Written and Audio-Visual Communication

Jens E. Wilhjelm

Ørsted•DTU, Ørsteds Plads, building 348

Technical University of Denmark

2800 Kgs. Lyngby

I Introduction

Written and verbal communication towards more than one individual, normally requires a thorough planning and preparation, as well as the consideration of many different aspects, in order to become a success. This document serves to help in considering these aspects for both writing of scientific reports and presentation of scientific material.

Chapter II introduces the structure of a typical scientific report, while Chapter IV does the same for audio-visual presentations. Chapter V and VI provide some different tactical information. The Appendices provides a number of different tools and various information.

II The content of the typical report

This should not necessarily be followed slavishly, but will give an idea of what goes into a typical report:

Abstract

This is a very short summary of the report. Only the "big lines" are included here. For a ten-page report, the abstract should maximal be 1/3 of a page.

Acknowledgements

Anyone who has contributed with a noticeable amount to the work, should be mentioned here. Do not be afraid of mentioning, that you have received help. This shows that you can collect information from many sources and it is an indication of the ability to collaborate. Mentioning of persons in the abstract does not free you from having to reference to them directly (see "7 References" below), if they provide you with specific postulates. Acknowledgements can also go at the end.

Preface

Contains aspects that are related to the "environment" of the report and the work.

Table of contents

The table of content shows the structure of the report. This is a very important part, because the report will never get better than the structure of the Table of contents allows. Thus, the titles of each chapter should cover the content of the chapter as well as possible. And the order of each

chapter, as well as their place in the hierarchy should be clear, concise and consistent. Ideally, the Table of contents should be readable by itself. See later for methods to arrive at this. All chapters and subchapers should be numbered appropriately.

Nomenclature or list of symbols

All symbols and notations that are used more than once should be listed here. Normally one item per line. The nomenclature will typically be on its own page(s). In general, symbols should be in *italics*. Specifically, the symbols should be in italics both in the sequential numbered equations and in the main text body.

When symbols are to be chosen, the following general guidelines can be given:

t, f, etc.	signifies general running variables such as time and frequency
A, T_0*, etc.*	signifies parameters that are constant during the events that are considered (*e.g.* T_0 is a constant time delay)

However, there exist several symbols that do not follow this convention. Some of them are:

f_0	The transmission frequency (*e.g.* in echo-ranging systems)
c	The speed of sound or light in a medium

Abbreviations or Acronyms

All abbreviations should be listed and explained here. Maximum one item per line. The abbreviations will normally be on its own page(s). Examples of Latin and French abbreviations are given below:

e.g.	*exempli gratia*, for example
et al.	*et alii (masc.), et aliae (fem.) et alia (neut.)* and others
etc.	*et cetera* and so on
i.e.	*id est* that is
SI	*Systéme International d'Unités*, International System Units

Examples of other technical abbreviations (or acronyms) are:

CW	Continuous wave
dB	decibel
FM	Frequency modulation
PW	Pulse wave
rms	root-mean-square
SNR	signal-to-noise ratio

Depending on the amount of words, special words can either be explained here or in an appendix. Examples of such words are given below:

ex vivo	Organs from the living body, taken outside the living body
in vivo	Within the living body
in vitro	Within the glass (outside the living body)

1 Introduction

The nature of the introduction depends on the type of report. In a research report, the background for the problem(s) is stated. Other people's (relevant) research must be stated, and it must be clear in which way your work contributes originally to the general knowledge pool. This can span from an entirely new idea, to an alternative way of looking at a problem considered previously by others.

It is also beneficial if the organization of the report is described here, maybe seen in connection with the above. Preferably, the content of each chapter should be described, and it should be clear why each chapter is included in the report! This part could be its own chapter. It must match the "Table of Contents".

Further details can be found in [1] and [2].

2 Theory

The theory chapter of the report explains the underlying theory for the work that is considered. Remember to reference to previous work and work that was used to understand the theory.

