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Guidelines for Writing Technical Reports

Version 1.1

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1. Introduction

In the course of your training in the engineering program, as a practicing engineer, a research engineer/scientist, or a graduate student you will be asked to write different types of technical reports, such as:

- *Technical Highlights*
- *Technical memorandum or letter report*
- *Progress report*
- *Full technical report (i.e., scientific papers for publication in refereed technical journals)*
- *Proposal*

This document contains suggested guidelines (broad frameworks) that people have successfully used to write many published scientific papers and a variety of internal technical reports both during the course of their engineering education and during their engineering career in different corporations. Specific formats and lengths of these technical reports will vary slightly from course to course, from organization to organization, and for different types of technical journals.

2. Types of Technical Reports

Technical Highlights

Written either weekly or monthly, highlights are 80 words or less. The purpose is to concisely communicate significant technical accomplishments, events or results. They are not meant simply to report technical activities; they should include the event or result, and the potential value or impact for the customer or your company. The potential readers of highlights are middle and upper management. They are for internal distribution only.

Technical Memorandum or Letter Report

This will consist of a one to two page letter (or memorandum). The purpose is to document significant events or proposals within a program, or to report on results of small-scale evaluation or consulting jobs. Letter reports can also serve to inform readers of new courses of action, make recommendations for new action, present options for future work, request direction from customers, or communicate results that can be appropriately applied. The potential readers are technical peers, department or division managers, and decision-makers at manufacturing facilities. They are usually for internal distribution.

Progress Report

This usually consists of a two to four-page summary of the current state of your study. It should include a review of results obtained to date and planned activities for completion of the study. The general purpose of progress reports is to disseminate technically significant information on recently completed work on an ongoing project, including information needed by the readers to apply any useful findings. They are usually internal documents sent to technical peers, managers, and decision-makers at manufacturing facilities. The organization of a progress report can be similar to that of a full technical report except that it primarily differs in the extent of the development of the information. This in turn depends on both the amount of work that has been completed and on the specific interests and needs of intended readers.

Full Technical Report

This report is expected to contain considerably more detail than the progress and letter reports, and could be an individual or group effort (i.e., only one report from the group will be required). These reports are used to fully document the completion of major projects. Information in the report may be used to apply new findings or implement new technologies. Full laboratory or technical reports are probably the most formal technical document you are asked to write as an engineer in a company. They often include complete background documentation including reviews of relevant literature.

For internal distribution within an organization, technical reports generally require *cover (or transmittal) letters*. A cover letter (or letter of transmittal) introduces the primary reader to the topic and purpose of the report and provides additional information the reader may need to know (e.g., problems encountered during the investigation, or information concerning the document's preparation or authors). Proprietary information should be communicated here rather than in the body of the report. The distribution list (i.e., names of people the report will be sent to) for the text may be included on the cover letter or on a separate piece of paper.

3. Notes for Guidance in Writing Technical Reports

There is no unique formula for writing a technical report. However, many published scientific papers and reports are based on a broad framework consisting of a number of different sections arranged in a logical sequence, each section dealing with a particular aspect of the work. The general pattern is as follows:

(a) Sections concerned with the relevance of the work and an analysis of theoretical concepts and previously published work connected with the particular study.
(b) Sections concerned with details of the experimental work carried out by the writer of the report, and the important results obtained.
(c) Sections concerned with an analysis and discussion of the results, their relevance or significance, any pertinent conclusions that emerge, and suggestions for further studies.

In addition, there is usually an abstract (or synopsis) at the beginning of the report. There may also be various appendices at the end of the report. The actual number, types, and sequence of sections will depend upon the specific nature of the work or the engineering course.

Each engineering course at the School of Engineering that requires technical writing is distinct and the associated writing requirements might differ from other courses. While these deviations are unavoidable, every effort should be made to conform to the general guidelines.

4. Typical Sections of a Technical Paper

Some of the most common sections are discussed in more detail below. Section headings used are representative only, and are quite likely to be different in some reports. In shorter reports, it may be acceptable to combine some of the sections (e.g., *Introduction and Theory*, *Results and Discussion*).

Title (or Title Page)

A title should be brief, but not too brief (about 2 lines maximum) and meaningful. It should aptly describe the contents of your report in the fewest words possible. It is a label and not a sentence. A good title identifies the subject and indicates the purpose of your study. The title page should include the title, date, author's name, course name and number, lab section number, and instructor's name. This page is not numbered.

