How to make reports – and improve your grades

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1. Introduction

During your DTU study, and most likely also in your professional career, you will have to write technical reports. Technical report writing is a distinct discipline and training is necessary. The present document is based on experience of numerous student reports, but should, of course, be adapted to your report. We hope that it will provide useful information that will improve your reports – and your grades.

There is nothing as illustrative as a good example, so find a couple of layouts and text books you like and print/copy them for future reference.

2. The content of the report

Technical report writing is in many respects a simple discipline. You have carried out some work, and you are going to report on this. Nothing more; nothing less. Of course, an introduction and a review of the present state of the art or back-ground theory are also needed, but when you decide the length of the different sections, your own work should constitute the major part. Even if you think your contribution is small or even meagre, never invent anything or describe things as

more complicated than they are. The purpose of technical reports is to clarify things and to shed light on complicated issues.

Your audience is also often quite well-defined. For DTU reports you might believe it is your teacher. This is, of course, in some sense true, but your teacher knows too much about the work. Imagine instead your teacher drops dead, and his colleague is assigned to the correction and grading task. It is acceptable if he does not understand everything, but he should be able to follow the logic of your work and get a crystal clear impression of what you have done. He has to be convinced about the soundness of your work even if he does not understand it all.

The general purpose of a report is to provide information so that the reader can:

- Understand what was done and the results achieved.
- Get good ideas and avoid bad ones.
- Make comparisons with similar work.

Therefore a report should have:

- A clear structure.
- Straightforward language.
- Consistent terminology and notation.
- The shortest possible length.
- Accurate figures.
- Good and proper references.

In order to achieve consistent notation it is often a good idea to make a list of symbols. But once compiled and used during the writing of the report, it is often superfluous to include the list of symbols in the report.

Always use the same terms for the same things throughout the report. And make sure you use the right terms. Your audience will be engineers and scientists, who are often very pedantic. It is how we are educated!

Often it is quite easy to draw a figure by hand, but it is a tedious process to make a final working drawing, even for a skilled graphic artist. Therefore, for most of your work (excluding your bachelor and master thesis) you should consider using scanned sketches. Good content gives better grades than fancy drawings. Data graphs should, of course, be generated by using a graph-plotting program.

3. The report structure

It is advisable to start the writing process by drafting a report structure. Select your headings and write a few notes on the content of each section before you start writing the details. A typical report structure is:

Each section starts on new page. Single-sided course reports are preferred as this allows for corrections on the blank left-hand pages.

Appendices also need numbering. Use A1, A2, A3, ... etc. for Appendix A, etc. or continue with numbering from main text.

All reports should contain sections entitled: Introduction, Conclusions, and References. The headings of the remaining sections should be chosen so that they reflect the contents of the sections. So the headings of sections 2 to 5 above should be considered as examples. Tips for each section are provided below.

In long reports you may decide to end some sections with a summary.

Always use page numbers. Maximum length requirements (e.g. max. 20 pages) usually apply to the text from the beginning of the Introduction to the end of the Conclusion.

Title page

Title, author(s), date, name of course/number, supervisor(s). This is the page where you have a lot of freedom. Consider using a picture illustrating the main result or topic. If you need a compact (memo-like) layout you may consider including the abstract and/or the table of contents on the front-page.

Abstract

In most reports an abstract is not required, but for scientific articles it is very important because it is put into article databases and will be searchable. Typical length is 100–150 words (maximum 200 words). The abstract describes the contents of the report and gives a short formulation of the problem or exercise. Theoretical and numerical methods are described using key words. No justification of methods is allowed. Write in a simple, direct way.

1. Introduction

The introduction consists of the following: background, justification, purpose, and range of work. Often, "range of work" is just an overview of the report structure. The introduction should never constitute more than 10% of the report length.

2. Theory

Theory or model description or "name of topic" or similar. This section must start with a precise description of the problem as well as any simplifications and approximations that will be applied. The section should also include a figure explaining the geometry (with coordinate system) or the system that will be investigated. References to earlier work should also be given here. Any assumptions or restrictions must be specified. Use sub-sections to describe the theory in details. Assign one sub-section to each element of the theory used, e.g.:

2.1 Antenna Gain

2.2 Free-Space Propagation

2.3 Ground Reflections

2.4 Impact of Polarization Mismatch

Caution! It is usually a good idea to avoid writing textbook like introductions to the theory. It is very difficult to (re-)write theory in a correct manner. Instead, try just explaining the setup, the concepts, the main equations, and how they are used for your specific problem. There is a fine line between explaining the theory in sufficient detail and pretending that you can give an account of everything.

