

## Directed Research Guidelines

Dr. James Van de Ven

**Directed Research:** The purpose of a directed research project is to explore a theoretical or experimental research problem towards a well defined goal. Research can be frustrating, but is also one of the most fun and exciting activities I know of. What can be better than exploring and creating the unknown?

**Structure:** Over a semester you will explore a mutually agreed upon research topic and present deliverables, which will include a written paper. We will meet on a regular, at least weekly, basis. During the semester you will write weekly project reports. While the time you invest in the project will vary from week to week, expect to spend an average of at least 15 hours per week for a 3 credit graduate directed research project. Because much of the work is unstructured, you must take the initiative and be self motivated.

### **Due dates and deliverables:**

**Project Proposal:** due 1 week after the start of the semester. Your project proposal is a 1-2 page document that will include:

- a) Introduction: Briefly describe the project you have in mind
- b) Problem Statement: What problem or gap in knowledge does the research project respond to? Why is the problem important?
- c) Objective(s): What do you intend to accomplish? What is the ultimate goal? Make sure that your objective(s) address(es) your problem statement.
- d) Method: Describe the procedures or plan of action you will use to accomplish your objectives.
- e) Risks: Describe the possible risks or roadblocks that might prevent successful completion of the project.
- f) Schedule: When will you accomplish the various aspects of your project? This will help you determine if the scope of the project is reasonable.

**Weekly Progress Reports:** due 24 hours before our weekly meeting. Every week you will write a short report on your progress for that week. The purpose of the progress reports is to provide a running documentation trail of your work, help you regularly collect your thoughts and look at where the project is headed, provide an auxiliary means for assessment beyond the final report, and enable more focused discussions during our weekly meetings. In your progress reports, you are encouraged to include pictures, graphs, figures, screenshots, or tables as appropriate. Try to view the progress reports as an extension of your laboratory notebook, summing up the work from each week. The progress reports should be sent to me via e-mail and uploaded to the SharePoint site.

**Final Paper Outline:** due 2.5 weeks before the end of the semester. An outline helps you organize your ideas, develops a logical flow to your work, and makes writing the paper much easier. Recommended steps: brainstorm the ideas you want to include in your paper, organize the ideas into related groups, and develop an appropriate order or flow for the information. There is no “right” format for an outline. I recommend labeling sections and sub-sections and using bullets to capture the main ideas. A good

outline takes time to develop, but will pay for itself multiple times in writing a cohesive paper that flows logically.

**Rough Draft of Final Paper:** due 1.5 weeks (10 days) before the end of the semester. I will provide feedback on your rough draft that can be used to improve your final draft.

**Final Paper:** due the last day of the semester. The format for your final paper is similar to a journal paper with the exception that your paper will include additional details that cannot be included in a journal paper due to length constraints.

### General Guidelines

- Times New Roman 11 or 12 pt font
- 1.5 spacing (Abstract may be single spaced)
- All units of measure should be in the SI system. If the U.S. customary units provide meaning, include them in parenthesis.
- Assume that the audience for your paper is well-educated but not necessarily a specialist in the area of your research project.
- If your research involves some form of modeling or analysis, develop the equations in the body of your text. Use “Microsoft Equation” or something similar to typeset your equations. Place each equation on a separate line and number your equations sequentially (Equation X).
- Avoid the use of first person adjectives whenever possible.
- In your writing develop your ideas from general to specific. Explain the forest before the group of trees before the specific tree before the specific leaf on the specific tree before the specific bug on the specific leaf on the specific tree.
- Where possible use schematics, pictures, graphs and tables rather than words. Captions should be placed above tables and below figures. Use tables when absolute numbers are important and graphs when trends are important. Always discuss a table or figure before presenting it. Explain to the reader how they should interpret the figure to avoid ambiguity.

### Structure of the Paper

#### **Title Page:**

- a) Project Title
- b) Author(s), Institution, Contact Information
- c) Prepared in partial fulfillment of the requirements of ME598
- d) Instructor
- e) Date

**Abstract:** An abstract is not an introduction. It summarizes the main highlights of the work, including the results. Your abstract should be less than 250 words and not include any citations or figures. The abstract should include one or two sentences on each of the following sections:

- a) Background: A description of the problem and why it is being investigated.
- b) Methods: Briefly summarize the primary methods used in this project.

- c) Results: Briefly describe the major results of the project.
- d) Conclusions: Summarize the conclusion of the results and discuss the meanings of the interpretation. In other words, describe the implications of your findings

**Introduction:** The introduction needs to capture the reader and provide the context and background information needed to understand the rest of the paper. The introduction is also your chance to establish your knowledge in the field by comparing and contrasting the works of others to your work through your literature review. Basic format:

- a) Describe the context of the problem and why it is important.
- b) As you develop the problem, define any terms and educate the non-specialized reader as necessary.
- c) Discuss previous research in the area and how it relates to your work. Do not merely summarize the contributions of each article you find, but synthesize and interpret the results from all of your reading to find commonalities and differences. Discuss gaps in the research and how this leads into your work.
- d) The last paragraph in the introduction outlines the remainder of the paper, providing the reader of a roadmap of what is to come.

