Experimental Design
CHEM 294
3.7.2016

http://files.abovetopsecret.com/files/img/si5190f728.JPG
Due today
294: Annotated Bibliography Literature Review
Aspects of Project Planning

• Identify the **hypothesis, goal or purpose** - Be SMART
  Specific, Measurable, Achievable, Relevant, Time-bound

• Enumerate possible tasks
  **Brainstorming**
  End products with deadlines

• **Evaluate risks** associated with potential tasks
  incremental vs high risk/reward science

• Split main tasks into **chewable bites**
  Decide how much time each task requires
  Consequences of a task taking additional time?
  Identify resources necessary

• Figure out **task order**
  **Critical steps**, sequential steps

• Allow some breathing room

• Plan for **contingencies**

http://www.projectsmart.co.uk/project-planning-step-by-step.php
http://www.nextscientist.com/manage-a-large-research-project/
Hierarchy of Experimental Planning

1. Strategic - Identify your purpose or goal. No actions.
2. Tactical - Actions needed to make your goal a reality. Identify constraints, sequential components, bottle necks, deadlines.
3. Operational - specific plans daily, weekly, etc. Specific actions that will make your plan happen.
I want to take a vacation to the Mediterranean.
I need to **STRATEGIZE** my vacation to the Mediterranean

**BUDGET**: I have a $3000 budget and 18 days vacation time

**GOALS**: I want to visit Rome, Athens, Pamploma, and Barcelona

I want to see the running of the bulls in Pamploma (July 6-14)
TACTICAL planning of my vacation to the Mediterranean

To do: Buy a plane ticket July 2-31 FAI-Madrid and Rome-FAI
Make hotel reservations, train tickets, ferry tickets, etc:
Madrid July 3-4
Pamploma July 5-15, Night train to Barcelona
Barcelona July 17-23, Train to Rome
Rome 25-27
Venice 29-30, Fly out of Rome

No time for Athens
OPERATIONAL planning of my vacation to the Mediterranean

To do TODAY: Buy a plane ticket July 2-31 FAI-Madrid and Rome-FAI

To Do TOMORROW: Buy Travel books at Barnes and Noble
Make a list of contacts for hotels, train stations, and ferry ticket booth

NEXT WEEK Make hotel reservations, train tickets, ferry tickets, etc:
Smooth execution relies on all levels

YOU CALL THAT PROJECT MANAGEMENT?
Project management

Consider in the planning phase how you will deal with all of these:

- Electronic data
- Calculations
- Figures
- Physical samples
- Timelines & Deliverables
- Procedures
- Written records
- Lab notebook
- Reference management

http://www.nextscientist.com/manage-a-large-research-project/
Experimental Design: Sampling Strategy

1. Completely randomized design
2. Systematic sampling
3. Randomized block design
Experimental Design: Developing a Procedure

Differentiate between influence of variable being studied and uncontrollable influences.

Considerations in designing a good experiment:
1. Maximize significant figures
2. Minimize dilutions
3. Consider what glassware is available
Experimental Design: Minimizing Error

Differentiate between influence of variable being studied and uncontrollable influences.

Requirements of a good experiment:

1. Absence of systematic error
   Removing influence of uncontrolled variables

2. Precision

3. Range of validity
   What other situations might your results be applied to?

4. Statistical validity

5. Simplicity
Precision vs. Accuracy

Precision:
- Repeatability

Accuracy:
- Reliability
Systematic User Error

- The more unnecessary steps involved, more potential errors introduced
- What does error look like?
Accounting for error: DMA80 Lab Rotation

Discussion:

How did we account for erroneous machine error when measuring mercury from fish tissues using the DMA80?

List 3 examples of introducing user operational errors into your sample measurement.
Attributes of a great plan

- Explains the problem, the current state of knowledge, your expertise in the problem area, your approach to solving the problem, and the products from the research program.
- Convinces the review panel that you are the best team to conduct this research.
- Presents your plan as a narrative from front to back.
- Showcases your ability as a project team to conduct this research and solve a problem.

By page 2 reviewers should know:

- The subject of your research
- Why it is important
- What it will produce
- How you are going to get there
Project management tools

• Evernote for science
• Shared drives, for example Google Drive, DropBox or SharePoint
• Diigo archives as an alternative to Evernote Web clips,
• Paper management software, for example Endnote, or Mendeley.
• Google Calendar or another app that allows long-term planning as well as scheduling appointments.
• A smart To Do list program, which allows you to prioritize and use different levels of tasks: Evernote, Google Tasks, Remember the Milk, Wunderlist,
• Understand how to search digitally in your library archives, for example through tools as the Engineering Village

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Time management tools

• To get a first rough planning, you can use the fun and visual Finished in Four (aimed at PhD students)
• ManicTime to track and tag your time
• RescueTime to keep an eye on how you spend your time,
• A tool for applying the Pomodoro technique
• Getting Things Done (or GTD) Method

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Looking Forward

**Lab today: Planning Experiments 1**
Due CHEM 294: Updated Annotated Bibliography
   Literature review
Due CHEM 694: Brainstorming notes (after lab)

---Spring break---

**Next Week (Mar 21)**
**Lecture- Writing Procedures**
   Reading: TBD
Due CHEM 694: Example SOP to share
   Literature review feedback

**Lab: Planning Experiments 2**
Resources

• Project Management and tools
  http://www.nextscientist.com/manage-a-large-research-project/
  http://www.gradhacker.org/2012/11/16/phd-thesis-project-mgmt/
  http://www.projectsmart.co.uk/project-planning-step-by-step.php

• Ebook specifically targeting undergraduate research

• Writing a project plan
  Writing an Excellent Project Plan- ars.usda.gov
  Project Management Plan Template- CDC- www2.cdc.gov