Project Management for Graduate Students:

How to Plan and Carry Out a Research Project

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Project Management

- Kinds of research projects

- How to get a project done

Things to ask about any project

- What is the goal?
  - (How will you know if you've achieved it?)

- What do you have to do to reach the goal?
  - (How will you interpret or evaluate the results?)

- What is already known?
  - (And how can you find out?)

- Where can the results be published?

The goal

Begin with the end in mind.

Identify as early as possible
all of the things you are going to have to do
and make sure you can do them.

Don't pretend obstacles will magically go away
or that some course will teach you needed skills.

What is already known

- "Literature review" may or may not be the name of a chapter of your thesis – but you have to do it.

- *There is no point in trying to do research without first ascertaining what is already known.*

What is already known

- It's not enough to just find *some* published source that mentions every important idea you want to use.

- You must actually trace each idea to its origin – find and read the actual published report of every piece of research that you are relying on.

- You are doing historical research! Your job is to find out how the current state of knowledge of your topic was achieved.

What is already known

Google Scholar and other search engines are
good at finding sources but not at *evaluating* sources.

- An original research paper in a refereed journal (or book in a scholarly book series)?
- A research paper about something else that happens to mention earlier work you're interested in?
- A reference work, textbook, popular book, Wikipedia article, course notes, etc., reporting other people's work?
- An unpublished paper placed on the Web by its author?

Use the first of these whenever possible.

What is already known

- Reference information found on the Web (even in the best sources) is often inaccurate. Go and look for yourself.

- Never copy a bibliography entry without understanding and checking it. (Even if you have the paper itself, the citation that came with it may be inaccurate.)

- A bibliography entry is like an address. It says exactly where to find something (with no further use of search engines).

What is already known

Your bibliography is a list of *sources you actually read,* not *references you found on the Web.*

You're not entitled to list anything unless you've seen it with your own eyes and are confident it contains what you're saying it contains.

Never copy a reference to a paper you haven't actually seen. That is a form of academic dishonesty.

What is already known

Your bibliography is not a list of everything you looked at while preparing your paper.

It is a list of sources of information you actually used, and you must indicate what information you got from each source.

If you don't refer to a reference in the text of your paper, it should not be in the bibliography.

Goal and evaluation

- Decide in advance what you're trying to do.

- It's OK to adjust your goal as the research proceeds. Just don't work without a goal.

    And don't change it so it's farther away!

    When you change it, make it come *closer* to you.

- Ask yourself what the results might be and how you would interpret them.

- How do you measure degree of success?

Goal and evaluation

Know when to abandon a project.

If you have good reasons to believe that the project is not worth finishing (e.g., someone else has done it or has proved it infeasible), then stop, and do something else. (But don't do this lightly.)

Don't feel you have to stick with a project forever just because you've put some work into it.

(This is the "Fallacy of Sunk Costs.")

Publication

- Look at examples of published studies in the same field (for the format, not just the content)

- Do not imitate bad writing. Many scientific papers are badly written.

- Aim to write a *good* paper, not just an *acceptable* one. You should have confidence that it's good, whether or not a journal accepts it.

- Understand that acceptance/rejection is chaotic. Many good papers get rejected. Revise and try elsewhere.

Publication

The journal(s) in which you hope to publish may require:

- A specific bibliography format (learn it!)

- A specific word processor (LaTeX)
  (common in the mathematical sciences)

Don't let this take you by surprise.

Kinds of research projects

- Data-oriented study
- Theoretical research
- Literature review
- Implementation project

Data-oriented study

- Common in psychology and biosciences

- Formulate a hypothesis, gather data, test it

- Try to foresee results and how you might interpret them

- Statistical significance tests are usually needed

- Results will be no more important or interesting than the hypothesis was, so *think*!

Theoretical research

- New theories, new algorithms, new applications of a theory or algorithm originally developed for some other application

- Criteria of success are often the hard part: when do you know you've done enough work?

- Try to identify questions you will answer

Literature review

- Goal is a *complete* review of *all* important prior research on a particular subject

- Must contribute *something new* (such as new connections between sources) – not just a summary

- Try to express important ideas better than the discoverer did (this is often not hard!)

- Must not leave out anything important

  (Must not include too much garbage either!)

Implementation project

- Common in engineering, including software engineering

- Implement a known technique on a somewhat novel problem and evaluate its performance

- Goal may be to produce a reusable software tool, or just a performance study

How to get it done

- Identify resources needed

- Make plans and measure your progress

- Recognize partial ordering and lead time

- Know when you're finished

Resources

What does your project need?

- Information
- Data sources
- Software
- Equipment
- Infrastructure skills
- Time

Resources

Is there anything necessary that is not actually available?

(Are you stuck because this is the case and you haven't realized it?)

Resources

Information, data, software, and equipment are more or less self-explanatory.

What about infrastructure skills?

