ME 492: Guide to Writing Reports for Capstone

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Due to their large scope and duration, Capstone projects have specialized documentation requirements. This web page provides guidance on how to document your Capstone project.

General Advice

The primary objective of an engineering report is to transmit technical information to individuals having training comparable to that of the author. The information in the report should be presented as clearly and concisely as possible, but always with sufficient detail that the client needs, design methods, design concepts, and performance evaluation can be well understood by the reader.

Imagine that you are writing a report that you would want to read. Imagine that you will have to make an important decision based on the information in the report. In addition to presenting essential information, a good report is well organized, clearly written, and uses a conventional style.

Regardless of how well the prose is written, the report needs to be built upon sound engineering, which means a design satisfies customer needs, and is supported by rigorous analysis and quantitative measures of performance.

Capstone Reports

A Capstone project report is more complicated than a lab report or technical research paper. Capstone project documentation is expansive and contains many different file formats. Capstone project documentation also evolves as the team's knowledge of the design problem and its solution evolves.

Complex Documentation Formats

A major complication with Capstone reports is the scope and variety of documentation required to make a design transferable: CAD files, computer programs for control systems, assembly instructions, bill of materials, etc. Including all this information in a single, written report would make the document unwieldy and, therefore, defeat the purpose of efficiently conveying information to the client and other engineering teams. Furthermore, the digital CAD files

and computer programs need to be made available in a reusable format that engineers can use in continued development of the design.

To address the scope and variety of information necessary to document a design, student teams create a digital archive to store information in different formats. At the end of the project, the digital archive is submitted on a USB (flash) drive. The written report includes an index to the material in the digital archive. Only select information from the archive, e.g. images from CAD files, a bill of materials, and diagrams of system components, are included in the written report.

Evolving Project Information

Another complication with Capstone documentation is that the information about the design changes as the design evolves. In some cases, the new documentation reaches different conclusions than the earlier documentation. There are two solutions to this complication. First, if later information is consistent with earlier information, simply refer to the earlier documentation without necessarily using the same level of detail. For example, a summary of key client requirements would be included in the final report, and the reader would be referred to the details documented in an earlier report.

A second complication with evolving information is when the team has knowledge at a later stage that complicates the earlier stage. The best approach in this situation is to keep the early report in the digital archive and release an updated version. Then, in a later report, the team refers to most recent report.

General Report Writing Guidance

The following sections provide general guidance for writing technical documentation. This guidance also applies to Capstone reports.

Purdue's OWL

The Purdue Online Writing Lab is an outstanding source of information on writing. If you have a question about the structure of documents, grammar, or citation of references, search OWL first. In particular, consider the following entry points to the OWL site.

- Writing in Engineering
- Professional, Technical Writing
- Research and Citation
- Grammar

Citation of Information not Created by the Team

All work of other others – images, data, equations, performance specifications, laboratory procedures, design documents – must be properly attributed to the source. The internet is an abundant source of information, and web browsers make it easy to copy text and images. Just because it is easy, *do not use information from the internet without attribution.*

For guidance on citations, refer to web sites by the American Society of Mechanical Engineers, the American Physical Society, the Institute of Electrical and Electronic Engineers, and the University of Pittsburgh Library.

- ASME Guide to references
- APS Example References
- IEEE Style Manual
- Pitt library guides on How to Reference Sources

Ethical and Professional Conduct

Appropriate citation of sources is an ethical responsibility of being an engineer. Refer to ASME's Ethical Standards for Authors.

