Formatting Instructions for Senior Thesis:
Supplemental Requirements Applicable to Civil Engineering

This document specifies requirements for Civil Engineering theses that are in addition to those specified in the School of Engineering document entitled "Formatting Instructions for Senior Thesis." The two documents should be used together in the preparation of a senior thesis. Should any conflicts exist, information provided herein supersedes that contained within the School of Engineering document.

TEXT

The main body of the report contains all relevant background information a specific description of the problem being addressed, an analysis of viable alternatives, a summary of the design strategy used, and a detailed description of the completed final design. A cost estimate shall also be provided for the project.

The detailed organization of the report will vary depending on which civil engineering sub-discipline is the focus of the chosen project. In any case, a consistent format must be followed.

The text shall be divided into sections (and subsections), each with its own heading. Each main section shall begin on a new page. All paragraphs shall be indented. In many cases, the main body of the thesis will include certain elements other than ordinary text such as figures, tables, chemical and mathematical formulas, and lists. They may be included only if they are specifically referred to in the text.

A sample organization for a design-based thesis is as follows:

1. Introduction (or Background)
   - Project history
   - Demonstrated need for project
   - General site details/description
   - Scope of work and organization of thesis
2. Analysis of Alternatives
   - Brief description of alternative solutions
   - Compare alternatives: technical feasibility, cost, environmental impact, and other non-technical issues
   - Final logic used to select solution
   - Summary of how solution best meets project needs
3. Design Criteria and Standards
   - Identify system or process performance requirements (if applicable)
   - Identify applicable codes and standards
   - Identify key values and assumptions used in design calculations
4. Description of Designed Facility
   - Summarize design approach (a "flowchart" of key steps)
   - Summarize detailed design results (how many units of what size or capacity)
   - Highlight special features and innovations
   - Explain how site-specific problems were solved
   - Describe permitting, political and safety issues
   - Indicate how environmental, political, health and safety, sustainability and/or related social/environmental justice concerns were addressed
5. Cost Estimate

- Engineer's opinion of probable cost
- Cost indexing assumptions

6. Conclusion
   - Summarize how the detailed design meets project needs
7. Appendices
   - All supporting calculations, including final computer runs
   - Catalog pages for specific items
   - Relevant legal constraints
   - Detailed drawings, using D-size sheets for site-specific details; standard details can be grouped together on D-size sheets or presented individually on 8-1/2 x 11 inch sheets.

The organization of a research-based thesis should be developed with input from the project advisor(s).

The text is typically written in the third person past tense. Required content should be addressed using clear, precise, and concise language. Padding to increase length is a disservice to the reader; avoid verbosity. Words should be used correctly and consistently, and once their usage is established, other words should not be substituted. Acronyms should be defined upon their first use; where many acronyms and abbreviations are used, a summary table should be provided.

Figures and Tables: All figures and tables must fit within the regular margins on the page that they appear. For figures and tables that would be unreadable when reduced down to fit on an 8-1/2 x 11 inch sheet of paper, as 11 x 17 inch sheet may be used. Figures and tables presented in landscape mode on an 8-1/2 x 11 inch page shall be aligned so that the top of the figure or table is parallel to and adjacent to the bound edge. All figures and tables on 11 x 17 inch paper and larger sheets shall be presented in landscape mode.

Figure captions are placed below the figure; table captions appear above the table. Figure and table captions must provide a sufficient description to allow the figure or table to stand alone. For example, "True stress versus true strain for cartridge brass as a function of annealing temperature" is a good caption, while "Stress vs. Strain" is inadequate.

While every figure and table should be able to stand alone, every figure and table must also be explained in the main body of the text. This explanation would include a reference to the figure or table by its numerical identifier. For example, "Figure 1 is a plot of engineering stress versus engineering strain for three concrete cylinders tested to failure under monotonic compression. The strain at peak strength was approximately 0.0022." Such descriptive, summary statements are necessary to ensure that the reader understands the significance of the information presented in each figure and table.

