Writing laboratory report

There is a number of tutorials about how to write technical report. However, it seems that a number of students are unaware how this should be done (or then they are just lazy). I would like to point out some good starting points in your journey:

- http://ltid.grc.nasa.gov/Publishing/editing/vidoli.htm
- http://www.csee.umbc.edu/~sherman/Courses/documents/hw_how_to.ps
- http://www.iit.edu/~writer/MMAE/maeguide1.html

I'm not gonna do again things which have been done many times, so I'm just gonna point out the most important parts in writing your report. This is largely based on the 'Guide to Laboratory Report Writing' by Mukund Acharya, Linda Bergmann, and John Way (*http://www.iit.edu/~writer/MMAE/maeguide1.html*)

Why

According to recent surveys, engineers spend at least fifty percent of their time writing reports and memoranda. Therefore, training and practice in report writing are important parts of the education of an engineer. The quality of oral and written reports presented by working engineers is invariably one of the criteria used by their superiors in performance evaluations. The ability to write a good, professional−quality report is therefore an essential, marketable skill.

How

Notebook

An essential requirement of engineering experimentation is that a laboratory notebook be maintained. This notebook should contain dated entries for every laboratory session, which include all the notes and sketches made during the session, all the data recorded (or information allowing access to the appropriate data files in which data were recorded, if the data were acquired by a computer−based system), and any other observations relevant to the laboratory session.

Professional engineers and scientists make it a standard practice to maintain such notebooks. There are several reasons to do so. A complete and updated note book permits easy access to information, eliminates bias in recording and interpreting data, establishes a time line that is vital for patent applications, and helps in the preparation of reports.

Format

Engineering professionals write several different kinds of engineering reports. The form, length, content and emphasis are determined by the purpose of the report and the intended audience[s]. ***However, the structure of all engineering reports is similar, and includes sections that describe objectives, methods and procedure, results and conclusions.*** While there is no single perfect format, there are several very good approaches that are similar to one another in most respects. By using a checklist and a standardized format, an engineer can ensure that the final report is well−written and complete, and that readers who have different interests and needs can access the information they seek from the report with a minimum of effort.

The content of each of the sections in an engineering report is described in the following paragraphs. Most of the descriptions are general enough to be valid for all engineering reports.

Title Page

Title page should contain following information:

- A brief but informative title that describes the report
- The name(s) of the author
- The date(s) the experiment was performed, and the date the report was due
- The laboratory assignment number and name
- The names of other group members who were present for the experiments (this is in case that not all of the group has participated in authoring of the report)

Table of Contents

A table of contents should be placed following the title page if the report is long (more than ten pages). It should list each section of the report and the corresponding page number. Also list of figures and tables should be added to this point if there is a large number of figures and tables in the report.

Summary

The summary encapsulates the major portions of the report and addresses an audience that might not read the rest of the document. It may be read both by engineers looking for data and by non−engineers, managers who will make crucial decisions about engineering projects. The summary provides a concise overview of your work. It should be about 100−200 words (one to three paragraphs).

Summary should contain the highlights of the major parts of the report, including the objective, results, conclusions and recommendations. No details should be included. The information must be communicated in such a way that the reader can understand what was done, and what the outcome was, without having to read the rest of the report.

The summary should be written completely in textual form−that is, in sentences. It should not include equations or references to anything else in the report. It should read smoothly and coherently, not like a collection of sentences from different parts of the report. When the report describes results from several short experiments, the summary should not resemble several small summaries of the individual experiments, but must provide smooth transitions between them. Although the summary is placed at the beginning of the report (for easy access by the reader), it should be written last, after the rest of the report has been completed.

In order to help readers deal with the very large number of reports and articles that are published, summaries are often extracted from reports and placed in catalogs or indexes that are available in print and on computer data bases. A reader searches these indexes, looking for reports of interest and reading the summaries. At this time, the reader has no access to the rest of the report. The summary therefore must be a stand−alone section that tells the reader whether or not the report is worth acquiring.

Introduction and Background Information

The appropriate information for the introduction varies with the kind of report. Most introductions provide the reader with the necessary background to help put the objectives and results in a proper perspective. When necessary, previous related work is described. If the report is on several short experiments, the overall purpose and background of the group of experiments should be described first, followed by the necessary information for each of the experiments. In this case, the introduction should not be a mere collection of material on each, but should be written using connected paragraphs with clear transitions between ideas and information.

With laboratory assingments this sections tells whether you have understood what this assingment was all about. Poorly written introduction is clearly a mark about poor preparation to the assingment and weakness of your technical knowledge.

Statement of Objective

State the objective(s) of the experiment concisely, in paragraph form. The laboratory manual or instruction sheet will help here. The fact that experiments in laboratory courses are being used to educate students is a secondary objective, and should not be stated in the report. The section should inform the reader precisely why the project was undertaken.

