

## Guidelines for Preparing Your Doctoral Thesis Proposal

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One of the requirements for the PhD in Materials Science and Engineering is the preparation and defense of a thesis proposal. Your thesis proposal outlines a research problem and general approach which, if carried through to completion, will provide a satisfactory basis for writing your PhD dissertation. Preparing a thesis proposal at an early stage teaches you to identify and articulate promising lines of inquiry and to place your research in the broader context of the state knowledge in your field. It gives you experience in writing a persuasive proposal and defending the ideas it contains, and it ensures that the thesis committee is in broad agreement with you about the general course of research to be pursued and what is required for you to successfully complete your thesis and receive your Ph.D. degree.

### Timeline

The proposal is of little use if you put it off too long, so you are encouraged to do it as early as possible, but in any event before the end of your third year (as stated in the official requirements for the Ph.D. degree). Note that it is not necessary for you to have a large amount of preliminary data for your proposal. The proposal is designed to show that you understand the context for your research, are familiar with the techniques that you will use, and have a sound rationale for your approach. Preliminary data can be helpful, but are not required.

Scheduling three faculty in the same room at the same time can be tricky, so get started early. You must submit the written proposal no later than two weeks before the scheduled date of your oral presentation.

### Thesis proposal committee

The thesis proposal committee consists of three faculty members, including your research advisor. Ordinarily, it is expected that the members of your thesis proposal committee will also become members of your thesis committee. You should choose the members of your committee in consultation your advisor, to ensure that all important topical areas related to your research are covered.

## Written thesis proposal

You must submit your written thesis proposal to the Academic Program Coordinator (Jeanine Majewski) as a single PDF file no later than two weeks prior to the date of your oral presentation. She will check your thesis proposal to ensure that it adheres to the format described below and distribute it to the members of your committee.

Your written proposal should present a clear outline of your proposed research. You should describe the significance of your research, its novelty or innovation, and your general experimental (or computational, or theoretical) approach. It should provide sufficient detail to allow assessment of the overall goals of your project and the experimental design. Review criteria for evaluation of NIH and NSF proposals provide valuable guidance in the content of research proposals and are provided as an appendix below.

## Sections, length, and formatting

Your thesis proposal must include the following sections, each strictly limited to the number of pages specified:

- Title page (1 page)
- Specific Aims (1 page)
- Research Context and Strategy (6 pages, including figures and tables)
- References

You should observe the following formatting requirements:

- All pages must be formatted for U.S. letter size paper (8.5" by 11")
- Margins no smaller than one-half inch on all sides
- Number each page, except the title page, at the bottom center
- Type must be 11 point or larger, using a standard font (*e.g.* Times New Roman, Cambria, or Arial).

Note well: If your thesis proposal does not meet these formatting requirements, it will be returned to you for correction and re-submission.

## *Title page (1 page)*

The *Title Page* should include the title of your project; your name; your matriculation date; the date, time, and location of the presentation; and the names and email addresses of your thesis advisor(s) and the other members of your thesis proposal committee.

### *Specific Aims (1 page)*

The *Specific Aims* section should provide a concise overview of your project, a numbered list of your specific aims or objectives, and a statement of the expected outcome(s) and impact of your project. Since this is the first section that will be read, it should be clear and concise. Here are guidelines for this section:

*First paragraph* — Include sentences that describe: (1) the topic of the research – what is your project about, (2) the current state of knowledge in your field or the state-of-the-art, providing only the details necessary to understand the context of the project, (3) the gap in knowledge or technology that you will address, and (4) the critical need, i.e. new knowledge, model, technique, material, or process that you will develop or design.

*Second paragraph* — Describe how your project will meet the critical need identified in the first paragraph. Having defined the critical need, this paragraph should make the case for your proposed solution. The components of this paragraph may vary depending on your project, but it should include: (1) a description of how the critical need will be met, (2) a statement of the overarching goal of your project, (3) the hypothesis (if your project is hypothesis-driven), (4) the overall objective of your project, and (5) the rationale for your project — how the solution was selected (often based on previous work in the literature or preliminary data).

