Graduate Student Professional Development

Small Project Management: Planning and Scheduling Your Thesis Work

Plans are only good intentions unless they immediately degenerate into hard work

Peter Drucker

Those who plan do better than those who do not plan, even though they rarely stick to their plan.

Winston Churchill

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January 16, 2019

BS M 137

Definition

"Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements."

Source: pmi.org

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Characteristics of a Project

A project is **temporary:** it has a beginning, a "muddle", and an end. There is a defined scope and finite resources.

A project is **unique:** it is not a routine operation, but rather it is a specific set of operations designed to accomplish an objective.

A project team often includes people who don't usually work together. In the case of thesis work, it may be almost all one person's work; but there will be supervision, and (hopefully) collaboration with fellow students.

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Project Management Processes

- Initiating (Setting Objectives)
- Planning the Work
- Executing (Working the Plan)
- Monitoring and Controlling
- Closing

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Areas of Knowledge to Consider in (Thesis) Project Management

- Integration
- Scope
- Time
- Cost
- Quality
- Procurement
- Human resources (umm, that's you)
- Communications (not just key deliverables)
- Risk management
- Stakeholder management

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A Few Design Methodologies

While we typically think of design as a technical activity, design also applies to a research process

Some methods include:
Waterfall
Kanban
Project Evaluation and Review Technique (PERT)
Critical Path
Scrum

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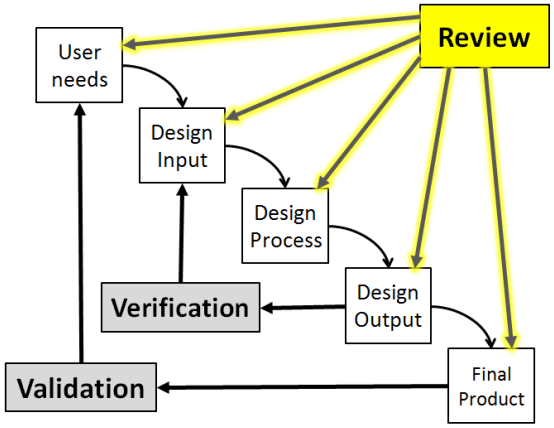
Waterfall

A sequence of activities where there is local iteration only



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Waterfall

Many theses can be described this way, with activities roughly mapping to the chapters in the dissertation:

Problem & Motivation

Literature Review

Solution Methodology

- (that is, a bunch of work you do to execute the methodology)

Results

Discussion

Conclusions & Recommendations for Future Work

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Problem Definition

Defining the problem gets you partway to the solution.

But this is different than identifying the specific objectives of your thesis, which relate to creating some new knowledge necessary to contribute to solving the problem.

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Literature Review

The literature provides additional context, by providing a summary of the state of the art of understanding of the relevant theory and knowledge that is relevant to the problem.

The literature review highlights limitations of the current understanding, that is, the gaps in knowledge that need to be filled in order to solve the problem.

The importance of the literature review cannot be overstated, as this shows the state of knowledge beyond which the new work has progressed.

Literature review is an ongoing activity throughout your thesis work.

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Objectives

Once the gaps in knowledge are identified, the thesis gives a very specific problem statement using the terminology explained in the literature review. The objectives may include any or all of the following:

- theory development to explain a discrepancy between current theory and experimental evidence, or to extend existing theory to describe new physical situations;
- experimentation to test an hypothesis;
- design methodology development related to new technologies; and
- application of theory or design in a case study to support the validity of the work.

Where possible, the objective should be a falsible hypothesis, which you will test in some way.

Objectives lead to anticipated contributions = papers.

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Methodology

Following the problem statement, there should be a description of the solution methodology, which outlines the key approaches that will be taken to tackle the problem.

If there are multiple objectives, then fulfilling an objective is a phase of your thesis project. Each chapter of your thesis roughly covers one phase of the work.

Even when there is only one objective, then there may be elements of the objective that are substantial enough for a phase (= a thesis chapter or a publication).

For instance, an experimental thesis may have chapters for experimental design (describing the apparatus and any new equipment, and the test plan with both controlled and measured variables, and the measurement methods), testing results, error analysis, and interpretations.

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Experimental Development

Design of experiments
- Controlled variables (fixed)
- Manipulated variables (varied inputs in known range)
- Responding variables (measured outputs)
- Randomization
- Factorial design

Apparatus development for experiments
- a subproject in technology development
- Do not underestimate the effort that may be involved

Design of surveys & protocols, ethics approvals

Detailed test plan(s)

Same level of detail for theory development for the problem of interest, and design method development

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Analysis of Results

Data by themselves have little value.

Information in context has value.

This includes data reduction (descriptive statistics, filtering, etc.), model verification and validation, comparative assessment with existing techniques, etc.

