Engineering your research

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A view on research and proposals
What is this workshop about?

Your plan for success

- The differences between research and engineering
- How to make sure you have the right research question and objectives.
- How to scope the Masters and PhD
- How you can avoid certain disaster.
- How examiners examine and how to meet requirements (what are the requirements anyway)
- How to get it right and graduate
- How to do it in good time.
What is this workshop about?

PhD and MSc research – at any stage
Some exploratory work has been completed
Topic and field of study is fixed

Not about discipline specific knowledge or methods
What is this workshop about?

Simple, clear purpose and principles give rise to complex and intelligent behaviour.

Complex rules and regulations give rise to simple and stupid behaviour

-Dee Hock
What is this workshop about?

Program:

Research as knowledge creation

The research objective

Cultures and disciplines

Complex problem solving
Writing as a tool

• Generative writing
  – Writing for yourself
  – Discover what you want to say, informal, full of errors

• Drafting
  – Writing for others, conversation, many iterations

• Editing
  – Polishing and rounding
Writing as a tool

• Writing is the act of learning and discovery

• You do not learn and then write

• Don’t wait until the end to ‘write up’
What is your research about?

• I am working in the field of...

• Because I need to discover...

• So that my reader can....
Simplistically:

Engineers build things that work

Researchers draw conclusions that are defendable
Engineering vs Research

Is the PhD or MSc
The thesis or dissertation, or...
is it the person?

How will you be different after postgrad study?
Research as knowledge creation

What is knowledge in your discipline?

• How is knowledge preserved? In a textbook?
• What is the nature of the stuff in the textbook?
• Is it words with descriptions? Maths, graphs, computer algorithms?
• Is it a convincing opinion? Is a person telling you? It is your supervisor?

How do you know things?
Research as knowledge creation

An engineering design is correct when it meets specification.

How do you know when new knowledge is correct?
Research objective
Research objective

• What do you want to achieve?

• Why can't we achieve it? – We don’t know how

• What knowledge is lacking?

• What knowledge does your research seek?
Research objective

• State your research question

• Can it be written in a simple form?
  i.e. can \( x \) be predicted from \( y \)?
Research objective

Be careful of words like:
- understand
- develop
- analyse

They are activities, not measurable outcomes
Research objective

• Given the question, what is the *shape* of the answer? (what does the knowledge look like?)

• Question: can x be predicted from y?

• Shape of answer: yes or no
  – No, because....
  – Yes, under condition that....
Research objective

• Does the question need to be bounded?
  – i.e. only in certain cases?

• Does the answer need to be limited?
  – Probably only known towards the end.
Research objective

• Check

  – Is the question a question.
  – Can it be disputed? (I disagree..)
  – Does it require new knowledge to answer?
  – Is the question answerable?

  – Is it important and significant?
Research objective

• Importance and significance

  – How do you know you are working on the right thing?
Research objective

• Importance and significance

− What becomes possible when we have the new knowledge?
− What does it allow or enable?
− How does your contribution fit into the existing framework of what is known?
Research objective

How do you know the new knowledge is correct?
Cultures and disciplines

• Who are the major players in your field?

• Where are the groups of expertise?

• Who are small but up and coming?

• Who is the target audience of your work?
Cultures and disciplines

• What are others doing in this field?
• Is your question unique or are there others also moving in this direction?
• Who are they? Where are they? What do they look like?
• Can you convince THEM? These are the true judges of your work.
Cultures and disciplines

• What are they looking for?

• What has been done before and what is the current thinking?

• Paying homage
Cultures and disciplines

- Literature survey as a discussion among peers
- If the person you are speaking to is not familiar with another discipline you must introduce it to them. (cross discipline research)
Examining and assessment

• Who would you want as your examiners?
• Why? Are they the best experts in the field?

• What would they expect to see? Something that looks like their work?

• Every discipline is different
How examiners examine
Mullins and Kiley (2002)

“... experienced examiners make judgements about the quality of a thesis by the time they have read the first two chapters, often sooner.”