*List of specific aims* — List the aims of your project by which you will test the hypothesis or develop the new technique, material, model or process. Typically there will be two to four aims, and they should be provided in a numerical list to make it easier for the reviewers to clearly identify and understand each aim. In general, each aim should have an active title that clearly states the objective in relationship to the hypothesis and/or overall objective. Ideally, your aims should be related to, but not dependent upon, each other to avoid the failure of one aim preventing the completion of the other aims. For each aim, write a few sentences that describe the experimental approach, the anticipated outcomes, and how each aim will help answer your larger hypothesis. In some cases it may be helpful to divide the aims into sub-aims.

*Final paragraph* — Should include a brief statement of the expected outcomes and potential impact of your project as a whole.

### *Research Context and Strategy (6 pages)*

This section should include the following sub-sections. Suggested lengths for each are

given; these are only guidelines, but the entire *Research Context and Strategy* section is strictly limited to six pages.

*Significance* (~ 1 page) — The *Significance* section should make a compelling case for your project and explain why it is an important problem in the context of current literature and/or the state-of-the-art. Use citations to support specific statements and show familiarity with relevant literature and prevailing concepts. This section should explain: (1) how your project will address an important problem or a critical barrier to progress in the field, and (2) how your project will advance or improve scientific knowledge, technical capability, and/or clinical practice be improved. This section will usually include: (1) a summary of the current literature, (2) your rationale for pursuing the proposed project, and (3) a description of the expected significance of your project — its expected contribution to science, technology, and/or human health.

*Innovation* (~½ page) — The *Innovation* section should address: (1) how your project challenges/seek to shift current research, (2) any novel concepts, approaches, methodologies, instrumentation, and any advantage over existing ones, and (3) any refinements or improvements to existing approaches.

*Approach* (~ 4½ pages) — The *Approach* section should include any preliminary data, an overview of the experimental design, a description of methodologies and analyses to be used, a discussion of potential difficulties and limitations and strategies to overcome them, expected results, and alternative approaches if unexpected results are found. Number each subsection to correspond with the numbers of the specific aims.

In describing how each aim will be addressed, it is useful to provide an introductory paragraph that describes the motivation, rationale, and/or objectives for each aim. Within the description of the methodologies for each aim, describe how you will collect, analyze, and interpret your data. Include benchmarks if appropriate. Explain why one approach or method was selected instead of others. At the end of the description of each aim, describe potential problems or high risk experiments, and possible alternative strategies. Preliminary results can be summarized at the beginning of the *Approach* section, or distributed in the individual aims.

At the end of the *Approach* section, include a timeline for the proposed project, indicating the projected start and endpoints for each aim and/or sub-aim.

### References

Cite sources using either numbers or an author-date format. Collect the references in a separate section at the end of the proposal, using any standard format of your choice. References do not count against the page limit.

### Figures

Figures should be used as necessary to provide preliminary data or illustrate important points of the proposal. Number the figures sequentially, and put them in the text (not collected separately at the end). Place each figure at the top or bottom of a page (or on a separate page, if necessary) as close as possible to the first place it is mentioned in the text. Each figure should have a brief explanatory caption.

Figures should be legible — take special care if they are reproduced from some other source. Do not be tempted to shrink your figures too much to save space. If color is used, be sure that the important information in the figure can be understood even if the proposal is printed in black and white. Provide appropriate credit or a reference for any figure you do not make yourself or which you adapt from another source.

### Oral thesis proposal

The second part of the thesis proposal is an oral presentation to your thesis proposal committee and other members of the department. There are no specific requirements for the format of the oral presentation, but generally speaking you will want to convey the same ideas that are contained in your written proposal. Plan your talk to be approximately 30-35 minutes long, and *no longer* than 45 minutes — rehearse it ahead of time and revise as necessary, anticipating that you may be interrupted for questions by the audience. As a very rough guide to pacing you should figure on something less than one slide per minute, so you will probably want about 25 slides total (more or less depending on your style). Be sure that your slides are legible, even from the back of the room.

After the public oral thesis presentation there will be a closed examination (of approximately thirty minutes) with the members of the thesis proposal committee, in which they will probe your understanding of the context of your work and your proposed project in depth. For this reason, it is important that you understand and be able to defend your proposal at a greater level of detail than provided in either your written document or your oral presentation.