Figures: Illustrative materials include drawings, maps, charts, diagrams, photographs, and similar material approved by the project's faculty advisor(s). Figures should be large enough to display the relevant information clearly, while avoiding excessive size.

Photographs of experimental systems and test specimens may also be used to provide needed detail and documentation. Photographs taken with digital cameras should be modified to include descriptive callouts (arrows and labels) that identify particularly relevant system elements and characteristics.

Recommendations for formatting charts are provided in Appendix A. Requirements for detailed design drawings are provided in Appendix B.

Tables: Tables must be clearly organized and have clear labels, identifying units where appropriate. Tables can be produced in Microsoft WORD using the "Table" drop-down menu on the "Insert" ribbon. Tables

and their captions should be centered horizontally on the page, except captions having two or more lines should be left justified. Place a period at the end of each caption. Table 1 provides an example.

Table 1: Ultimate tensile strengths (MPa) of two materials tested slowly to failure.

Material	Sample Number			Mean	Standard Deviation
	1	2	3		
As-rolled 1020 steel	410	422	417	416.3	6.0
Cold-drawn A36 steel	372	380	378	376.7	4.2

Equations: Mathematical formulas of two or more lines should be centered horizontally on the page between text segments. Two blank lines should separate the equation from the text, both above and below the equation. Each such equation shall be provided with a numerical identifier (i.e. Eq. 1) for reference purposes. This identifier shall be located on the same page line as the equation and shall be right justified. Where appropriate, definitions of variables (or parameters) should be provided in the text immediately after they first appear in an equation. Greek symbols can be made using the Symbol font.

Number Use and Precision: Numbers presented in the thesis should not have excessive precision. Limits in precision are associated with uncertainty in design values and limitations in the instruments used to acquire experimental data. Digitally acquired data may have more digits than are justified based on the precision of the instrument used to acquire it.

Standard deviation should be reported with the same precision as the measurement.

SI prefixes or scientific notation should be used to eliminate unnecessary zeros. When converting between units, use all significant figures available for the data and the conversion factor. Reported data should be presented with an appropriate number of significant digits.

If a number is less than one and written in decimal form, a zero should be placed before the decimal point (e.g. 0.25 kg, not .25 kg).

Exponents should be shown as superscripted characters (e.g. use 10^3 and not 10^3).

Do not begin a sentence with a number written in numerical form. Do not write out a number (using words) followed by its units. Do place a space between a number and its unit.

The number and its units should not be separated at the end of a line. Such separation can be avoided in Microsoft WORD by pressing “Option + Space” simultaneously, to produce a space that will keep the words before and after the space together on a single line.

Lists: Lists form a continuing part of the text and may be numbered, lettered using lower case letters, or bulleted. Lists shall adhere to the normal rules of grammar as far as capitalization and punctuation.

REFERENCE MATERIAL

All work completed by others and used as a source of information in the thesis must be properly referenced. This includes books, journal and magazine articles, design codes, standards, technical reports,

and other similar published documents. Factual information obtained from an internet web site and utilized in the thesis must also be properly documented. Reference citations must be included in the main body of the text immediately after the external information is presented or an observation or a conclusion attributed to others is quoted or paraphrased. Reference citations in the main body of the report should follow the citation guidelines of Table 2.

The parenthetical citation should appear within the sentence where the external information is presented. In the event that multiple works would be associated with the same citation, the individual references should be distinguished by an alphabetical suffix (i.e. Smith and Jones, 2000a; Smith and Jones, 2000b; etc.).

Table 2: Reference citation guidelines.

Number of Authors	Citation Format Example
1	(Smith, 1998)
2	(Smith, 1998)
3	(Smith, *et al*., 2002)

A detailed and comprehensive list of all references referred to within the main body of the text shall be provided in a section entitled "References" at the end of the report. A Bibliography is optional. The list of references shall include all previously referenced works and shall be presented in alphabetical order by the last name of the first author. References shall be printed in a standard double-spaced format with double spacing in between individual entries. Examples of the proper format for typical references are provided in Appendix C.

