

Laboratory Report Guidelines

Typically the comprehensive report will contain the following sections:

- Title Page
- Abstract
- Table of Contents
- Introduction
- Theory
- Experimental Setup and Procedure
- Experimental Results
- Discussion
- Conclusions and Recommendations
- Acknowledgments
- References
- Appendices

Details of what these sections must contain is given below.

Title Page

The title page clearly identifies the following elements:

- Title of the experiment

The title should be descriptive of what was done. So, for example, instead of just “Viscosity Experiment,” write something like, “Measurement of the Temperature Dependence of Viscosity for 10W-30 Motor Oil.”

- Author(s)

Put the name of the principle author first, but include all collaborators.

- Entity for which the experiment was done (e.g., San José State University, Department of Mechanical and Aerospace Engineering, ME 120 Experimental Methods, etc.)

- Date

The date is one of the most important items. Don’t forget it!

Strive for legibility, clarity, and balance in laying out the title page. Don’t overdo font size, all caps, or bold effects. An example of an acceptable title page is shown at the [end](#) of these guidelines.

Abstract

The idea behind the abstract is to summarize the major points of the report in a *concise* manner to enable the reader to determine whether or not to read the entire report. Abstracts are often used to index reports in electronic databases.

The abstract consists of answering the following three questions in just a few paragraphs, *at most*:

- What did you do?
- How did you do it?
- What did you find?

It is important that you avoid filler and extra verbiage that does not address the three questions above when you write an abstract. It is also important to include *specific* information. Don't be too general in your answers to the questions above. For example, you would be writing too generally if you said, "We found that the viscosity was lower than published values over the temperature range we tested." Instead, it would be better to say, "We found that the viscosity was 22% lower than published values over the temperature range of 20 °C to 80 °C." An example of a decent abstract is given at the [end](#) of the guidelines.

Table of Contents

The table of contents lists the titles of the major sections of the report and the page numbers where they begin to enable the reader to easily find a particular section. If you have extensive sub-sections within the major sections, you should consider listing the titles of the sub-sections in the table of contents also. Sub-section titles should appear (indented) below the titles of the major sections of the report. Use a tabbed leader line from the end of each title to the page number to make it easy for the reader to associate the correct page number with the section title. (In MS Word, insert a tab by clicking on the ruler. To get a tabbed leader line, double click the tab mark on the ruler, and select the leader style.)

Introduction

The introduction should give some background on the problem your experiment investigated. The introduction should also clearly explain the objectives and motivation for the experiment. In writing the Introduction, answer the question, "What was the purpose of this experiment?", and explain *why* it was important to do the experiment. Think beyond, "it was a requirement for the class". To make it easy for the reader to identify your objectives, it probably makes the most sense to group them as a bulleted list at the end of the Introduction section under a sub-heading called 'Objectives'.

Theory

This section presents theoretical models, equations, physical principles, etc., that are relevant to the investigation described in the report. Be sure to define any variables that are used and include their units, preferably in SI. There must be prose in this section that explains what is being presented. Don't just list a bunch of equations! Equations should be numbered as shown below, so they can be referred to in the text of your report, e.g., "Equation 5 shows that torque is a function of speed..."

$$T = K_1 K_2 \frac{\omega}{4} \quad (5)$$

You can easily format mathematical formulas using Microsoft Equation Editor (which comes with MS Word. If you don't see it in the list of Object types when you go to Insert → Object, you should be able to install it from the MS Office CD.), MathType, or some other equation editing software. Equation 5 is much easier to interpret and is less ambiguous than equation 6.

$$T=K1*K2*(w/4) \quad (6)$$

Any lengthy derivations, tables, or other information that might break up the flow of the major points in this section should be put in an appendix at the end of the report.

Experimental Setup and Procedure

This section describes what you did and what equipment you used to do it. The idea is to explain in sufficient detail how you carried out the experiment, so that another engineer, who is not familiar with the experiment, could repeat what you did. As a general guideline, start by listing the equipment you used, then describe the experimental setup, then describe what you did.

Don't forget to include such things as the model/serial numbers of any instruments used, the date of last calibration, software rev., etc.