2.1 Main Text Body

Be very concise in the description. Remember to define terms and expressions clearly before they are used. If several words are used for the same thing, then define the most correct words and place the other words in parentheses right after the word. Illustrations are very helpful for these matters.

Remember to keep a leitmotif throughout the text. In this regard, the report can be thought of as a tree with branches and leaves. Extensive deviations from the main topic can be very confusing, and leading the attention of the reader towards less important matters. Consider this when illustrations are made, so that the most central material gets the most attention. This is also important, when the reader skims through the report before reading.

When the material is presented, make sure that it is done with an increasing level of detail. That is, start with a general description that explains the topic. Then, if details must be explained, first indicate which details you will explain. When the general description is made, be sure that it is consistent with the "Table of Contents".

Never use abbreviations in the main text body. However, exceptions are *e.g., i.e., etc*.

All units must be SI, unless other units are used conventionally. In the later case, however, only units that are closely related to the SI system are appropriate. It is very important that all numbers are given with appropriate units. More details on units are given in Appendix X.I. The unit is not written in italic.

A few other notes: Please make correct use of the minus sign and the slash, "–" and "-", respectively. The previous sentence also indicate the correct use of "respectively" and comma.

Also, be systematic with the use of italics. It is a good idea to italicize words that are not considered generally well-known to the reader. Such words can be medical terms, in a technical report, special technical terms, words in other languages, *etc*. However, they should only be italicized the first time they are mentioned. Of course, words that are to be emphasized should be in italics as well.

3 Materials and methods

This chapter explains which materials that were used to do the experiment and how it was done. The work described in the report should be documented well enough so that others can reproduce the entire work. For a typical experimental situation: Show a block diagram of the experimental setup, the data processing and analysis. Give data in a table for each parameter used, *e.g.* sampling frequency, length of signals, as well as parameters such as typical processing time for a computer program, when performance matters.

3.1 Layout

In general, the layout used in this report can be followed. The font size should be 12 points. A good font is Times (New) Roman. The line spacing should be approximately two for all material submitted for critique and 1.2 - 1.5 for the final version.

The right and left margins are 20 mm and the top and bottom margins are 10 mm (*i.e.* 10 mm from edge of paper to beginning of header/footer). The white space in between main text body and headers/footer should be maximal 10 mm. It is a good idea to place a page number at the bottom of the page, together with a revision number (typically indicating how many times the document has been saved), date and (maybe except for the final document) the name of the document file.

At the top of each page, the current chapter and/or section can be indicated, as exemplified at the top of this page.

All paragraphs must have the first line indented to make it clear when a new paragraph starts (2-10 mm is enough). Space between paragraphs should be 1.5 times the line spacing.

3.2 Equations

Equations should each be typed on its own line, be sequential numbered at the right margin, and be accompanied by leading (and maybe tailing) text. Even if an equation is never referenced again, it should be numbered. An example: The power of the signal, *g(t)*, in watts deposited in a 1Ω resistor is the integration of the square of the magnitude of the signal over the time it lasts:

$$P = \int_0^T |g(t)|^2 dt \qquad (1)$$

where T is the duration of the signal. Note that all symbols embedded in the text are in *italics* (as are the symbols in the equation itself). In addition, all symbols should be properly defined and described the first time they are used. Also note that there should be an equal amount of white space above and below the equation.

Another example relates to the Fourier transform of the signal *g(t)*. The Fourier transform is a function of frequency, *f*, and this function is also called a spectrum. This can compactly be written as: $g(t) \leftrightarrow \tilde{G}(f)$, where we note that the spectrum is denoted with a tilde (~), to indicate it can be a complex function. Other diacritical marks are given in Appendix X.

If the equation is somewhat abstract, it is a good idea to describe with words how the equation should be understood. However, the description must be compact in order not to remove attention from the steps involved in arriving at the overall result.