Appendices: Supplementary materials that, due to length and/or content, would not be appropriate to include in the main body of the report text may be included in one or more report appendices. This would include, but not be limited to, extensive tables of experimental data, key analysis/calculation results (manual and computer-based), survey data, boring logs or other forms of field data, passages from related technical reports, relevant manufacturers' literature, background cost estimating information, computer algorithms and code, detailed design drawings, and standard details.

Each appendix shall have its own cover page with the appropriate appendix letter designation and its formal title printed on this page. Every appendix shall be referenced at the appropriate location within the main body of the thesis, and shall be presented after the main part of the thesis in the same order in which it is referenced. Wherever practical, appendix material shall conform with the formatting requirements applicable to the main body of the thesis. Pages including system analyses and related computations may be neatly handwritten with the approval of the project advisor.

CLARIFICATIONS AND INTERPRETATIONS

In cases of uncertainty about the formatting instructions, the student(s) should consult with the department chair. The department chair shall be the arbiter of any such questions.

Some useful points on writing style are addressed by ASCE (see http://www.asce.org/Audience/Authors,--Editors/Books/General-Book-Information/Author-s-Guide--Writing-Style/). Examples of the style and format requirements can be found in any ASCE publication.

Appendix A: Formatting of Plots

Recommendations for formatting of charts and data plots are provided in this appendix. Data plots typically will be of the type "X-Y scatter plot" rather than a "line plot" (which plots ordinate values at a uniform spacing on the abscissa). It is recommended that a plot style be developed that is consistent with the following recommendations and is then applied consistently to similar plots.

A guiding principle is to promote a clear understanding of the data and eliminate needless distractions. Line styles and symbols should be selected to aid in interpreting and comparing the underlying data. While color may be used to aid in visual interpretation, plots should be readily interpretable in black and white. (This is because (i) some readers have partial color blindness and (ii) at some point the document may be reproduced in black and white).

Generally applicable recommendations are illustrated by means of the data plot of Figure 1. Note the following:

- The abscissa (horizontal axis) and ordinate (vertical axis) both have titles, with appropriate units indicated. No plot title is included, because the caption describes the plot. Any text should refer to the "ordinate" or "abscissa" rather than "*y*–axis" or "*x*–axis."
- A legend should be provided to allow multiple data series to be identified. If using EXCEL, each data series should be named, since the default labels (e.g. "Series 1") does not help the reader to understand the data. As an alternative to a legend, labels can be used to directly identify the data (e.g., Figure 1). If only one data series is plotted, a legend is not needed since the caption should be sufficient.

Figure 1. True stress versus true strain for Ti–6Al–4V and pure aluminum in uniaxial compression.

- Measured data is shown using discrete points, while fitted curves are generally shown using solid lines.
- If data points are connected by lines, only straight lines should be used, as fitted spline curves may suggest behavior that does not have a scientific basis.
- Where large amounts of data are plotted, the size of the data symbols may be reduced, and the symbols themselves may be selected to be a dot or a shape formed from crossing lines (e.g. , +, or ☒×) rather than a bulkier symbol (e.g. ○ or □) to improve clarity. Always avoid shadows and 3D symbols.
- Formatting recommendations, using the terminology of Excel:
    - Turn on gridlines for both axes, and set the line type for the grid to a dashed line that is 50% gray.
    - Format major tick marks to "Cross" and minor tick marks to "Inside" for each axis.
    - Format the plot area to have no color.

    - Format the chart area to have no border.
    - Have the abscissa and ordinate lines (and labels) located at the bottom and left edges of the plot, respectively, rather than having them run through the data.
- Pick suitable limits and intervals for each axis scale. This will often require manually entering the ranges for the abscissa and ordinate. Ranges should be selected to provide a small amount of white space beyond the data.
- Avoid the temptation to truncate the vertical axis unless you clearly specify that you have done so in the figure caption. (Shifting the origin from zero along the ordinate axis causes trends to appear more dramatic than they actually are.)

