Guide to Prospectus Writing

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This brief guide is provided to aid my graduate students in writing the M.S. or Ph.D. prospectus required by the BYU Chemical Engineering Department. It supplements the information contained in the department's Graduate Student Handbook. Many of the principles here also apply to writing the thesis or dissertation.

1 Objectives and audience

For any kind of writing you should understand the objectives of the document and tailor your material for the intended audience. The objectives for almost all technical writing are to

- Sell your ideas. This means you should convince the intended audience that your experiments and theories are important, interesting, valid, and useful.
- Disseminate scientific knowledge. This means you should accurately and concisely document your experimental procedures, mathematical model, and numerical results for others to use and verify.

The prospectus is a research proposal. It is written to gain approval to carry out the project. In defining the scope of your project, the approved prospectus becomes a kind of contract between you and your committee so that you know when you are *done*. It is recognized that you may change directions along the way, but with the prospectus in hand you have a place to start and an idea where to stop.

Because the prospectus is written before most of the research work is done, the emphasis is on the first item above ("Sell your ideas"). You must convince your graduate committee that

- Your project addresses an important problem in an appropriate way.
- You have adequate preparation and a plan to solve the problem in a reasonable amount of time.

The audience is your graduate committee, a small group of professors. They will understand general chemical engineering concepts like process optimization, phase and chemical equilibria, kinetic vs. transport limitations, validation of numerical models, experimental design, and data analysis. Not all committee members are experts in your particular subfield, and so will need to be given the appropriate background material to understand the terminology and theory specific to your project. They need to be told what is "common knowledge" in your subfield and what is new and innovative about your work.

2 Content

Below is the general order of topics that I recommend, along with a suggested length for each item for a Ph.D. prospectus. The Ph.D. prospectus should contain about 24 total pages; an M.S. prospectus should contain about 10 total pages.

1. Give a brief background of your field of work, identify a problem, and establish the problem's importance (around 1 page). This is your opportunity to generate interest in the audience about your project. Avoid using highly technical jargon at this point.

2. State the scope of your project (half page). Do not just say you will work on X or study subject Y. Instead give scientific hypotheses you will test or research questions you intend to answer, and outline the tools and methods you will use.

3. Outline the topics that are covered in the remainder of the document, i.e. give a road map (small paragraph).

   Note: it is vital that the introduction (items 1 through 3) be well polished in order to generate a good first impression and set the tone for the remainder of the document.

4. Do a more extensive background discussion on the problem, showing you have a good grasp of the field in which you are working (around 10 pages). This section includes your "literature review," though don't name it as such. In particular, describe where others' prior work overlaps with your proposed work, showing ideas you can glean from them or knowledge gaps that need to be filled. You are preparing your audience to understand the nature of the problem and appreciate the value of your proposed solution (see item 6). Extensive experimental details or equations are not appropriate in a research-proposal type of document.

5. Give prior results generated by you, showing a few quantitative or theoretical results to demonstrate you know how to get started and have been able to overcome a couple early hurdles (2 pages). You do not need to show everything you have done—the purpose is to establish your credibility in carrying out the proposed research, not to provide the same level of detail that would be found in an academic publication. Sometimes this section can be combined with item 4 or item 6, depending on the best logical flow of material.

6. List the tasks that are required to answer your hypotheses or questions, giving detail on the technical challenges you anticipate and how you plan to overcome those challenges (around 8 pages). While doing this, provide the logical framework guiding your choice of tasks, so that the reader can see why the proposed activities are the best means of answering your questions. Figures and tables illustrating the proposed experimental design(s) are quite helpful. Give alternative paths (backup plan) if your original plan of attack is not successful. State how you will maintain laboratory safety.

Note: items 4 and 6 will each require multiple subsections as you cover different technical topics. Also, help the committee to distinguish your unique contribution to the field by explicitly identifying ideas that are new to your work as opposed to ideas that originated with others.

7. Give a time line or Gantt chart summarizing the tasks and steps that will lead to completion of dissertation or thesis (half page).

8. List cited references in a section at the end (2 or more pages). Use a consistent citation format taken from a leading journal in your field.