Theory and Analysis

A concise description of the relevant theory should be provided when the theory is needed to understand parts of the report, such as the data analysis or discussion sections. This section is sometimes combined with the introduction and background section, if this results in a more readable report. The relevant equations should be introduced and all the terms to be used in the report should be defined. Equations must be presented as parts of complete sentences. You can find examples of this from the textbooks.

Description of Experimental Setup

Provide a neat, correct and clear schematic drawing of the experimental set−up, showing all the interconnections and interrelationships. Include a short textual description that refers to all parts of the schematic drawing. This section should have all the information needed for a reader to duplicate the setup independently.

List all the equipment and materials used in the experiment. Include identifying marks of all equipment so that reader can connect equipement to the schematic of experimental set−up

Procedure

Detail the procedure used to carry out the experiment step−by−step. The laboratory manual or instruction sheet, together with the instructions given to you by the laboratory instructor, will be of help here. Sufficient information should be provided to allow the reader to repeat the experiment in an identical manner. Special procedures used to ensure specific experimental conditions, or to maintain a desired accuracy in the information obtained should be described.

Data

All the pertinent raw data obtained during the experiment are presented in this section. The type of data will vary according to the individual experiment, and can include numbers, sketches, images, photographs, etc. All numerical data should be tabulated carefully. Each table, figure and graph in the report must have a caption or label and a number that is referenced in the written text. Variables tabulated or plotted should be clearly identified by a symbol or name, and units, if any, should be clearly noted. This section should contain only raw information, not results from manipulation of data. If the latter need to be included in the same table as the raw data in the interests of space or presentation style, the raw data should be identified clearly as such.

However, there are number of occasions when there is so much raw data that this could not be done in a feasible way. Then one can do things rationally by adding raw data in electronic format or by putting it to the web site.

Analysis of Data

This section describes in textual form how the formulaic manipulation of the data was carried out and gives the equations and procedures used. If more than one equation is used, all equations must carry sequential identifying numbers that can be referenced elsewhere in the text. The final results of the data analysis are reported in this section, using figures, graphs, tables or other convenient forms. Sample calculations and details of calculations and analyses should be placed in the Appendix, and the reader directed to the appropriate section of the Appendix for that information. The end result of the data analysis should be information, usually in the form of tables, charts, graphs or other figures that can be used to discuss the outcome of the experiment or project. This section must include statements about the accuracy of the data, supported where necessary by an error analysis. Details of the error analysis are to be included in the Appendix.

Discussion of Results

This section is devoted to your interpretation of the outcome of the experiment or project. The information from the data analysis is examined and explained. You should describe, analyze and explain (not just restate) all your results. This section should answer the question ***'what do the data tell me?'*** Describe any logical projections from the outcome, for instance the need to repeat the experiments or to measure certain variables differently. Assess the quality and accuracy of your procedure. Compare your results with expected behavior, if such a comparison is useful or necessary, and explain any unexpected behavior.

You should always be objective when analysing results. If you have any experience from similar set−up, you should compare results to your knowledge. If there is a correlation, you probably have done things right, but if ... Also common sense is good judgement of results. ***Would you buy your results ?*** If you would, then you are probably on the right track. However, we do receive a whole lot of reports which have proven things which are against common sense.

Conclusions

Base all conclusions on your actual results. Explain the meaning of the experiment and the implications of your results. Examine the outcome in the light of the stated

objectives. Seek to make conclusions in a broader context in the light of the results.

Also you should address the issue of learning. How did the experiments contribute to your knowledge? What should you avoid in the future? What are the applications of the material? What have you learned?

Feedback and recommendations for development

This section is sometimes combined with the conclusions to make the report more readable. The section should address extensions, changes or modifications of future experiments and the reasons why these suggestions are made. Several issues can be raised. Do the results suggest the need for other experiments? If so, what are the new objectives? Is the present procedure inadequate or incorrect? If so, how should it be changed? Does it call for a different technique or a different instrument? Is the objective itself reasonable?

References

Using standard bibliographic format, cite all the published sources you consulted during the conduct of the experiment and the preparation of your laboratory report. List the author(s), title of paper or book, name of journal, or publisher as appropriate, page number(s) if appropriate and the date. If a source is included in the list of references, it must also be referred to at the appropriate place(s) in the report.

- http://www.hut.fi/Yksikot/Kirjasto/Palvelut/Koulutus/Informatiikka/Tietoiskut/Lahde−tietoisku.html

- http://www.hut.fi/Yksikot/Erillislaitokset/Kirjasto/Informatiikkakurssit/Tietoiskut/e−viite.html

Appendix

Details of analysis, computations, etc. that were referenced in the main body of the report should be included in the appendix. If the appendix contains more than one item, each one is designated by a specific letter (Appendix A, Appendix B, etc.) and listed in the table of contents.