Here are a few resources with suggestions on how to put together a good presentation:

Randy Olson, *Houston, We Have a Narrative: Why Science Needs Story*. University of Chicago Press, 2015. ISBN ISBN: 9780226270845

High-level stuff about how to organize your presentation (and your written proposal, for that matter) in a way that tells a compelling story.

Marilynn Larkin, *How to Give a Dynamic Scientific Presentation*

<https://www.elsevier.com/connect/how-to-give-a-dynamic-scientific-presentation>

Practical advice on the presentation itself.

Susan K. McConnell, *Designing Effective Scientific Presentations*

[http://media.hhmi.org/ibio/mcconnell/mcconnell\\_powerpoint\\_pt1.pdf](http://media.hhmi.org/ibio/mcconnell/mcconnell_powerpoint_pt1.pdf)

Lots of good tips on how to use PowerPoint (or Keynote) effectively.

## APPENDIX 1

### **NSF Proposal Preparation Guidelines (from NSF Grant Proposal Guide)**

[https://www.nsf.gov/pubs/policydocs/pappg17\\_1/pappg\\_2.jsp#IIB](https://www.nsf.gov/pubs/policydocs/pappg17_1/pappg_2.jsp#IIB)

The Project Description should provide a clear statement of the work to be undertaken and must include the objectives for the period of the proposed work and expected significance; the relationship of this work to the present state of knowledge in the field, as well as to work in progress by the PI under other support.

The Project Description should outline the general plan of work, including the broad design of activities to be undertaken, and, where appropriate, provide a clear description of experimental methods and procedures. Proposers should address what they want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified. These issues apply to both the technical aspects of the proposal and the way in which the project may make broader contributions.

The Project Description must contain, as a separate section within the narrative, a section labeled "Broader Impacts". This section should provide a discussion of the broader impacts of the proposed activities. Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to the project. NSF values the advancement of scientific knowledge and activities that contribute to the achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the US; and enhanced infrastructure for research and education.

## APPENDIX 2

### Proposal Review Criteria

In writing your thesis proposal it is helpful to consider how the proposal will be reviewed. Below are the review criteria for NSF and NIH grants. Make sure that your thesis proposal clearly addressed the review criteria.

#### Relevant NSF Review Criteria (from NSF Grant Proposal Guide)

Reviewers will be asked to evaluate all proposals against two criteria:

*Intellectual Merit:* The Intellectual Merit criterion encompasses the potential to advance knowledge; and

*Broader Impacts:* The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to:
  - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
  - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

#### Relevant NIH Review Criteria

[https://grants.nih.gov/grants/peer/critiques/rpg\\_D.htm#rpg\\_01](https://grants.nih.gov/grants/peer/critiques/rpg_D.htm#rpg_01)

**Significance.** Does the project address an important problem or a critical barrier to progress in the field? Is there a strong scientific premise for the project? If the aims of the project are achieved, how will scientific knowledge, technical capability, and/or clinical practice be improved? How will successful completion of the aims change the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field?

**Innovation.** Does the application challenge and seek to shift current research or clinical practice paradigms by utilizing novel theoretical concepts, approaches or methodologies, instrumentation, or interventions? Are the concepts, approaches or methodologies, instrumentation, or interventions novel to one field of research or novel in a broad sense?

Is a refinement, improvement, or new application of theoretical concepts, approaches or methodologies, instrumentation, or interventions proposed?

**Approach.** Are the overall strategy, methodology, and analyses well-reasoned and appropriate to accomplish the specific aims of the project? Have the investigators presented strategies to ensure a robust and unbiased approach, as appropriate for the work proposed? Are potential problems, alternative strategies, and benchmarks for success presented? If the project is in the early stages of development, will the strategy establish feasibility and will particularly risky aspects be managed? Have the investigators presented adequate plans to address relevant biological variables, such as sex, for studies in vertebrate animals or human subjects? If the project involves clinical research, are the plans for (1) protection of human subjects from research risks, and (2) inclusion of minorities and members of both sexes/genders, as well as the inclusion of children, justified in terms of the scientific goals and research strategy proposed?