Don't simply regurgitate the instructions given in the lab manual. You should cite the lab manual as reference in this section to direct the reader to a step-by-step procedure, but in this section you need to describe what YOU did. See the section on References below for the proper ways to cite references.

Make good use of diagrams, sketches, or photographs to show the layout, wiring, connections, etc. involved in your experimental setup.

Experimental Results

In this section you present your results and summarize the data using figures and tables. A figure is any item that conveys its information primarily using pictures, graphs, drawings, photographs, etc., whereas a table presents a systematic ordering of data, like a list of items. Figures are vitally important in engineering reports, because the product of engineering work is often complicated and not easy to explain by words alone. Raw data or extensive tables should go into an appendix, which appears at the end of the report. Note any difficulties with the measurements in this section, but save the discussion of their *implications* for the Discussion section.

A common error many students make is to simply dump a bunch of graphs and tables into this section (or any section) with no explanation. Don't do that! Make sure you have some lead-in paragraphs that explain what is coming, and some verbiage that guides the reader through each table, graph, etc. that is included in this section. For example, "Figure 7 shows that...", etc. It is best to locate figures and tables within the text (and preferably on the same page where they are referred to) rather than grouping them together at the end of the report.

It is also extremely important to format the figures and tables properly. Each figure and each table *must* have a number, e.g., Figure 1, and Table 1. Each figure and each table *must* have a title and a caption. A caption is a descriptive paragraph that guides the reader to extract the most important information included in the respective figure or table. See Figure 1 and Table 1 below for example. The title of the figure is, 'Simplified schematic diagram of the electrostatic transducer used in the new profiler', and the caption is the sentence that follows. The caption for this particular figure points out information that the author wants the reader to understand about how the transducer works. It is quite alright (even expected) that the text of the report will repeat the information given in figure captions. The purpose of the caption is to provide the hurried reader, who might only leaf through the report looking at the figures, the key information. Note also how labels and arrows are used to identify key items shown in the figure. These can easily be applied in MS Word by using the Drawing toolbar. (If this toolbar is not visible, go to View → Toolbars and select 'Drawing'.) Important note: by convention, figures have their annotation *below* the figure, but tables have their annotation *above* the table.

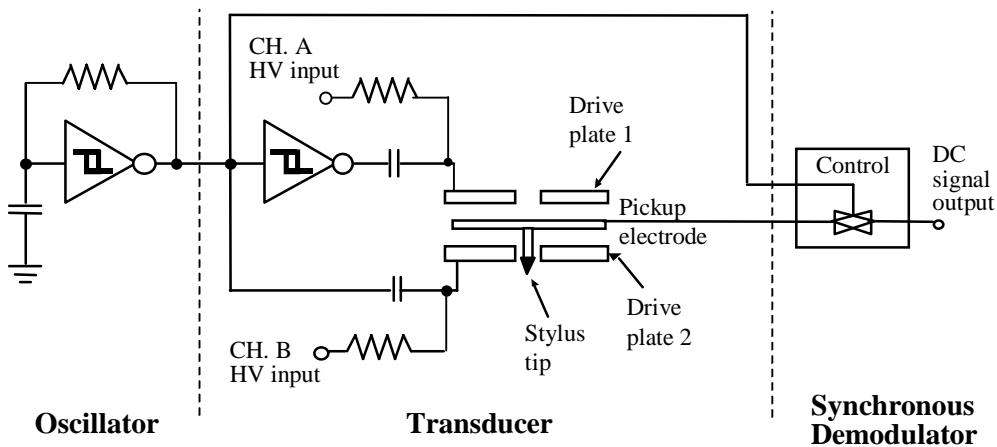


Figure 1. Simplified schematic diagram of the electrostatic transducer used in the new profiler. The stylus force is controlled by the application of DC voltages to the drive plates, and displacement of the stylus is determined from the voltage between the pickup electrode and the lower drive plate.

If figures are included in landscape mode (i.e., where the long direction of the paper is oriented from left to right), they should be oriented so that the figure title is adjacent to the outer edge of the report, not adjacent to the binding.

Table 1. The first three letters of the alphabet. The letter ‘A’ is a vowel, while the letters ‘B’ and ‘C’ are consonants. (Note that the annotation for this table is located ABOVE the table.)