A check list to equations (both numbered and those embedded in the text) is given below:

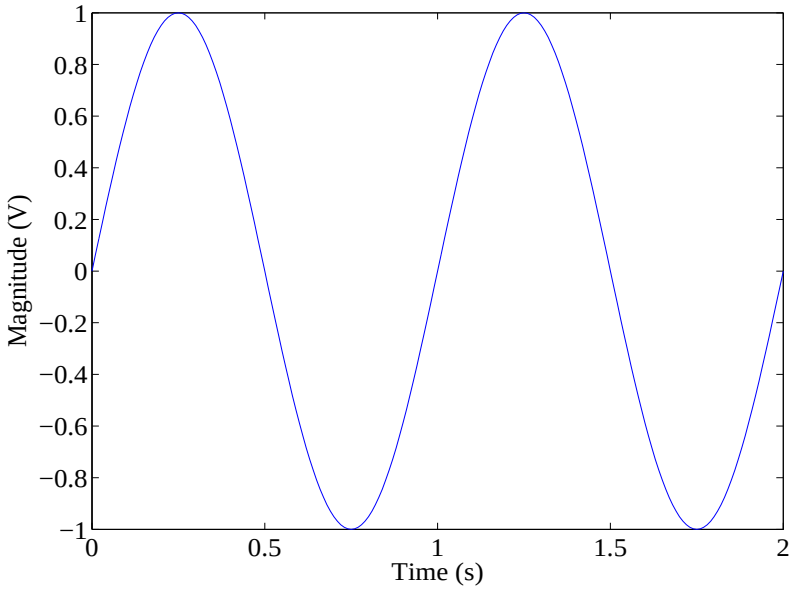

Figure 1 Plot showing two periods of a 1 Hz sinusoidal waveform. Both axes are properly defined with units. The figure goes preferably on top or bottom of page, and the reference in the main text body is preferably located before the physical location of the figure. The caption text (*i.e.* this text) can be of slightly smaller font and the margins larger in order to easier distinguish it from the main text body. If the figure is taken from another publication, then the source should be identified (*e.g.* "From [].") at the end of the caption.

- Are the physical units correct and identical on both sides of the equal sign?
- Are the dependencies correct (*e.g.* an equation for spectral bandwidth must depend on the spectrum)?
- Is the format correct (*e.g.* a scalar cannot be equal to a vector)?
- Are all variables (on both sides of the equal sign) properly defined? Are all variables listed in the nomenclature, except those that are used only once (or on the same page)?

3.3 Figures and Tables

Each figure and table must be accompanied by an appropriate text caption, so that the figure or table can be understood without consulting the main text body. In principle, this means that the report should be readable by the figures and tables alone. Each figure should be referenced in the text at least once, and the figure should preferably be physically placed after the first reference in the text. It helps readability, if the figures are placed at the top or bottom of the page. An example is given in Figure 1. Avoid making the main reference to a figure this way: "(see also Fig 1)". The appearance of the caption (font and margins) must be adequately different from the main text body, so that it is clear that it is not main text body. The figure itself should contain words and parameters that match those of the document, and for plots, all axes must be labelled appropriately.

The considerations given for figures applie equally well to tables. An example is given in Table 1, which shows the key words used for references to equations, figures and tables. Parameters that relate directly to the table, can be given at a line just below the table.

It is recommended that graphics are linked to, not embedded in the document file. This way updates to the graphics are straight forward, in the sense that only the graphic file should be updated.

Table 1: Overview of equation, figure and table references in text. d indicates the running numeral (1, 2, 3, ...). Note that the content of the Table caption follows the general rules for figure captions, except that the text goes on top. Location on the paper follows that of figures.

In main text body		At location	
English (US)	Danish	English (US)	Danish
[Eq.] (d)	[Formel] (d)	(d)	(d)
Figure d	figur d	Figure d	Figur d
Table d	tabel d	Table d	Tabel d

4 Results

This chapter presents all the results. Various points that should be noted can be pointed out. But the results should not be *commented* on. This will happen in the next chapter.

5 Discussions

This chapter discusses the results and comments on consistency as well as lack of consistency. Error sources can also be treated and discussed here.

