Applied Acoustics' guidelines for report writing

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(based on previous work by Jens Forssén, Patrik Andersson et al.)

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A. Introduction

Report writing is an essential element in courses that include practical work. Reports may help you after a period of time to refresh your knowledge about certain topics, methods, procedures, standards, obtained results, etc. Being able to write a good report is not only a requirement at Chalmers, it is without doubt also a necessity in industry. As an engineer, you will often be asked to perform measurements, experiments, investigations, etc. that require adequate documentation.

There exists something like a good report-writing-practice which includes certain assumptions on how a report is structured, how specific parts are formatted, what type of language is used etc. These regulations are usually imposed in order to facilitate and simplify the understanding of the document and avoid misunderstandings. Between different fields of research, engineering areas or even individual companies the certain set of rules might differ, also there are slightly different requirements depending on the type of report to be written: A research report about a new listening test certainly has different requirements than a measurement report documenting the sound insulation of a wall. In this regard we do not think it is helpful to set up strict rules which you should follow blindly all of the time.

What follows is more a compilation of guidelines which we think can be commonly agreed upon. As such, they should be helpful to you for writing a good (technical) report. Deviations might be necessary from time to time, depending on your individual task. However, it should be evident that specific parts (such as giving references, stating units, etc.) are strict requirements which apply to all reports.

B. Report Structure

A document has a specific audience. The reports that you are going to write at the Division of Applied Acoustics should allow everyone at the same scientific level as yours to understand and repeat each step described in the report. For this, you have to find a way to include all necessary information without unnecessary repetitions, without too much additional information which does not help you to make your actual statements and without including things which can be considered obvious for your audience[1]. In other words, one of the main features of a good report is the right level of conciseness. The reason for this is that unnecessary long reports are more difficult to follow, meaning that it is easy to miss the really important parts. This is especially true when there are many repetitions or the text is "leading away" from the topic.

In the following we will present a suggestion for a report structure which should help you in organising your thoughts. The titles of the different sections and their sequence of appearance are not binding. They can be renamed according to your own style and should follow the specifics of your task. Some chapters may be omitted if it is motivated by your task. Especially, it is often beneficial to combine the *Data* and *Discussion* sections in such a way that the data is thoroughly discussed directly when each figure/table/list is presented.

1. Goal/Introduction/Purpose

This part of the report gives a brief introduction to your work. Usually, this is what one reads first to find out what specifically lies behind the report title. The problem or the task that will be investigated is formulated here. In addition a short introduction to the problem should be made. Background information on why a specific topic might be of interest can be included as well.

2. Approach/Theory/Method

This part of the report motivates the usage of a certain procedure that is used to realise the goal of the work. Different approaches that can be applied to a given problem are described. They may be compared and evaluated with respect to the problem treated in the report. Limitations of the different options are also considered here. If necessary a discussion of the theory behind the task may be done. If so, explanation of equations and their solutions, including assumptions and programs may be made. At this point existing standards may be described.

3. Implementation/Setup

This part part should describe what you actually did to solve the task, both in theoretical investigations (such as calculations or simulations) and/or experiments. The aim is that

[1]For example, for reports at Applied Acoustics, one could assume that it is generally not necessary to start the *Theory* section by deriving the wave equation (unless there is good reason to do so).

the information given here should be sufficient to repeat what you did. For steps, which should be clear from specified references, it is, however, perfectly fine to just point to these.

For experimental work this usually means that a detailed description of the used experimental set-up should be made. It should nicely clarify the equipment that is used[2], the connection between the parts of the setup and the used procedure. Usually, this is made by means of a sketch, which should also include dimensions if necessary. An example for such a sketch can be found in Fig. 1.

For theoretical parts it is often sufficient to just point to what was already said in Sec. 2. If special methods, tricks or complicated derivations are necessary for solving the task, these should nevertheless be explained here.