A	B	C
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Any figure or table included in the report must be *referenced* in the text of the report. In other words, you need to introduce or explain every figure or table in the report to the reader. Don’t just dump a bunch of figures or tables in your report without explaining them to the reader! For example, “Figure 1 shows a simplified schematic diagram of the transducer used in the new profiler.”

Discussion

In this section you discuss the *meaning* and *importance* of the experimental results, compare the results to theoretical predictions, describe the accuracy of the results, address discrepancies, and ultimately draw conclusions in regards to the objectives of the experiment.

This is also the place to comment on any problems with the measurements, and what they mean with regard to the objectives of the experiment.

Conclusions and Recommendations

This section summarizes the conclusions that have been made and gives *specific* recommendations for the next steps that could be taken in subsequent experiments or further

research. (Note: your instructor will greatly appreciate any recommendations with regard to how the experiment could be improved, so please include these recommendations too!) One often finds that the results of an experiment generate more questions than answers, so here it is appropriate to describe what should be done next.

Make sure that you recapitulate the important results and do so *specifically*. Most beginning technical writers write far too generally. Consequently, it makes it difficult for the reader to extract the most important points without hunting through the report for specifics. For example, if your experiment consisted of comparing the acoustic noise of two fans, you would NOT be writing specifically enough if you wrote, “We found that Fan A was noisier than Fan B over the applied voltage range.” While this may be true, it would be far more effective if you wrote something like, “We found that the average noise level for Fan A was 8 dBA higher than that of Fan B over the applied voltage range of 6 to 12 V.” Does this make sense?

Acknowledgments

It is probably overkill for a report in this course, but in general, it is very important to recognize the contribution of others to the success of your work. Be thoughtful about how others helped you achieve success. Common areas to acknowledge and give credit where credit is due are:

- Project sponsorship or financial support
- Donations of equipment, supplies, etc.
- Technical help
- Other help of a significant nature

If you do include an Acknowledgment section, explain why or what you are acknowledging. Don't just list a bunch of names.

References

It is extremely important to list all literature (books, articles, papers, etc.), catalogs, interviews, figures, photographs, etc. that have been directly used or referred to in your experimental work and report. In other words, anything that is not original from you and not common knowledge must be cited and referenced. For example, if you included an equation from a textbook in the section on Theory and Analysis, then the source **MUST** be cited at the place the equation is used in the report, and a full bibliographic citation for the source must be included in the References section.

There are two common methods for making a citation. The first is to use a reference number placed in square brackets, such as:

“Published values for absolute viscosity of 10W-30 oil at 100 °F are approximately 8 μ reyn plus or minus ten percent [1].”

Then, in the References section, the corresponding complete bibliographic citation (note: authors' names, date of publication, title of the work, edition, publisher, and place of publication) is listed in *numerical* order:

1. Shigley, J. E., Mischke, C. R. (1989). Mechanical Engineering Design, 5th ed., McGraw-Hill, New York.

If you take this approach, you'll need to keep track of the order of the citations in your report. If you have lots of references, and you make lots of changes, it is easy to get out of synch.

The other, perhaps more desirable method is to cite using the author's last name and date of publication, such as:

“Published values for absolute viscosity of 10W-30 oil at 100 °F are approximately 8 μ reyn plus or minus ten percent (Shigley & Mishke, 1989).”

or

“Shigley and Mishke (1989) report that the absolute viscosity of 10W-30 oil at 100 °F is approximately 8 μ reyn plus or minus ten percent.”

Then in the references, list the references in *alphabetical* order:

Shigley, J. E., Mischke, C. R. (1989). Mechanical Engineering Design, 5th ed., McGraw-Hill, New York.

This approach makes it easier to keep the citation and bibliographic references in synch.

References from a paper or article must include the authors' names, title of the paper (in quotation marks), journal name, volume, number, date, and page number:

Vito, R.P. and Atilla, T.H. (1990). “Computers in the Undergraduate Mechanical Engineering Laboratory”, J. Eng. Ed., Vol. 1, No. 3, pp. 122-25.