Abstract or Synopsis

Described sometimes as the mini-version of the report (or paper), an abstract is separate from the main body of the report. It summarizes, in about 100-250 words, the whole report in one or two paragraphs (preferably one) and usually includes ***concise*** details of the:

(i) Principal objectives (or rationale for) and scope of the investigation
(ii) "Problem" to be studied
(iii) Experimental methods and materials used
(iv) Main results
(v) Main conclusions

A good abstract addresses the following questions:

(i) What did I do?
(ii) Why did I do it?
(iii) How did I do it?
(iv) What did I find?
(v) What do my results mean?

It should ***not exceed 250 words***. It should be written in past tense, because it refers to work done. It should not contain any information or conclusion that is not stated in your report. The objective of including the abstract is to allow the potential reader to make a quick decision regarding the relevance of the paper without having to read any other part of the paper.

Introduction

This section establishes the background for the work to be reported. It will usually include a description of the "problem", the reasons for the work being done, and an indication, in general terms, of how it is to be tackled. It should include the purpose, objectives, and scope of the report along with references to previous related studies.

The introduction may include information on institutional or scientific background concerning the motivation of the study, or reviews published in literature (if a separate literature review is not included). Reviews of previous work can be presented not only as useful background but also as evidence that the work under discussion will yield new information and will fill a gap in current

knowledge. In addition to background information, the introduction section can include the *problem/purpose statement*. A problem/purpose statement is a concise and explicit statement of the purpose of the report, the problem that is the focus of the report, and the technical and/or financial importance of finding the source of, or solution to, the problem. This section should conclude with an overview of both the content and organization of the remaining text.

Relevant Theory (Scientific Background)

This section should have a title that reflects the discussed topic. Do not title it "*Relevant Theory*". It should consist of the necessary analytical background and information needed by the reader in order to understand the subsequent analysis/design section. This section should include theory, equations, and figures, as needed.

Analysis/Design

This section should describe, in details, the design problem and its solution. It should be based on the theory section (refer to it as needed) and carry all necessary calculations and derivations. It should contain relevant figures and schematics.

Simulation and Design Verification

This section should contain applicable software simulation of the design (such as P-Spice, MathCad, or Matlab). In some cases there is no applicable software available; then this section is omitted. Following the simulation, a discussion of the agreement/discrepancy between the analytical design and computer simulation should be included.

In some cases, depending on the course, or the subject under investigation, the *Introduction*, *Relevant Theory*, and *Analysis/Design* sections might be combined into a single section, oftentimes simply called "*Introduction*".

Note that all the sections described so far reflect the activities performed "off line", that is, outside of the laboratory environment.

Experimental Procedure

This is a clear description of materials, relevant equipment or apparatus, techniques and tests carried out. The information should be sufficiently detailed that the reader could repeat the experiments under exactly the same conditions. There will also be reference in this section to precautions, error, and accuracy of measurement. Normally the only apparatus and techniques that are described in detail are those which are "non-standard" or unfamiliar, e.g. equipment that has been specially built and designed for the project.

Alternatively, this section could be titled "*Experimental Equipment*", and simply provide a list of materials, usually in a table format. The following section titled "*Experimental Results*" would include the other details.

Experimental Results

In this section, the experimental results are presented in the form of numerical data, graphs, tables, histograms, photomicrographs, etc., as appropriate, with a ***concise*** description of the important features that are to be discussed later (in the *Discussion* section of the report). It is a report of the specific findings obtained in the laboratory while conducting the experiment. This should be ***factual***, and usually includes ***no opinion*** of any kind.

Discussion

This section contains a critical analysis of the results obtained, an interpretation of those results in terms of the original "problem", possibly some comparison with previously reported work, an appraisal of the accuracy of the results, discussion of any shortcomings in (say) experimental techniques, and conclusions. The results of different analyses illuminated in the *Experimental Procedure* and *Results* sections are extended to consider the possible interrelationships between them. Logical links between results and interpretations that lead to conclusions are stated here. The author's opinions may be included.

In this section, discuss the practical implications of the results of your study. Relate the results of your current study to previously published work in the area of investigation and discuss how it substantiates or refutes current knowledge in the area of investigation.

Conclusions

This section consists of a concise re-statement of the main points that emerged from the work described in the report. The conclusions should state what was shown, discovered, verified, proved, or disproved. Each conclusion should be based on information included in the report. When the work performed yields several conclusions, the may be listed in a numbered sequence, from the most to the least important.

Recommendations

Recommendations are usually optional. Whenever required, they should be worded carefully to convey the proposed actions and advice. Hedging language again is useful here if the authors are not completely certain as to the best course of action, (e.g., "Engineering might consider changing design of equipment …," "Similar serious accidents might be avoided if …").

Future Work

This short section contains suggestions for further study or investigation that follow logically from the reported work. It is optional.

Acknowledgements

This is optional. It is used to recognize people who have made contributions, such as reviewing the text, providing research guidance, and conducting some of the experimental work.

