'s that I have produced populate all three categories.

Finally ....

Practically all research consists of **incremental** advances over the state of the art.

Even the most stunning developments are stunning only from the outside. To those on the inside, they are practically always incremental.

In rare cases, when they seem stunning on the inside, it is because someone injected a brand new approach (from what was until then an unrelated area) into a problem domain.