In its publication, On Being a Scientist, the National Academy of Engineering cite the U.S. Office of Science and Technology policy on behaviors that constitute research misconduct:

> - Fabrication is the "making up of data or results"
> - Falsification is "manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately" represented in the research record."
> - Plagiarism is "the appropriation of another person's ideas, processes, results, or words without giving appropriate credit"
>
> Source: National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. 2009. *On Being a Scientist: A Guide to Responsible Conduct in Research*: Third Edition. Washington, DC: The National Academies Press. `https://doi.org/10.17226/12192`, p. 15

Tables and Figures

All tables and figures should have a number and caption. Captions for tables go above the table, as shown in Table 1, below. Captions for figures go below the figure, as shown in Figure 1, below

Software packages that create plots, e.g. Excel, R, MATLAB, provide the option of creating a plot title that is usually displayed above the plot axes. The plot title *is not a caption.* For a single plot frame, the title supplied by the software is usually redundant. When the figure is a composite of two or more plots, titles for individual plots are helpful.

Table 1: Dimensions of heat sinks: demonstration of a table caption.

Label	H (mm)	L (mm)	W (mm)
A	18	43	44
B	10	53	53
C	5	43	44
D	10	53	53
E	25	53	54
F	17	43	44

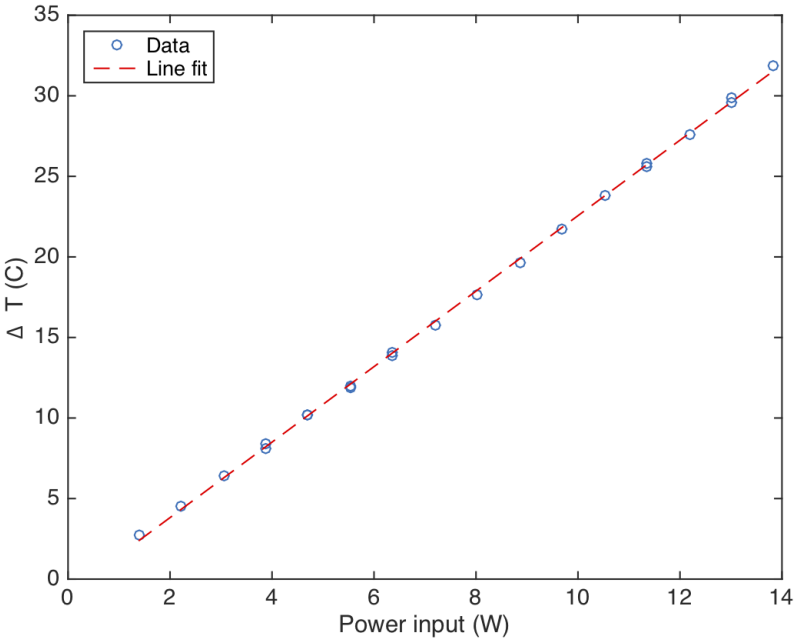

Figure 1: Measured temperature rise versus power input: demonstration of a figure caption.

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 \qquad \text{(Equation 1)}$$

Equation labels
are only numbers

Figure 2: Only use numbers as equation labels.

Equations

There are two ways of presenting equations in technical documentation: in-inline and displayed. An in-line equation flows with the rest of the text. For example, Einstein's famous equation is $e = mc^2$. In-line equations can be used as a rhetorical device to aid reasoning, as shown in the following examples

> The hydrostatic equation, $p = \rho g h$, shows that the fluid pressure increases linearly with depth, h, and does not depend on the *volume* of fluid.

> From the formula for moment of inertia of a rectangular cross section, $I = \frac{1}{12} b h^3$, the beam stiffness is significantly more influenced by changes to the beam depth, h, than to changes to its width, b.

In both of the preceding examples, the in-line equation adds precision and clarity to the statement. It would be less efficient and more clumsy to attempt conveying the same information in words only.

A displayed equation occupies a separate line in the document. For example, using the displayed equation format, the Bernoulli Equation is

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 \tag{1}$$

Displayed equations should be centered and have a right-justified, numerical label in parenthesis. *Do not* label equations with "Equation" or other text, as illustrated in Figure 2.

Displayed equations are generally preferred, especially when documenting a calculation procedure or explaining a trend in a plot. The use of equation numbers makes it easy to unambiguously refer to an equation.