6 Conclusions

This chapter must contain the conclusions obtained and be consistent with the problem introduced in the Introduction. It is a good idea, when the Conclusions has been written based on the main text body, to re-read the Abstract, Introduction and the Conclusions to verify for consistency.

It is also a very good idea to have other people read the report and give critiques - this is not cheating, as long as you do all the work yourself.

7 References

All postulates in the report must either be referenced or proved in the report. There are several ways of stating references in the text, but the least space consuming is with [] in superscript[97].

Note the difference between these three references:

"The spectrum is even, and it can be simplified to:[97]"

"The spectrum is even[97], and it can be simplified to:"

"The spectrum is even, and it can be simplified to[97]:"

In the first case, the entire sentence is proved in [97], while in the second case, only the fact that the spectrum is even is proved in [97]. In the third sentence, it is only the simplification of the spectrum, that is shown in [97].

The general layout of the list of references, which should be alphabetized, is as follows:

Papers:

[96] LastName, FirstName (abbreviated), repeat for all authors, or, et al.: Title. NameOfTransaction, vol. Number, pp. ____ - ____, Year.

Books:

[97] LastName, FirstName (abbreviated), repeat for all authors, or, et al.: Title. PlaceOfPublication: PublishingCompany, [pp. ____,] Year.

Personal communication:

[98] LastName, FirstName, affiliation, *personal communication*. 2003.

Internet addresses:

[99] Organization and complete http. Date downloaded.

For journal papers, the page numbers of the entire paper should be specified. For books, page numbers are normally not given, however, if only a small part of the book is to be referenced, then page number(s) for this part can be given.

As an alternative to alphabetical listing, the references could be cited in order of appearance in the text. When there are more than four authors in the reference, the first author and "*et al.*" can be used.

8 Appendices

Appendices are used when larger deviations, reasonings, data material, *etc.*, should be moved out of the main document. However, each appendix must be readable by itself, so it should start with an outline of the problem that is to be treated. In general, the language of the appendix can be more compact than that of the main text body. Illustrations, tables, *etc.* are acceptable.

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III The structure of the report

III.I The typical structure for an experimental report

Chapter II explained the typical content of chapters and they are repeated here for clarity:

Title
Abstract
Preface
Table of contents
Nomenclature or list of symbols
Abbreviations or acronyms
Introduction
Theory
Materials and methods
Results
Discussions
Conclusions
References
Appendices

III.II Verifying for consistency

The structure of the report is important. The report will never get better than the structure allows, as mentioned before. In order to work with the structure of the report, one can do the following: Take a big table (or use the floor) and place all printed pages next to each other. Now concentrate on the headings (the table of content) and consider the questions:

- Does the title of each heading explain what is taking place in that chapter (or section).
- Does the subsections belong under the heading?
- Is the order of appearance logical?
- Are there any repetitions of information that could be avoided? In general, only write the same thing once!
- Is the level of details OK?

You will have to consider these questions at all levels. When you work your way through the text of the actual subsections (that is, the body text), it will be a good idea to read the text briefly, and group the information (make coloured boxes around text with the same kind of message). At this time, you probably will move things around and remove redundancies. Be sure to do this process after a break (*e.g.* in the morning), so that you are equally open to changes in all parts of the document.

Another thing, that is tough, is that you might now have to remove text that is too detailed or too much away from the scope of the report. This can be mentally unpleasant, if you have used a lot of time on this. But leaving it there, just means that you will use even more time on it, without getting credit in the end.

