BIOE 196 – Senior Design
Final Design Thesis (FDT) Guidelines
Medical Device Track

Suggested FDT Organization

While the particulars of each project might lead to alternate organizational structures, the outline below is typical of many senior thesis documents in the past. For general formatting guidelins, use format at: http://scu.edu/engineering/srdesign/student.cfm.

General Comments - Reports must be neatly word processed, carefully proofread for correct spelling and grammar, and edited for continuity and style consistency between different authors.

Formatting Comments – Follow the following guidelines:

- There should not be large sections of white space in the body of the thesis. Move text or resize figures accordingly.
- All references must be properly cited and listed in a bibliography. This is critical – you MUST have fully documented citations, and all cited work MUST be properly credited.

Common report organization – This shows a typical final thesis outline, although actual contents and organization may vary by project. Consult with your advisor and/or the instructor if you would like to get feedback on an alternate report structure.

Although the format may vary, underlined topics are required for all theses. For the FDT, you are required to include, at a minimum, the sections that are underlined.

- Signature page – use format at: http://scu.edu/engineering/srdesign/student.cfm.
- Title page – use format at: http://scu.edu/engineering/srdesign/student.cfm.
- Abstract – this is a well-crafted and highly concise summary of the report. A good abstract motivates the issue, states the goal of the project and the work accomplished, summarizes the results, and notes the impacts and/or conclusions. use format at: http://scu.edu/engineering/srdesign/student.cfm.
- Acknowledgments – You MUST properly acknowledge financial support and in-kind contributions of sponsors, donors, mentors, etc. Sponsors may have very specific wording that must be included in such reports, so check on this with your advisor. You may also use this section to thank friends and family for their assistance and support.
- Table of contents use format at: http://scu.edu/engineering/srdesign/student.cfm.
- List of Figures - use format at: http://scu.edu/engineering/srdesign/student.cfm.
- List of Tables - use format at: http://scu.edu/engineering/srdesign/student.cfm.

- Introduction (What and Why)
  - background/motivation of subject matter (big picture rationale)
  - review of field/literature (with references cited in bibliography)
  - statement of project goal, objectives and results

- Systems-Level Chapter (the big picture) – Projects with several subsystems are often complicated enough that you need to use a systems-level chapter to provide the reader with an overview of the system so that they have a good 'big picture' idea of what's going on prior to your discussion of detailed component-level analyses and designs. If this applies to you, here are common topics in the appropriate order for such a chapter:
  - System-level overview – Summary of the overall system with a mission/product architecture sketch with words that point out the main parts of the system and how they interact, a physical configuration sketch with words that describe the physical layout and location of key elements, a functional component-level sketch showing main parts and how they are functionally connected to perform tasks, etc.
  - Customer needs and system level requirements - refer to PDS (preliminary design specification), market survey report, QFD (quality function deployment), as needed
  - Benchmarking results - what's out there that is similar
  - Functional Analysis – note that this section shows how the system is broken into the main subsystems with the idea that your next few chapters will go into these subsystems in more detail
    - Functional decomposition (main functions and subfunctions)
    - Specific lists of subsystem-level inputs/outputs, behaviors, constraints, performance requirements, resource budgets, etc. (summarize here, details in appendix)
  - Key system level issues, system options, tradeoffs, rationale for choice (refer to selection matrices in appendix)
  - Team and project management
    - Project challenges and constraints and how they are dealt with
    - Budget (discuss main issues, refer to appendix for spreadsheet)
    - Timeline (discuss main issues, refer to appendix for Gantt chart)
    - Design process (your approach to design for this project)
    - Risks and mitigations
    - Team management (approach, issues, responses)

- Subsystem Chapters - one for each major subsystem
  - Intro to role/requirements of subsystem (match systems chapter)
  - Summarize options and trades (refer to selection matrices in appendices)
  - Detailed design description, novel approaches/solutions to problems
  - Detailed supporting analyses (brief description of approach to, and results of, major analyses) and/or prototyping results
  - Detailed mech/elec/code descriptions as needed with photos, sketches, CAD drwgs, layouts, flowcharts, etc. High level descriptions and summaries blended with narrative, detailed documentation in appendices
  - Detailed subsystem test/verification procedures/data specifically showing whether requirements are met or not

♦ System Integration, Test and results (experimental protocol and results, comparison to predictions) – Given that many of the previous chapters are often specific to the details of the subsystems and components of your system, the purpose of this chapter is to discuss how these systems were integrated and tested. It details how tests and verification was performed and what the results were. In presenting results, there should be an emphasis on demonstrating that critical requirements and customer needs were sufficiently met. For FDR, include a simple description of your integration and test/verification approach (is integration challenging, how much planning will it take, will you have any formal procedures for assembly, what verifications/tests will you perform and how will they be accomplished, do any of them require special equipment or procedures, how much time will assembly take, how much time will verification take, and so on).