3 Wheeler's points of style

1. With a polished draft I can spend more time addressing "big picture" things like the logical structure and flow of ideas, rather than just correcting grammar and spelling mistakes. This means you should edit and revise your writing multiple times before showing it to me. It is helpful to have a "fresh pair of eyes" edit your document—this person does not necessarily need a technical background.

2. Use headings or subheadings *at least* every two pages. Transitions between major sections are a good time to remind the reader where you are going. This helps the reader track the logical progression of topics.

3. Every time you write a paragraph or section, ask yourself: "What is the main idea of this paragraph or section?" That idea should come out in the first one or two sentences. Do not switch ideas in the middle of the paragraph or section; instead start a new paragraph or section. Do not include extraneous information that does not support the main idea.

4. Technical writing requires a precise choice of words to convey meaning clearly and concisely. With each sentence, ask yourself: "Is there any way for a reader to misinterpret the meaning of this sentence?" As one example, confusion can arise if you use an anaphor (e.g. *it* or *this* or *that*) to refer to an antecedent (a previous idea, object, or person) and it is not clear to which thing or things you are referring because there are multiple possibilities.

5. Compound adjectives abound in technical writing. A compound adjective is an adjective that modifies another adjective, and together these words act to modify a noun. These generally require hyphens to eliminate possible misunderstanding. As an example of the importance of hyphens in compound adjectives, note the difference in meaning in the following phrases: man eating dog vs. man-eating dog, twenty two minute delays vs. twenty two-minute delays, out of the box solution vs. out-of-the-box solution.

6. You cannot presume an audience will simply trust your conjectures or opinions. Whenever you present an idea or conclusion that is not generally understood or accepted in the scientific community, or is likely to be questioned by your audience, you must support it by mathematics, logic, or data or provide a citation that does the same. If the matter is not central to your project, a citation is generally preferred. If you cannot support a questionable statement, then you should qualify or narrow the statement so that it is supportable, or eliminate it entirely.

7. Similarly, you must provide a citation for any unique ideas, text (even if you change a few words around), or data you obtain from another source. Not to do so is called plagiarism, and this academic sin can have serious consequences.

8. When discussing upcoming sections, figures, and equations in the present document, or discussing enduring scientific principles, use verbs in the *present* tense.

When discussing human actions, such as experimental data collection or the work of others, you may use the appropriate *past* or *future* tense.

9. Some academics insist that personal pronouns and possessives (*e.g. I, we, my, our*) not be used in technical writing. I do not agree with this. As appropriate you may occasionally use *we* and *our* (which are somewhat less personal than *I* and *my*) in describing proposed research and results.

10. Each table and figure should be numbered, and have a caption that contains a title and, in most cases, an additional description that allows it to "stand on its own" without other supporting text. Generally, the caption text should contain a description of the symbols in the plot. Generally speaking, in your plots represent experimental data with points or symbols; represent fits to the data or theoretical relationships with lines or curves. If you use a series of graphs to represent related data, use a consistent system of symbols to aid the reader. If you use Microsoft Excel to generate plots, know that the default settings do not make for nice graphs in printed documents—you will need to adjust formatting so it looks better.

11. If you are describing an important experimental apparatus or model geometry that is unfamiliar to your audience, a line drawing or schematic is necessary.

12. Whenever an equation is given, all variables should be defined if they have not been defined previously. An equation should be punctuated with a comma or period if it is part of a sentence. An important equation should occupy its own line and be numbered. Example: the ideal gas law is

$$PV = nRT\,, \tag{1}$$

where P is absolute pressure, V is volume, n is number of moles, R is the universal gas constant, and T is absolute temperature.

13. Format quantities appropriately: $h = .221$ is wrong, $h = 0.221\,\mathrm{W/(m^2K)}$ is right; $k = 1.2E-3\frac{W}{mK}$ is wrong, $k = 1.2 \cdot 10^{-3}\,\mathrm{W/(m \cdot K)}$ is right. All variables should be italicized with the following noted exceptions. Greek-letter variables and named dimensionless numbers (Re, Pr, Nu, etc.) should not be italicized. Vectors and matrix variables should be in bold font, unless one is referring to an element: v_i is scalar element i of vector $\mathbf{v}$. Units and common mathematical functions should not be italicized.