References from a source on the Web

Furman B. J., “ME 120 Laboratory Report Guidelines” (2003). Retrieved September 19, 2003 from: <http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/ME120labreportguide.pdf>

The format of a reference can vary depending on the discipline or required format in the case of journal papers, conferences etc. The important idea is to include enough information that an interested reader could track down the reference from a library or on-line information retrieval service. For more information on the APA format and examples of alternate formats, see: <http://www.lib.nus.edu.sg/lion/s/citeapa.html>.

Appendices

Appendices contain information that is pertinent to the experiment or project being reported on but that might otherwise break up the report or distract the reader from the crucial points. Some examples of items that should appear in an Appendix are:

- Raw data taken during the experiment
- Detailed calculations or derivations that support the results or their analysis
- Calibration data for sensors used in the experiment
- Manufacturer's data sheets for sensors or equipment used in the experiment

Group items of a kind together into separate appendices. For example, Appendix A might be titled, 'Raw Data', Appendix B, 'Sample Calculations', etc. It is important to add some verbiage in each appendix that explains what is contained therein. Don't just dump a bunch of tables or equations at the end of the report and call it an appendix. Use a heading and title for each appendix. For example:

Appendix A – Raw Data

etc.

Comments on Style

Reports must be typed. The text of your report should be spaced at 1.5 lines to make it easier for your instructor to give feedback. Headings should be prominent (in boldface or underlined). Use 1-inch margins all around. Put page numbers in your report, preferably in the top or bottom right corner. Be sure to spell check before you print.

For a more information on report writing, especially on prose style, see the guide, “Engineering Report Writing,” put out by the University of Connecticut EE Department,

<http://www.ee.uconn.edu/SeniorDesign/designone/Handout%2002%20Technical%20Writing%202003.doc>

Final Words

Before you write, make an outline of the major points you are going to cover in each section. Think about what the key figures will be. Read your report out loud to yourself or a friend before you submit it. This will help you catch lots of grammatical errors, and it will help you work out awkward phrasing. Strive for completeness and clarity.

Your report may outlive you and serve as the sole piece of documentation for an experiment or design for perpetuity, so do a good job on it!

Executive Summary

The executive summary is a brief, concise summary of important information, intended for specific readers who want to know, but don't have the time, patience, or energy to slog through a rambling, obscure report.

The executive summary answers the following questions:

- What was the problem?
- What was the solution of the problem?
- What actions are recommended or have been taken?

The executive summary must be:

- **Brief:** The executive summary is generally not longer than a few pages, unless figures make up a significant portion.
- **Crisp:** Words and sentences must be relevant to the subject. Avoid filler and verbiage that doesn't add important information.
- **Readable:** The executive summary should be organized and formatted so that the reader can quickly extract the essential information. Use ample headings and subheadings to form a clear outline of the subject that can be readily understood by the reader. Multiple points or features should be tabulated or bulleted (for example, this list). All statements in a common tabulation must have the same grammatical structure.
- **Well-illustrated:** Figures must have brief, self-explanatory titles with text that explains the significance of what is shown. Figures should be integrated into the text, not grouped together at the end.

A suggested organization and heading structure for the Executive Summary is:

- Introduction and Objectives
- Procedure and Results
- Conclusions and Recommendations

Note: the section for Procedure and Results should also contain discussion of the results. Also, don't forget the Title Page, Abstract, References, and Appendices.

Measurement of the Temperature Dependence of Viscosity for 10W-30 Motor Oil

A report on an experiment performed for

ME 120 Experimental Methods

San José State University

Department of Mechanical and Aerospace Engineering

By

John D. Doe

Jane A. Student

February 3, 2003

Abstract

A new rotor balancing method has been proposed that uses deformable torsional elements to shift mass in a plane as the rotor spins. The time dependent torsional deformation of thin-walled tube samples of 304 stainless steel was investigated at temperatures approaching 80% of the melting point. The samples were heated by passing a predetermined number of cycles of 60 Hz electric current through them as they were held in a specially designed fixture that also applied an approximately constant torsional stress below yield at room temperature. The experimental results indicate that the torsional deformation of the balancing elements can be controlled to better than 1% by pulse heating, and that the proposed balancing method is feasible. Additional work is needed to integrate the subsystems of the proposed balancing method into a working prototype.