IV Audio-visual presentations

This chapter briefly introduces some of the basic aspects of audio-visual presentations. The suggestions given here are not ultimate, but the considerations mentioned here should be kept in mind, if a different approach is used. You can follow these steps:

- You can choose any electronic media. Examples: Microsoft PowerPoint, Lotus Freelance Graphics, Latex (with proper setup, ask us), Matlab, *etc*. But it has to be a consistent presentation, so use the same program for the entire presentation. Overheads and slides are also possibilities, but the work with these, will be larger.
- Select a report and choose the material that you want to present. You have exactly *N* minutes. If your presentation is longer, you will typically be stopped after 8 minutes. If you calculate with *N* to *N+2* slides (*e.g.* pages in your electronic presentation), you will probably have a good starting point. But you must rehearse the presentation in advance to make sure that you meet the time requirements.
- Make the slides according to this order:

Title	The title of the project, your name, advisor's name (if any), affiliation and maybe date.
Contents	List the contents of the presentation. This is an important key in guiding the audience through the material.
Motivation	Statement of the background and the problem/topic. The motivation for the work should be clear (also to non-technical people)
Theory	Explain the theory in a very short and simple fashion.
Materials	Outline the materials, instruments, equipment, *etc*. Good drawings are important as time normally is short.
Methods	Explain what you did in order to make the measurement.
Results	Graphs and similar illustrations.

Discussion	How reliable are the results? What problems were there? What could you have done better?
Conclusions	What did you achieve?
Acknowledgements	If necessary, can be placed here.

- A key question is how much information can be presented on each slide. In answering this question, consider the typical viewing situation. A new slide appears. At this time, the audience is either still digesting the previous slide or expects a continuation (of some kind). However, at the same time the speaker starts talking again. The audience now listens, and can, for example, not read a long sentence on the slide at the same time. Therefore, if a long sentence is necessary, read it loud word for word. It is, however, better to present a bullet-list, logically grouping the keywords of the topic of the slide. A drawing, with only the necessary text is often the best. Some of the points are highlighted in Figure 2.

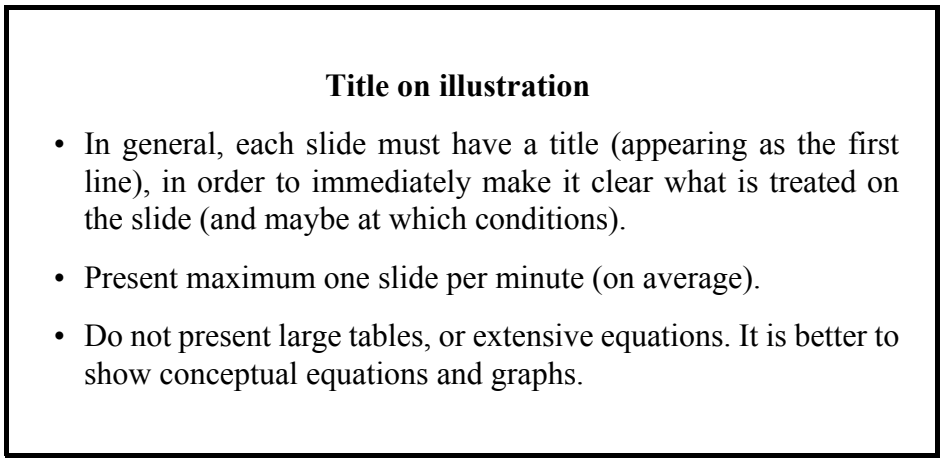

Figure 2 Typical layout of a slide or overhead with a so-called "bullet-list". Notice the problem here: The first and third bullets are *too long*.

- Each illustration in the presentation should be numbered in this format, *e.g.* "1/10", here indicating 1 out of 10, so that the viewer knows where in the presentation he is. This will strongly ease discussions afterwards.
- When you have made the presentation, show it to someone else (*e.g.* your mother, a good friend, your teacher) to get comments. This is a very important step, because normally a good presentation does not materialize itself. And the first requirement for success in front of the audience is a good consistent series of slides.
- Do rehearsals, maybe in front of people that you are comfortable with. Do not speak too fast, and do not try to rush through the presentation to get it over with. If you do, you will never get success and you will never obtain the feeling of having had a success. Watch TV, see how others (politicians) present information.

V Borrowing from others

It is absolutely OK to borrow a figure or text from somewhere. But you have to write very clearly where it is from; otherwise you might be accused of plagiarism. And you will have to fully understand the things you borrow (see more in Chapter VI).