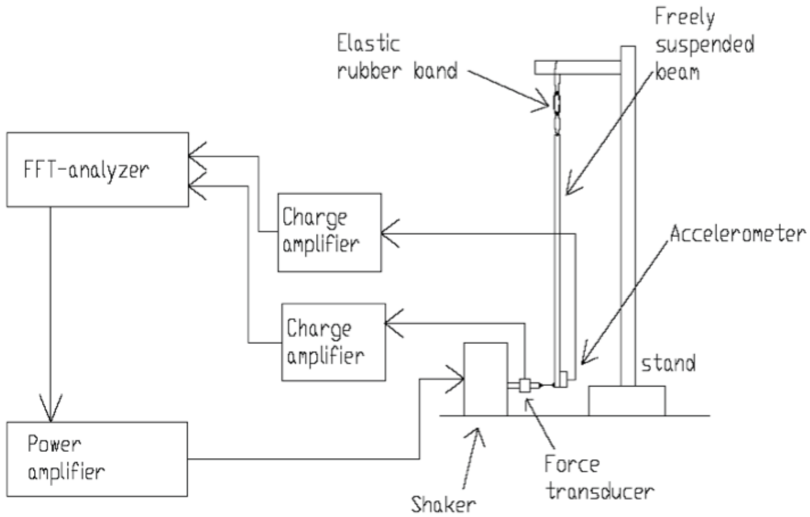

Figure 1: Example for a setup sketch (Caption would read: Setup for measuring the driving point mobility of a beam).

4. Data/Results

Your theoretical, practical or experimental results are presented here. The gathered data should be structured in an easy-to-read way suitable for a further investigation, preferably in figures and tables with accompanying text (see Sec. C for examples on table and figure formatting).

[2]This can be as specific as stating the serial numbers of the items. There have been many cases where this data later helped explaining strange results because it was found out that one piece of equipment was not working correctly.

5. Discussion

An interpretation of the data or results presented in the previous section should be given. This should be done in regard to the used methods and their specific characteristics (e.g. different transformation methods might lead to different results) and should include an evaluation of measurement uncertainties and errors. If necessary, validity assessments of the data and/or comparison with theory/model predictions should be given here. As mentioned, the sections *Data* and *Discussion* are often combined in such a way that the data is thoroughly discussed directly when each figure/table/list is presented.

6. Conclusions

Conclusions based on the result of the work are described here. A comparison with the initial goal is desired. This may include proposals for further work, too.

7. References

Specify all used sources (books, papers, web addresses). An example follows, where the references [1] to [5] are examples for a journal article, a PhD thesis, a standard, a book and a webpage.

[1] P. Sabiniarz, W. Kropp, *A waveguide finite element aided analysis of the wave field on a stationary tyre, not in contact with the ground*, Journal of Sound and Vibration, Vol. 329, No. 15, Elsevier (2010), pp. 3041–3064.

[2] F. Wullens, *Excitation of tyre vibrations due to tyre/road interaction*, PhD thesis, Chalmers University of Technology, Göteborg (2004).

[3] *ISO 18164 passenger car, truck, bus and motorcycle tyres — methods of measuring rolling resistance*, International Organization for Standardization (2005).

[4] A. Nashif, D. Jones, J. Henderson, *Vibration damping*, Wiley-Interscience (1985).

[5] *Applied Acoustics — Sound and Vibration Measurements*, Division of Applied Acoustics, Chalmers University of Technology, `http://www.ta.chalmers.se/education.php?page=cpg_svm` (last visited 2010/09/01).

C. Proper formatting

Physical quantities, numbers and units

- Symbols for physical quantities (e.g. v for velocity) should be explained the first time they are used in a document (see equation (1) for an example of how to that).

- For units, it is assumed that, unless otherwise specified, you are using the SI system.

- For levels expressed in dB it should always be clear which reference value is used, i.e. it should be mentioned at least once in the document (the first time the corresponding level is used) but when in doubt preferably with each table or figure (as done in Fig. 2).
- Symbols for physical quantities are generally expressed in italics (a few exceptions exist, e.g. for matrices) whereas unit symbols are written in regular type, e.g. "f in Hz". By doing so, it is, for example, unambiguously clear that m means meter and m mass.
- There should always be a small space between quantity and unit.
- It has become a common practice to denote unit symbols by square brackets when labelling plots or tables, e.g. "f [Hz]". However, this is strictly speaking **not** correct as square brackets are an operator denoting "unit of", i.e. "$[f] = \mathrm{Hz}$" means "The unit of frequency is Hz". Now what should be the unit of a unit? Correct ways of relating physical quantities and their units are "$[f] =$Hz", "f in Hz" or "f/Hz" where the latter two versions would be typical choices for labelling tables or figures, see Tab. 1 and Fig. 2. Never ever put [] around the unit in normal use with a number, i.e. **do not** write something like 100 [Hz].
- When stating numbers think about which precision (i.e. number of decimals) is necessary or can actually be achieved[3]. Also try to use the same precision in connected areas of your report.

Equations

Label equation with numbers. The first time you use a variable you should explain its meaning. Comment on the physical meaning of the used equations, for example:

The wave equation is given as

$$\frac{\partial^2 p}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2 p}{\partial t^2} = 0\,, \tag{1}$$

where p denotes the pressure, c the adiabatic speed of sound and x and t are coordinates of space and time.