**Body:** Divide the body of the paper into logical sections and subsections. Typical sections include:

- a) **Methods:** Describe the methods of your work to the extent that a competent peer could reproduce your work. Give details about equipment used, sample preparation, data collection methods, computational methods, etc.
- b) **Results:** Present the key results of the project without interpreting the meaning. Present the data through tables and figures as appropriate.
- c) **Discussion:** Interpret the results of the project based on the framework you laid in the introduction. Do the results agree with your hypotheses or with what others have found? Why or why not? Discuss the theoretical and practical implications of your results.
- d) **Conclusion:** Use the conclusion to summarize the significance of your results and provide a framework for future work. Provide an honest critique of your work, emphasizing the good, but also discussing the bad. Give direction for future work. Close the paper with the implications of your work.

**References:** List all of the references used in the paper. While current journals use a variety of citation styles, I recommend using ASME's style as a baseline. Please see the next page for the guidelines that are directly from ASME's author's guide ([http://journaltool.asme.org/Help/AuthorHelp/WebHelp/JournalsHelp.htm#Guidelines/Getting\\_Started.htm](http://journaltool.asme.org/Help/AuthorHelp/WebHelp/JournalsHelp.htm#Guidelines/Getting_Started.htm)):

## References

Within the text, references should be cited in numerical order according to their order of appearance. The numbered reference citation within text should be enclosed in brackets.

Example: It was shown by Prusa [1] that the width of the plume decreases under these conditions.

In the case of two citations, the numbers should be separated by a comma [1,2]. In the case of more than two references, the numbers should be separated by a dash [5-7].

List of References. References to original sources for cited material should be listed together at the end of the paper; footnotes should not be used for this purpose. References should be arranged in numerical order according to the sequence of citations within the text. Each reference should include the last name of each author followed by his initials.

(1) Reference to journal articles and papers in serial publications should include:

- last name of each author followed by their initials
- year of publication
- full title of the cited article in quotes, title capitalization
- full name of the publication in which it appears
- volume number (if any) in boldface (Do not include the abbreviation, "Vol.")
- issue number (if any) in parentheses (Do not include the abbreviation, "No.")
- inclusive page numbers of the cited article (include "pp.")

(2) Reference to textbooks and monographs should include:

- last name of each author followed by their initials
- year of publication
- full title of the publication in italics
- publisher
- city of publication
- inclusive page numbers of the work being cited (include "pp.")
- chapter number (if any) at the end of the citation following the abbreviation, "Chap."

(3) Reference to individual conference papers, papers in compiled conference proceedings, or any other collection of works by numerous authors should include:

- last name of each author followed by their initials
- year of publication
- full title of the cited paper in quotes, title capitalization
- individual paper number (if any)
- full title of the publication in italics
- initials followed by last name of editors (if any), followed by the abbreviation, "eds."
- publisher

- city of publication
- volume number (if any) in boldface if a single number, include, "Vol." if part of larger identifier (e.g., "PVP-Vol. 254")
- inclusive page numbers of the work being cited (include "pp.")

(4) Reference to theses and technical reports should include:

- last name of each author followed by their initials
- year of publication
- full title in quotes, title capitalization
- report number (if any)
- publisher or institution name, city

## Sample References

[1] Ning, X., and Lovell, M. R., 2002, "On the Sliding Friction Characteristics of Unidirectional Continuous FRP Composites," *ASME J. Tribol.*, 124(1), pp. 5-13.

[2] Barnes, M., 2001, "Stresses in Solenoids," *J. Appl. Phys.*, 48(5), pp. 2000–2008.

[3] Jones, J., 2000, *Contact Mechanics*, Cambridge University Press, Cambridge, UK, Chap. 6.

[4] Lee, Y., Korpela, S. A., and Horne, R. N., 1982, "Structure of Multi-Cellular Natural Convection in a Tall Vertical Annulus," *Proc. 7th International Heat Transfer Conference*, U. Grigul et al., eds., Hemisphere, Washington, DC, 2, pp. 221–226.

[5] Hashish, M., 2000, "600 MPa Waterjet Technology Development," *High Pressure Technology*, PVP-Vol. 406, pp. 135-140.

[6] Watson, D. W., 1997, "Thermodynamic Analysis," *ASME Paper No. 97-GT-288*.

[7] Tung, C. Y., 1982, "Evaporative Heat Transfer in the Contact Line of a Mixture," Ph.D. thesis, Rensselaer Polytechnic Institute, Troy, NY.

[8] Kwon, O. K., and Pletcher, R. H., 1981, "Prediction of the Incompressible Flow Over A Rearward-Facing Step," *Technical Report No. HTL-26, CFD-4*, Iowa State Univ., Ames, IA.

[9] Smith, R., 2002, "Conformal Lubricated Contact of Cylindrical Surfaces Involved in a Non-Steady Motion," Ph.D. thesis, <http://www.cas.phys.unm.edu/rsmith/homepage.html>