The use of fitted curves is illustrated in Figure 2. Note the following:

- Fitted curves should reflect known behavior. For example, a linear fit should be used to calculate the elastic modulus of a material based on the linear elastic portion of a stress–strain curve.
- When curve fits have been made, display the equation on the graph in the appropriate form. Notice that the curve fit equation has been modified to use "" and "" not "*x*" and "*y*."

Figure 2. Surface shear stress ( ) versus surface shear strain ( ) for a Zr alloy tested in shear while subjected to a tensile stress of 920 MPa. The slope of the linear fit is the shear modulus of the material, which is calculated to be 30.5 GPa.

When introducing graphics into a document prepared on a word processor, please note the following:

- To avoid having large file sizes, copy and paste plots into a word-processing program using the "Paste Special" or "Paste as Picture" commands; avoid linking the plot to the source file as this can lead to corrupted files. While this approach is preferable, an alternative is to display the plot on the screen, hit the "Print Screen" key, place the cursor in the document where you wish the image to appear, and insert using Ctrl–V. The image will need to be cropped; thus it may be difficult to maintain consistent graphic sizes and quality with this alternative.
- A useful approach for controlling the placement of figures in Microsoft WORD is to paste figures into a table whose borders have been set to "none." To do this, insert a new table (e.g. 1 column wide by 2 rows long), change the borders to not print, and paste the plot into the desired cell of the table (e.g. the first row). The figure caption is also placed into a table cell (e.g. the second row of the table).

Appendix B: Formatting of Detailed Drawings and Standard Details

Detailed design drawings shall be included in an appendix. Design drawings should be formatted for printing on D-size paper (24 x 36 inches or the SI equivalent). Any standard details that accompany project-specific drawings can also be provided on D-size paper or can appear individually on A-size (8-1/2 x 11 inches) paper. Requirements for margins apply to these pages as well. Design drawings shall incorporate the standard title blocks and borders developed for the approved standard paper sizes and made available by the Department of Civil Engineering. Instructions for locating these templates (in AutoCAD) will be made available to students at the beginning of each winter term.

The first drawing shall be a cover sheet. At a minimum, the cover sheet shall include the project title (displayed prominently), a list of drawings, a vicinity map, and a location map. Where appropriate, the title page or the second drawing page shall also provide a list of commonly used symbols and/or a list of abbreviations and acronyms. Where project complexity warrants separating the drawings into more traditional categories, the drawings shall be arranged in the following sequence: cover sheet, general civil drawings, structural drawings, mechanical drawings, electrical drawings, and standard details.

Samples of drawings demonstrating expected formatting details for drawing identification, titling, scaling, lettering, sectioning, and labeling are available under separate cover in the departmental Analysis and Design Lab. North arrows should be included on all large-scale plan view drawings. Plan views should be aligned so that downward pointing north arrows are avoided. Where survey information is provided, the means by which bearing and elevations have been established/referenced shall be clearly indicated.

Final D-size drawings included in an appendix shall have received approval of the project advisor. Use calibrated scale markers, so that the correct scale is clearly indicated after possible photo-reduction or scaling of the printed copy. All lettering and dimensioning shall be clearly readable after possible photo-reduction. Margin requirements apply to the D-size drawings, recognizing that margins will be reduced during any photo-reduction or scaling.

Appendix C: ASCE Formatting Examples for Common References

Journal References: Include year, volume, issue, and page numbers.

Frater, G. S., and Packer, J. A. (1992a). "Weldment design for RHS truss connections. I: Applications." *J. Struct. Engrg.*, ASCE, 118 (10), 2784–2803.

Stahl, D. C., Wolfe, R. W., and Begel, M. (2004). "Improved analysis of timber rivet connections." *J. Struct. Eng.,* ASCE, 130 (8), 1272-1279.

Conference Proceedings and Symposiums: Include the publisher of the proceedings, AND that entity's location—city and state or city and country. Only include the sponsor of the conference if it is part of the title of a proceedings. If there is no "publisher", then the name and location of the sponsor are required.

Garrett, D. L. (2003). "Coupled analysis of floating production systems." *Proc., Int. Symp. on Deep Mooring Systems,* ASCE, Reston, VA, 152-167.