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Discussion of Results

Limitations of the results
Error and uncertainty analysis
Applicability to the problem of interest

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Conclusions & Recommendations

A summary of what has been accomplished and its context
A list of scientific contributions
Description on limitations of the applicability
Possible future work to extend the applicability or to close knowledge gaps

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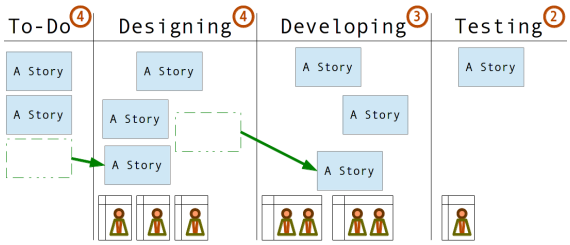
Kanban

Work flow is modeled to understand the value that each activity (or "story") adds to the process, and how activities shift into new phases

Kanban was originally developed for lean manufacturing but is now also used in project management

Your committee can help you develop the plan



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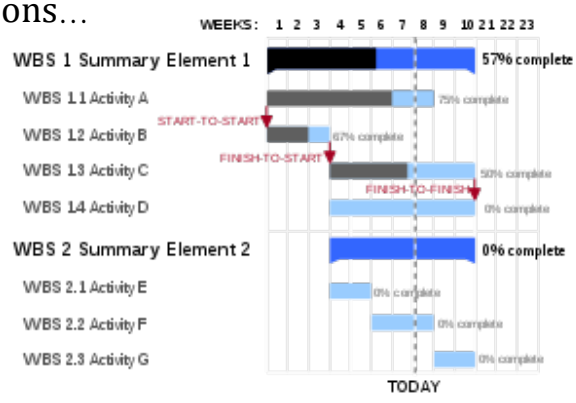
The Gantt Chart

The Gantt chart allows progress and schedule dependencies in the Work Breakdown Structure (WBS) to be shown simply

But not resource dependencies from parallel actions…



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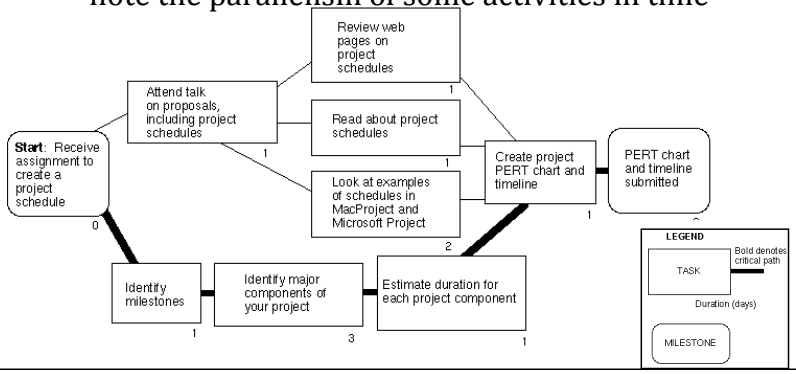
Project Review & Evaluation Technique (PERT)

PERT is a structured approach to project planning
Define objective, brainstorm all design activities
Estimate resource and time requirements
Arrange a timeline with connections

- note the parallelism of some activities in time



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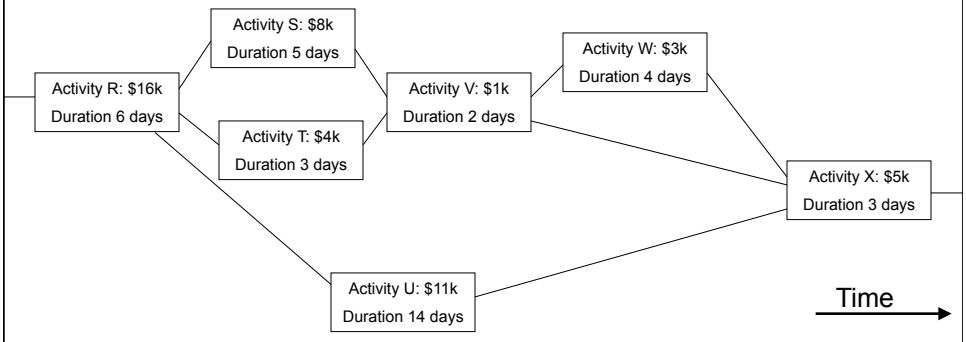
Critical Path Method (CPM)

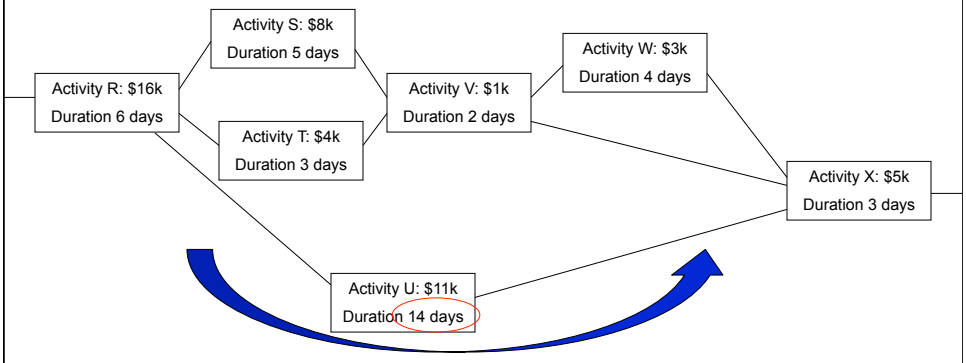
Scheduling of tasks is driven by time & resource constraints
While we carry out all the activities in order,
keeping on schedule means putting extra effort into activities that are on the "critical path"