Infrastructure skills

Identify *all* the technical skills that you need to *complete* the project.

- Knowledge of programming
- Knowledge of statistical software
- Knowledge of word processing and writing tools
- Knowledge of writing, library work, bibliographic citation, etc.

Don't forget that your goal is a *paper*.

Infrastructure skills

Often, when a project gets bogged down,
it's because the researcher is lacking
needed infrastructure skills
and hasn't quite recognized it.

Infrastructure skills

Writing is often the step you're afraid of.

To ensure good progress, create an incomplete rough draft very early – then add to it.

Don't save all the writing until the end.

Milestones

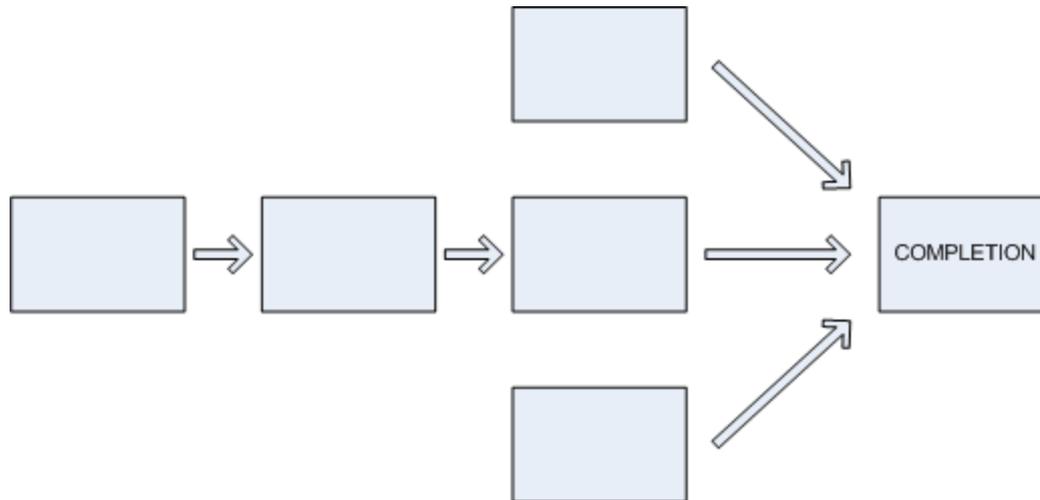Divide your main goal into subgoals (milestones).

Make a tentative time line as early as possible.

(But recognize that it may be inaccurate.)

Partial ordering
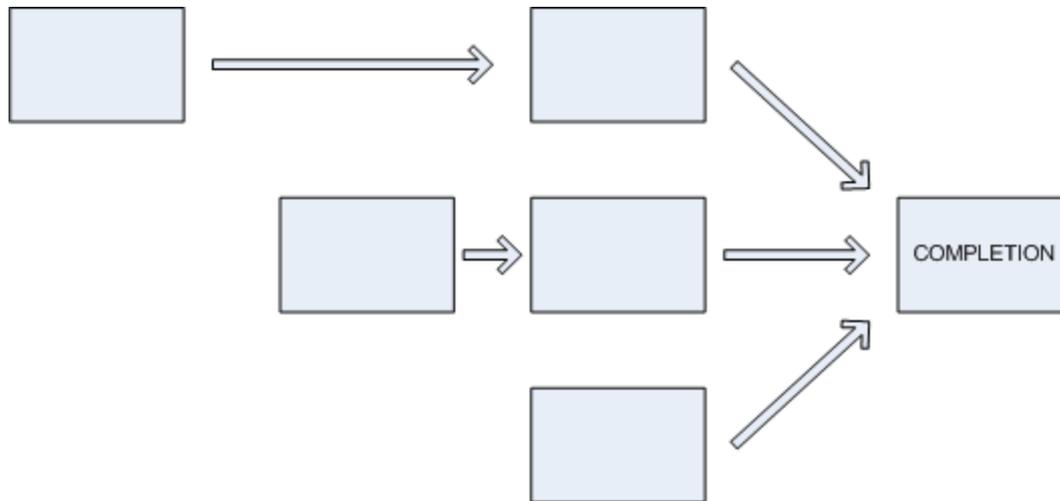
The time line is not exactly a line.
Some tasks can be done independently of each other.
Other tasks have to be done in a particular order.

COMPLETION

Lead time

Some tasks have to start long in advance of when their results are needed.

Progress

- Understand that progress is irregular, *but* never let two days go by with no progress.

- Time is not fungible. Some blocks of time will be much more productive than others.

- Avoid distractions.
  - Thesis writing is the opposite of leisure!

Know when you're finished

- Don't try too big a project.

- Almost all thesis projects start out too big.

- If you've done a well-defined subset of what you originally wanted, it may be time to stop.

- Don't let *fear of writing it up* keep you from ever finishing! (Start writing *early.*)