VI Your invitation to questions

Whatever you write or say, it will invite to questions. So be sure to understand what you write, so that you can explain it in more detail (a typical problem is if you "borrow" a figure from somewhere else,

and this figure contains information that is wrong or not in line with your presentation or have more details than you need, you strongly invite to unpleasant questions about these things).

VII Conclusions

It is the hope of the author, that this manual has answered some of the most relevant questions regarding technical report writing. Other supplemental information can be found in [1] and [2].

VIII References

[1] O. T. Andersen: Om at skrive projektrapport. Laboratoriet for Elektronik. Technical University of Denmark, Lyngby, Denmark. 2nd edition. 1987.

[2] L. Rasmussen, O. T. Andersen, J. S. Jacobsen: Rapport og artikel, råd og vink om udformningen. Odense Universitetsforlag, Odense, Denmark. 1994.

[3] http://www.iss.stthomas.edu/studyguides/labreports.htm.

[4]Dorland's Illustrated Medical Dictionary. 27th edition. W. B. Saunders Co., Philadelphia, PA, USA. 1988.

IX Acknowledgements

Tove C. Pedersen and Jacob Willadsen are gratefully acknowledged for proofreading.

X Appendix

X.I SI units and prefixes

Table 2 provides a list of letter symbols for SI and other units while Table 3 provides a list of prefixes to be used together with most of these units.

Table 2: Letter symbols for SI and other units

Symbol	Name	Symbol	Name	Symbol	Name
A	ampere	J	joule	rad	radian
Å	Ågnstrøm	K	kelvin	r/min	revol. per minute
Bq	becquerel	ℓ	liter	R	roentgen
C	coulomb	lx	lux	s	second (time)
°C	degree celsius	m	meter	S	siemens
Cd	candela	min	minute (time)	T	tesla
f	farad	mmHg	mm of mercury	V	volt
g	gram	N	newton	W	watt
h	hour	Np	neper	Wb	weber
H	henry	Ω	ohm	°	degree (angle)
Hz	hertz	Pa	pascal		

Table 3: Prefixes for units

E	P	T	G	M	k	m	μ	n	p	f	a
Exa	Peta	Tera	Giga	Mega	kilo	milli	micro	nano	Pico	Femto	Atto
10^{18}	10^{15}	10^{12}	10^{9}	10^{6}	10^{3}	10^{-3}	10^{-6}	10^{-9}	10^{-12}	10^{-15}	10^{-18}

X.II Diacritical markers

This appendix provides a list of different diacritical markers often used in reports involving physics and signal processing (*a* is any variable):

$\dot{a}$	First derivative of *a*
$\hat{a}$	Estimate of *a* or unit vector
$\tilde{a}$	Complex version of *a*
$\vec{a}$	Vector *a*
$\bar{a}$	Mean value of *a*

X.III Check list for reports

When the report is finished for handing in, please check the following aspects (it might take some time to go through all these points):

- Are there references to all figures and tables from the main text? Are there captions under all figures and over all tables? Can the figures and tables be understood from just reading the captions? Did you remember to use lower and capital letters for figure/Figure and table/Table?
- Check all equations: Are they consecutively numbered, are the units the same on both sides of the equal sign?
- Is the Table of content consistent with organization of chapters and sections? Can it be read independently?
- Did you spell check the report? Did you make a database (in your word processor) with the words it did not recognize? And did you check the spelling of such words?
- Does the report contain repetitions?
- Does each page have page number and revision number?
- Do you have sentences that are very well formulated, but do not fit in? This is the “kill your darlings” dilemma.
- Are all symbols (variables) in *italic* in both equations and in text?
- Are all units correct for numbers given and are units written in normal font (*i.e.,* not *italic*)?
- Does the title page contains all important information including date?
- For figures and text taken from other sources: Are these properly referenced, so that the source is clearly identified? For figures write: “From ...” or “Modified from ...”.
- Have you spell checked the document?