♦ Costing analysis (analysis of overall prototype costs vs. budget, and, if appropriate, production costing estimates and evaluation) – depending on your project, this may be an appendix

♦ Patent search or Business Plan – depending on your project, this may be an appendix

♦ Professional Issues and Constraints (discuss how the following considerations impact your design: ethical, science, technology, & society, civic engagement, economic, health & safety, manufacturability, usability, sustainability, and environmental impact). At least **five** of these factors must be discussed in sufficient detail to show understanding of the issues and relevance to the project. Refer to http://scu.edu/engineering/srdesign/upload/Professional-Issues-and-Constraints.pdf for guidance and background on these issues. For FDR, include 5 topics of your choosing with one paragraph describing the importance and relevance of each topic. Note that this is not just a creative writing assignment. Most projects have very real standards and constraints that are relevant – either you face them directly as you do your project, or perhaps they would be an issue if your product were to ever really be put into production/use.

♦ Summary and Conclusions – This is the final chapter of the main body of the thesis. It typically starts with a summary of the project. In this Summary section, you should restate your project objective and the work you did, discuss results (overall evaluation of the design, experimental results, the extent to which the product satisfied the customer, etc.), and review the impact of the work you did. This chapter also typically has a Future Work section in which you provide a well-thought out list of suggested improvements and areas for future exploration. The chapter often concludes with a Lessons Learned section in which you reflect on the project as an educational experience, discuss what your challenges were, consider what you did well and what you realize you must improve, and identify nuggets of wisdom to pass on to future students. For FDR, I expect at least two-page summary of your project goals, the work you did, discussion on the results (overall evaluation of the design, experimental results, the extent to which the product satisfied the customer, etc.), and your plan for the rest of the year. The details of this plan should be included as an Appendix, and should include the build/buy plan, a list of possible problem areas/risks, and a development timeline.

♦ Bibliography – you MUST cite references properly and completely. Use format at: http://scu.edu/engineering/srdesign/student.cfm

♦ Appendices – Appendices hold the detailed information that isn't appropriate for the body of your narrative design report. That said, you should realize that the body of your report should still include some detail – but it is a selected set of detail. So, the body should include key figures,

summary tables of specifications and results, high-level drawings (like configuration sketches, functional and component diagrams, data flow diagrams, etc.), specific test and simulation plots showing behavior and results, and perhaps particularly interesting detail (mechanical drawing, electronic schematic, pseudo-code, etc.) of critical components. That said, ALL detail is included in the appendix – to include complete sets of mechanical drawings, source code, circuit designs, analytic results, experimental plans/procedures/results, etc. In general, all important "work product" generated as you develop your system should be presented via an appendix.

- Detailed design definition information and reports, such as customer needs surveys, the PDS, requirements lists/flowdowns, resource budgets, etc.
- Detailed design analysis results such as functional decomposition, sketches and lists of alternate designs, decision matrices or rationale, QFD analysis, etc.
- Detailed engineering analyses - readable and well organized detailed calculations (hand and FEA), dynamic and controls analyses and simulations, etc.
- System-level descriptions – configuration sketches, mission/product architectures, functional and component diagrams, etc.
- Mechanical detail and assembly drawings (only drawings that are specifically referenced should be in the body of the report). **NOTE**: a full set of detail and assembly drawings with complete bills of materials must be included.
- Electronic circuit designs
- For biotechnology related projects, schematics of your experimental system – drawings/charts that show the overall experimental processes, and any schematics of each step that explains the working principles of your system
- Software source code
- Project management data - time lines and budget spreadsheets, build/buy plans/decisions, etc.
- Test and verification information – test plans/procedures, experimental data
- Information from manufacturers – spec sheets, manuals and application notes for key components, etc.
- copies of important patents