References

This is a detailed list by numbers (as indexed in the text) of all published work or private communications quoted in the body of the report. Use appropriate bibliographic format (e.g., Chicago, Materials Transactions Journal, etc.). Oftentimes, this section is omitted when the report is based solely on the laboratory activities associated with a particular course. In the professional setting, this section should never be excluded.

Appendices

These are optional. They contain useful information that is not included in the body of the report because it would distract readers from the report's primary focus or response. They would be used, typically, for:

(i) Mathematical derivation of formulas used when the derivation is longer than, say, 2-4 equations.
(ii) Complete set of data (or extensive set of figures, tables), from which only typical examples have been presented in the results section.
(iii) Basic theory (in appropriate cases).

Appendices usually have their own pagination (Appendix A, Page A-1, A-2, etc.). The rules for labeling the figures, tables, etc. remain the same as for the main body of the report.

5. Additional Comments and Tips

(a) Accuracy - Scientific English has to be precise. Avoid ambiguity, and ensure that the ideas intended are expressed correctly by the written word.

(b) Brevity - Short words are generally better than lengthy synonyms. The report itself should be as short as can be achieved without sacrificing necessary detail or accuracy.

(c) Spelling and Punctuation - Bad spelling gives a poor impression and may even lead to misinterpretation. It is always a good idea to proof read your report and use the spell-checker to check spelling. Errors in these basic elements of writing in the final copy of your report are inexcusable.

(d) Passive voice/Pronouns - In general, the passive voice should be used: e.g. "the specimen was polished …" as opposed to "Polish the specimen …" or "I polished the specimen …".

In general, personal pronouns *(I, you, he, she, we, my, mine, our, us)* ***are not*** used in technical reports. The only exception is when the writer ***must*** involve himself personally in the report, as when writing a report to be used as a basis for patent. In that case, the writer must state that he/she was the inventor.

(e) Tense - The choice of the tense of verbs can be confusing to student writers. The following simple rules are usually employed by experienced writers:

Past tense - Use to describe work done in the laboratory or in general, to past events, as in the *Experimental Procedure* section, e.g., *"Hardness readings were taken on all specimens."*

Present tense - Use in reference to items and ideas in the technical report itself, e.g., *"It is clear from the data in Figure 1 that strain energy is the driving force for recovery"* or *"The group recommends that the experiment be repeated"* (present opinion).

Future tense - Use in making prediction from the data that will be applicable in the future. *"The market data given in Table II indicate that the tonnage will continue to increase in the next ten years."*

(f) Style - Simplicity is best. Grammatical conventions should be followed and "flowery" language avoided. Also, avoid the use of colloquial language (and local vernacular). For example, the following expressions do not belong in a technical report: *"…figured out", "…to fix it", "…fixed it", "…messed up", "…a little bit", "…coolest thing", "…ain't", "…won't", etc.*

(g) Equations – Equations should be numbered. All symbols and variables used in the equations should be defined or explained either prior to their appearance or immediately after the equation. When including a group of equations, "walk" the reader through them. That is, explain in words what is being done to each equations and why. Show the reader the purpose of your derivations. A group of equations without any explanation following or preceding each of them is not acceptable. Each equation should be referred to in text prior to its appearance.

(h) Figures and Tables – Figures and tables containing the results should be sequentially numbered, have suitable captions, and be referred to in the text. The figure or table may not be just put in the report without being referred to or explained. The statement of reference should be placed in text preceding the table or the figure. A section may not begin with a figure or table; there needs to be at least one preceding sentence explaining what follows. Each table or figure should be able to stand on its own and tell the story when removed from the rest of the report. Each table must be an essential part of the text and contribute to the overall story in the text. All tables must have the following parts: *Title, Column headings, Row headings*, the data, and explanatory comments to clarify the table. Repetitions should be avoided. Only the relevant materials, figures, tables, etc. should be included in the paper. Irrelevant or redundant materials should not be included.

(i) Additional Comments - Sentences of varying length help to "lighten" the texture and relieve monotony. Avoid using absolute statements (e.g., "The surface roughness did not change because…") unless you are sure about your claim. If you are not sure, rely on hedging phrases and words in your text such as "It appears that …", "It is probable that …", or "The evidence indicates that …". If your conclusions are based on evidence that is not very strong, state so explicitly. If you are preparing a failure analysis report, remember that your report has the potential of being involved in court litigation. Because people with different backgrounds and purposes read many technical reports, try to tier the information in your report, bearing in mind that not all readers will read all of the text. You may need to repeat information in different sections (such as abstracts, introductions, summaries, and conclusions) to accommodate the reading strategies of different audiences.