3. Design and construction

Design and construction or developed model or similar. This section is about the considerations behind the design of the device and should contain a description of the commercial software used to carry out the design. Provide details of the

device's construction. State the applied approximations and limitations of the design.

For software/modelling projects this section should describe the developed software/model in an implementation-independent (mathematical) way. The purpose of this section is to explain to the reader how the model works. And you all know that it is easier to understand maths and figures than other people's code!

Again using sub-sections is often a good idea.

4. Results and comparisons

This gives a description of the experimental setup or configuration used to verify the design. Remember to include a figure showing the setup. For software/model projects you may choose to devote a separate section to model/design validation.

Results should always be presented as graphs unless very few (less than four) numbers tell the whole story. Comparison should be made between theoretical and experimental results from the present work and/or results previously published in the literature. Results to be compared should normally be presented in the same graph. To ease comparison between graphs and images, try to unify the scaling and axis ranges (while still using a reasonable part of the dynamic range of the graphs/images). Avoid more than four different graphs in one figure.

This section should also include a discussion of the validity of the results with respect to the assumptions used in both the theory and the experimental setup.

5. Program architecture and user manual

This is a description of the programs developed during the project, if any. Again, this should be programming language independent, but taken a step further than pure maths. Imagine that you are describing the architectural design for another student in your group, so that he/she can actually implement the algorithms in a language of his/her choice.

Describe input and output data. Problems that can occur while executing the program, e.g., overflow or numerical instabilities, should be mentioned.

6. Conclusions

In the conclusion the results of the work are briefly described. The conclusions should include:

- A short summary of the work carried out.
- Results of comparisons.
- Description of which parts of the problem which have been solved and what still remains to be solved.
- Future work.

The conclusion should constitute about 5% of the report length.

References

Proper referencing is very important. References should credit other people's work and provide an entry-point for further study. See also the section on Referencing and Plagiarism later in this guide. References may either be cited using numbers of first appearance ([1], [2], …) or by enclosing in parenthesises the surname of the author followed by the year of publication. For a single author use: (Mohr, 2000), for two authors use: (Mohr and Madsen, 2000), for three and more authors use: (Mohr et al., 2000). Append a, b, … to the year in the case of ambiguity. When references are cited by author, sort the references alphabetically by surname.

When referencing books, remember page numbers. You do not want your reader to have to read the entire book to find the relevant pages!

There are many different conventions for writing references. For example, the IEEE standard for articles and books is:

[1] Author(s), "article-title," journal, vol. *x*, no. *y*, pages, date (year).

[2] Author(s), book-title, publisher, address, edition, year, pages.

In order to save space, references are often formatted by using a smaller font size than the main text.

Appendices

Long calculations: Even when calculations are presented in an appendix, the presentation should be of the same (high) standard as the rest of the report. Remember that it should not be necessary to read or browse the appendices in order to follow the logic of the report.

Results: Input data and graphs which would make the reading of the report difficult if placed in the main part. Again, this should not be data and graphs essential for understanding the results and conclusions of the report. However, they may be essential if other people want to reproduce the results or conduct further work.

Source code: Often, it is a good idea to include source code listings. This provides the ultimate "truth" about how results were generated. Any code must be cut-and-paste, since it is almost impossible to retype code error free. Use a fixed width font so that formatting is preserved and ensure that tabs are handled properly. Both the main program and the subroutines (functions) should be documented. Pay attention to sequence and formatting (e.g. when you use "new page"), so that the structure of the program (listing) is clear. Writing clear and transparent code is an art, so try to do this, but never change the code after cut-and-paste to the report.

4. The two-page rule

Remember to allocate time for report writing. A rule-of-thumb is that one person can produce two pages (only 2 pages!) of quality text in one day.

A handy example is the present document of 8 pages. One author spent one day on the draft, another two days to compile and write the rest, and all of us spent perhaps one day in total for proofreading and modifications. Still don't believe it? – Try asking your fellow students how much time they spent on their Master or PhD theses.