“No first rate researcher is without a belief that they understand the standards in that field and can recognise excellence in that field ... So if you ask me to examine, you are going to get [my] standard”
How examiners examine

Mullins and Kiley (2002)

Positive indicators

• ‘sparkle, energy, enthusiasm and sense of confidence with the material’
• cohesiveness and clarity
• a student who makes the ideas his/her own, with some originality of presentation
• professionalism—as demonstrated by mature comments, and the accuracy of the logic
• style and sophistication
How examiners examine

The final, substantive judgement is determined by:

• the student’s confidence and independence;
• a creative view of the topic;
• the structure of the argument;
• the coherence of theoretical and methodological perspectives; and
• evidence of critical self-assessment by the student.
The plan for success
The plan for success

Linked by argument

Initial State

Goal State

Adapted from Hanrahan

Barriers
Interaction
Steps
Argument

• “... an argument is a series of statements in which the author leads the reader from certain premises to a particular conclusion.”

• “... an argument has at least two parts a claim (conclusion, hypothesis) and evidence (premise, proof) for that claim.”

Belcher 2009
Argument

• What evidence is needed to support the type of claim you will make?
• How is evidence gathered in your discipline?
• Do specific tools need to be mastered?
• List the milestones within the argument.
• What inputs and outputs do the milestones need?
Argument

• The importance of guessing, (intelligently)

• “a hypothesis refers to a provisional idea whose merit requires evaluation” wikipedia
Resource planning

- What resources are required to gather the evidence for the argument milestones?
- Time and intellectual ability are yours to supply.
- What others can be outsourced?
- Ethics clearance?!
Time planning

• Gantt chart almost never works.

• Plan the milestones within the argument not the dates for completion.

• Assign time budgets in productive hours.

• Nominally 3600 hours for PhD, 1800 for MSc.

• If you are part time you will need to find this in your schedule.
Risk

• What can go wrong, causing delay / failure?

• Hurdles will be encountered. Will they be fatal?

• What are the salient points of the argument? What if they are not achieved?

• Can they be ranked by severity?

• How will they be dealt with?
Common issues

• Research question is irrelevant / not significant / not original
  – Not important to other in the field

• Theory or Method is flawed
  – Argument structure is no good

• Tools used incorrectly
  – Interdisciplinary problems
Common issues

• No argument
  – I did some stuff and saw some stuff
  – I built it and it worked

• Irrelevant sections
  – Well known in the discipline

• Too narrow or too broad
  – Mismatch between evidence and claim

• Bad care and Feeding
  – Lack of attention to detail

• Voice not present
  – Too much reliance on the work of others
Common issues

• Too shallow
  – not embedded in the discipline, trivial

• Plagiarism
  – Unfortunately too much of this. Attend the referencing course!

• Multiple disjoint projects
  – Several MSc’s do not make a PhD.
The Plan

• It is your plan for success
• Keep it up to date and revise often
• A version of it will be seen and approved by a committee
• Every School has its own tick boxes
• If your plan is robust the tick boxes are simple
• Talk to your supervisor often.
Bibliography


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Some research questions 1

How can x data be used to predict Y?  
What method can be used to estimate state Y?  
What must be done to ensure data X is suitable for analysis Y?  
How do parameters x and y affect process Z?  
What is the range of parameter y to cause process X?  
Verify conclusion of previous study with larger sample size and different tools?  
Determine a model for process X?  
Evaluate three existing models under new conditions using new experimental data?  
What can be inferred from process x given measurement limitations?  
Can process x improve process y?  
How can process x be improved?
Some research questions 2

Can process x be improved by doing y?
Is process x dependent on parameter y?
Does process x change in location y?
Is process x time dependent?
Can parameter x of process y be measured?
Can process x be used for purpose y?
If process x is modified will it still meet its original objectives?
Can process a and b be combined to achieve C?
How does process X perform in situation a,b,c,d?
Can process a be used in situation b?
Does replacing x with y have benefits for process z?