Figures and tables

Any figure or table you put in the report should appear on purpose after being introduced in the text and should be discussed. Each figure should have proper axes notations, labels, a legend and a caption, which should include all necessary information for understanding the plot. A title is not necessary.

[3]For example, if your measurement error is ±1 dB, it is not useful to state results like 45.347 dB, because you are pretending to achieve a precision which you actually do not have.

Assure that plots are easy to read. This includes using big enough font and line sizes as well as not plotting too much data in one plot. Also keep in mind that in black and white printing, many colours (e.g. blue and red) often appear as the same shade of grey. Try therefore to make use of different line styles. An example can be found in Fig. 2.

Tables should have a caption (which usually goes above the table), clear column and/or row headers and a consequent number formatting. Units should preferably be stated in the column header, see Tab. 1.

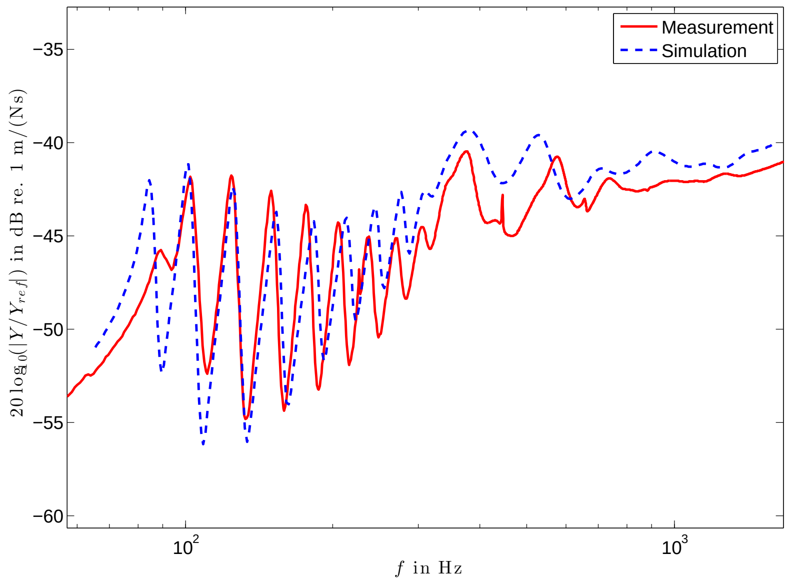

Figure 2: Example for figure formatting. (Example taken from a report about car tyre vibrations. Caption would read: Comparison between measured and modelled radial point mobility for force application to the tread centre-line.)

Table 1: Example for table formatting. (Caption would read: Overview of properties of different plate materials. h plate thickness, E_p Young's modulus, ρ_p density, μ_p Poisson's ratio, η_p loss factor, f_c critical frequency.)

	h	E_p	ρ_p	μ_p	η_p	f_c
	in mm	in N/m^2	in kg/m^3	-	-	in Hz
Aluminium	3.0	$7.2 \cdot 10^{+10}$	2700	0.34	$1 \cdot 10^{-4}$	3869
Oak	10.0	$5.0 \cdot 10^{+8}$	700	0.10	$5 \cdot 10^{-2}$	7504
Sylomer M	12.5	$1.3 \cdot 10^{+6}$	400	0.40	$16 \cdot 10^{-2}$	80 738

Cover page

The first report page should contain the name of the institute (university, department), course name, title of the report, authors (names, ID numbers, e-mails for contact) and report date.

File type and name

It is expected that you hand in your report electronically as a PDF-file. This is the way you will be asked to do in industry too. It is also more convenient for you to correct it and for us to read it. Be sure that the file has a proper name which clearly identifies the task and your group.

D. General remarks

- The report is to be written in the official language of the course if not agreed otherwise.
- Use present tense apart when you describe the actual measurements.
- If you number sections, figures, tables, references and equations it is a lot easier to refer to them in the text by just pointing to the corresponding number (see examples in this document).
- There is no general need to include program source code (such as MATLAB code) in the report. If source code is needed for documentation purposes, only those parts relevant for understanding should be included in the main text (or the appendix) and not the complete program. As an alternative, complete source code files (m-files, etc.) can be attached to the mail with the report. Note that source code can only enhance essential explanations in the text, under no circumstances can it replace them.
- In general your report should be written in a coherent way, i.e. there should be no noticeable change in formatting, language, style, etc.
- Always check the spelling of the report.
- Carefully read the report a final time before you hand it in.
- **Note that copying from other sources[4] without proper references is considered as stealing and has to be dealt with according to Chalmers' policy on plagiarism.**

[4] Examples would be books, articles, standards, web pages, course material or even your own previous reports or material from fellow students.