While ensuring safety & quality of work
And ensuring that all other key conditions of success are met

Critical Path Example

For parallel sequences of activities:
The sequence with the longest duration is the "critical path"



This is where delay in an activity would delay the <u>whole</u> project
Precedence overrides priority, if necessary

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Why Don't We Just Work the Plan?

"Research is what I'm doing when I don't know what I'm doing."

- Werner von Braun

Most research work does not play out according to the original plan. Insights are made that lead to new approaches being pursued. Experimental results don't come out as expected. Stuff breaks.

In these cases, there needs to be a way to learn from failure and to modify the plan.

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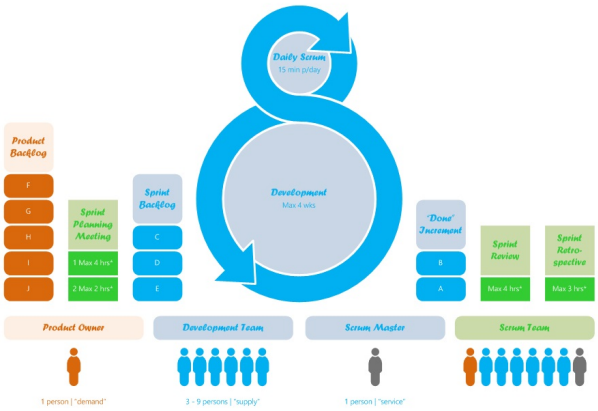
Scrum (Design Thinking)

Prototyping (experimenting) is included as an explicit design step to reduce uncertainty, this allows quick testing of ideas, followed by new planning based on the updated understanding



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Project Plan Deliverables

Ensure that schedule is reasonable and achievable

- Is 20 hours per day for three years reasonable and/or achievable?
- Calculate a reasonable individual weekly workload
- Include any delays. If you are going to a family wedding for a week, then put it in the plan (and discuss it early with your supervisor)

Use ***graphical methods*** to summarize & document the plan in your reports (Gantt chart)

- Show on overall duration (based on something less than 100% effort)
- Compare estimates with actual time spent to see how you are doing
- Communicate potential time & cost changes to your supervisor early(!!)

Why do we do all this stuff . . . ?

- learn to estimate engineering design projects
- first hand experience with estimates vs. reality
- develop your own scheduling metrics & safety margins
- Apply lessons learned here to your first job as an EIT

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Project Management as the Project Progresses

Update task descriptions and time estimates regularly as your understanding of the project develops.

Contingency (time & money buffers to allow for scope uncertainty) shrink as the project progresses. By the end of the project the schedule reflects what actually happened!

Track engineering/design time and costs throughout the project.

Keep your supervisor regularly apprised of the progress. No-one likes surprises.

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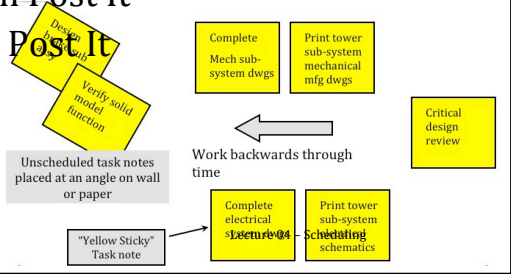
Creating a PERT Chart the Old-School Way

Write individual design activities on Post It notes
Place end objective sticky note on RHS of paper
Place sticky note defining task(s) that must be completed immediately before that objective
Repeat process working backwards through time
Identify parallel tasks
Estimate hours – write on Post It
Assign people – write on Post It



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An Activity to Complete for Next Week

Review the steps in creating a schedule

Define scheduling objectives

- (completing manuscripts, submitting final thesis draft, etc.)

Brainstorm project tasks

Create PERT chart from the network of Post Its

- Add missing tasks as required
- Remember to connect the activities graphically

Assign rough time estimates (including < 100% effort at times)

Then… Enter the data into a project planning and tracking package (such as MS Project, Liquid Planner, Google Sheets, Basecamp, Wrike, Slack with Pivotal Tracker & Trello, etc., or even Excel) as soon as possible, and discuss it with your supervisor

Review schedule deliverables

Use the package to keep track of what you are doing!

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Summary

"Chance favours the prepared mind." (Pascal)

A good plan is critical to good delivery.

The plan will change. That's okay.

Review the steps in creating a schedule
Define the objective
Brainstorm project tasks
Create network of connected tasks with approximate estimates of time & resources (people)
Use a project planning and tracking package
Keep a notebook for your personal documentation
Use the software to keep track of what you are doing!
And update the plan as necessary

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