5. Referencing and plagiarism

Apart from providing a link for further investigation, references also provide a way to acknowledge other people's work. Failure to do so is plagiarism and this is unacceptable in academia just as in other areas of life. Indeed, DTU has rather strict rules about this and there are a number of consequences when these rules are

violated. The rules can be found in Section 3.10 and the actions in Section 8.2 of Chapter 6 of DTU's Study Handbook on http://www.dtu.dk/. In the Study Handbook you can read the following:

> "*DTU regards it as cheating if an examinee submits work that is not a result of his or her own independent merit …*"

Your reports will typically be part of an examination. DTU also finds it necessary to spell out the common rules of quotation and other use of material:

> *"The rules regarding citations and references to sources in written assignments are that citations must be indicated by quotation marks at the start and end of the citation and that the source of the citation must be referred to either in parentheses or in a note to the text. The Office for Study Programs and Student's Affairs must be notified on suspicion of any violation of the rules regarding examinations. Any violation may lead to the sanctions."*

From this it can be seen that when you copy sentences from a source, it must be in the form of a quotation and when you take information from a source, it must be immediately followed by a reference. Note also that teachers must notify the DTU administration even in the case of suspicion of plagiarism.

During your studies at DTU, as well as in your future professional career, it is important that you avoid any kind of plagiarism.

6. English or your mother tongue?

Often you have no choice but to use English. However, Danish students are encouraged to write their first reports in Danish. It is always easier to write using your mother tongue, and before you have some proficiency in writing there is no need to complicate the process.

Good advice for everyone is to draft or outline what you want to say using your mother tongue before you translate the meaning to English. This decouples structuring of logic from translation (which is a complication – small or large – for all non-native speakers).

7. Learn to use your word processing tools

At DTU you may hear statements like: Engineers use LaTeX – secretaries use Word. Both have advantages. Many find it is a breeze to use LaTeX for technical documents due to its superior handling of equations and references and since you can easily split a document into smaller pieces. On the other hand, many Word users find it too complicated to control layout of LaTeX documents, an easy task in Word. You can write top class reports with both, but whichever tool you use, you need to learn to use it.

Common problems for Word users:

- Use "styles" to ensure a homogenous layout. Never use the buttons to fix the layout. The need to use the buttons indicates that you have not yet decided on a layout and defined a proper set of styles.
- Learn to use the different "styles" in the Equation Editor. In particular pay attention the difference between: maths, text, function and variable.
- Ensure that maths in running text has the same font as in displayed equations, i.e. the equations on an empty line. Handling of maths in running text is why many LaTeX fans go insane when they use Word.
- The line spacing "single" is often too dense.

Common problems for LaTeX users:

- Remember to apply a spell and grammar checker.
- Find a way to change the layout to something suitable for A4 paper.
- Figure out how to control the position of figures and tables.

8. General style guidelines

This last section is a kind of checklist for the formatting and structure of the text. It is by no means complete, but it addresses common issues.

Figures

- Must be numbered and referred to in the text.
- Must appear after the reference (except when at the top of the page with the reference).

- Must have captions.
- Caption layout should differ from main text layout.
- Graphs must have axis labels (quantity and unit).
- Labels and numbers must be readable (i.e. be sufficiently large).
- Graphs should be labelled if more than one appears in a figure.

Tables

- References, appearance, and captions: same rules as for figures.

Main text

- Do not use double line spacing! (But in Word "single" is often too dense).
- Number of characters on each line should not exceed 85 (75 is even better).
- Indicate new paragraph: one empty line, half an empty line, or indentation.
- Introduce all (really!) acronyms when first used.
- Explain all (really!) symbols in equations.

Units

- Use SI.
- Non-breaking space between number and unit like in "1 kg".
- Either use parentheses or exponents for combined units, i.e. $\mathrm{m\,V\,/\,(s^3\,A)}$ or $\mathrm{m\,V\,s^{-3}\,A^{-1}}$ but not $\mathrm{m\,V\,/\,s^3\,/\,A}$ or $\mathrm{m\,V\,/\,s^3\,A}$ which are both ambiguous. Also note that you either need a (thin) space or a "·" to separate units so that meter Volt is not taken for millivolt.
- Further guidelines in (Taylor, 1995); available on www – use Google.

References

Taylor, Barry N., "Guide for the Use of the International System of Units (SI)", NIST Special Publication 811, 1995 Edition, Physics Laboratory, National Institute of Standards and Technology, Gaithersburg, MD 20899-0001, USA.