Eshenaur, S. R., Kulicki, J. M., and Mertz, D. R. (1991). "Retrofitting distortion–induced fatigue cracking of non–composite steel girder–floorbeam–stringer bridges." *Proc., 8th Annual Int. Bridge Conf.*, Engineers' Soc. of Western Pennsylvania, Pittsburgh, Pa., 380–388.

Books: Include author, book title, publisher, the publisher's location, and chapter title and inclusive page numbers (if a whole book is used, or pages here and there throughout, page numbers need not be given). If no author is listed, alphabetize the entry by book title.

Alley, M. (1996). *The Craft of Scientific Writing*, 3rd ed., Springer–Verlag, New York, NY.

Duvant, G., and Lions, J. L. (1972). *Les inequations en mechanique et en physique*. Dunod, Paris, France (in French).

Lotus 1–2–3 reference manual; release 2.01. (1985). Lotus Development Corp., Cambridge, Mass.

Melan, J. (1913). *Theory of arches and suspension bridges*, D. B. Steinman, translator, Myron C. Clark, Chicago, Ill.

Zadeh, L. A. (1981). "Possibility theory and soft data analysis." *Mathematical frontiers of the social and policy sciences,* L. Cobb and R. M. Thrall, eds., Westview, Boulder, CO, 69-129

Reports, Codes, and Standards: Same as for books, as above. For publications authored by institutions: spell out institution acronym on first use, and follow with acronym in parentheses, if applicable. If subsequent references were also authored by that same institution, use only the acronym. For publications authored by persons, include the full institution name—no acronym—and its location.

American Society of Testing Materials (ASTM). (1991). "Standard practice for the use of the international system of units (SI) (the modernized metric system)." E 380–91a, Philadelphia, Pa.

Duan, L., Loh, J. T., and Chen, W. F. (1990). "M–P–f–based analysis of dented tubular members." *Struct. Engrg. Rep. No. CE–STR–90–27*, School of Civ. Engrg., Purdue Univ., West Lafayette, Ind.

Federal Highway Administration (FHWA). (1991). "Evaluating scour at bridges." *Rep., Hydr. Engrg. Circular No. 18: FHWA–IP–90–017*, Washington, D.C.

International Conference of Building Officials. (1988). *Uniform building code*. Whittier, Calif.

Unpublished Material: Unpublished material is not included in the references but may be cited in the text as follows: (John Smith, personal communication, May 16, 1983) or (J. Smith, unpublished internal report, February 2003).

In Press Articles: As an exception to the "Unpublished Material" section above, in press articles (i.e., those that have been accepted but have not yet been published) may be included in the references as follows:

> Dasgupta, G. (2008). "Stiffness matrix from isoparametric closed form shape functions using exact integration." *J. Aerosp. Eng.*, in press.

In press articles should be updated to include the actual publication information whenever possible.

Web Pages: Include author, year of publication or last revision, title of "page," title of the complete work, Web address enclosed within angle brackets, and date material downloaded.

> Burka, L. P. (1993). "A hypertext history of multi-user dimensions." *MUD history,* <http://www.ccs.neu.edu> (Dec. 5, 1994).

CD-ROMs: Include authors, copyright date, titles, medium, producer/publisher and its location, and section, chapter, and page numbers if available.

> Liggett, J. A., and Caughey, D. A. (1998). "Fluid statics." Fluid mechanics (CD-ROM), ASCE, Reston, VA, Section 3.1, Chapter 2, 167-177.

Theses and dissertations: Include authors, copyright date, title, and the name and location of the institution where the research was conducted. Note that some institutions use specific terminology; for example, "doctoral dissertation" rather than "Ph.D. thesis".

> Chang, T. C. (1987). "Network resource allocation using an expert system with fuzzy logic reasoning." PhD thesis, University of California at Berkeley, Calif.

> Sotiropulos, S. N. (1991). "Static response of bridge superstructures made of fiber reinforced plastic." M.S. thesis, West Virginia Univ., Morgantown, WV.