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How to Write a Good Report

[Ratschläge zur Abfassung eines guten Berichts]

This text attempts to give some guidance on how to write good technical reports (Footnote b) and to prevent the most currently occurring mistakes. Ask yourself a few simple questions and perform a few "checks" while you are writing; this can help you to better present your work.

The technical report presents the results of an investigation in an easily **understandable** [verständlich] and fully **traceable** [nachvollziehbar] way. The report should be **comprehensive** [umfassend] and **self-contained** [in sich geschlossen] to the extent practical (judgement is needed here; if not sure ask your advisers).

The report is addressed to persons who have the same background as the person writing it (in our case, engineers or scientists). It should be understandable by persons who did not follow the development of the work (it is *not* written only for a professor and your advisers who followed your work).

Organization of the Report [Gliederung des Berichts]

The report should have the following parts:

Abstract or Summary [Zusammenfassung oder Inhaltsangabe]

The Abstract is a *self-contained, independent,* part of the work. (It may be the only part of the report "abstracted" in electronic data banks, etc.) The Abstract should be between 10 and 50 lines long, depending on the importance of the report. It is *independent of the main report* and vice-versa. The Abstract helps the reader who is in a hurry learn what the report contains. It is *not* an introduction to the work; it is intended for a reader already somewhat familiar with the subject of the report. It should convey as much information as possible about the particular method followed and the main findings/conclusions of the report.

Table(s) of Contents

It is particularly necessary for long reports. It provides a good way of finding the relevant sections of the report and gives an overview of the work. (Tables of tables and of figures can also be added).

Introduction [Einführung]

The following are typically included in the Introduction:

- the **background** [Ausgangslage] that motivated the work is briefly presented (Example*: it has*

been observed that car crashes often lead to injury of the passengers who are projected forwards - therefore a system cushioning their impact could help: we are designing an air bag).

- **previous work** in the same or neighboring areas is mentioned. (Example: *air bags have been discussed in the important paper by Benz (1993)...,* or *...were the subject of the previous Diploma project by Ethgenious (1992)*). Here you may add the important conclusions or results obtained by previous investigations and/or the way these were presented, mentioning their limitations, as well as your own critique. (Example: *Ethgenious (1992) presents interesting plots of damage to the head as function of air bag size; his results are, however, limited to air bags of older design.)*

- the **definition of the problem** is given, i.e. what exactly we have undertaken to study and which results we seek (Example: *we are designing an air bag capable of protecting adequately the head of an adult passenger; the bag should have the following characteristics...)*

- the **contents** of the report may be briefly summarized (Example: *in Chapter 2 we summarize the general theory needed to understand air bags. Chapter 3 proposes various design alternatives,...)*

Main body of the report [Hauptteil des Berichtes]

Your work should be presented in a concise (not unnecessarily long), logical, clear and traceable way.

Presentation of the work: Describe the experiments conducted, the theory developed, or the computations performed.

Discussion of the work: Discuss what you found. For example, what you learned by examining the various figures that you produced, or why a certain design alternative was found to be preferable, or why your theory failed at some point to describe some experimental observations. To the extent possible, make comparisons between theoretical predictions and experimental results (best on the same plot).

If you are not sure about certain findings, but have good reasons to believe that they are likely to be correct, you may still include your ideas, but you should use words like "these findings suggest that" or "it is conjectured that," or "we are (fairly) confident that" etc. to indicate the lack of *full* evidence. When you are not sure about the reasons of certain discrepancies (what was missing in the analysis and/or the experiments that could have produced the discrepancies) again, use words like "these findings suggest that."

Conclusions [Abschluss, Schlussfolgerungen]

This is generally a rather short section summarizing the main findings [Resultate] of the work and, as applicable, their implications [Bedeutung]. Recommendations for future work may be made here ("Conclusions and Recommendations"). The conclusions should, in principle, not contain statements *not* supported from material included in the main body of the report. In a long report, you may wish to have conclusions at the end of each chapter and a summary of these in the general Conclusions chapter at the end.

The reader not interested in following the details of your work (or unable to understand them) should be able to profit from your findings by reading only the Introduction/Statement of the Problem and the Conclusions.

Acknowledgments [Verdankung]

These are to thank those who helped you, provided unpublished results, financial assistance, gave permissions to do certain (possibly unusual) things (e.g., use a machine in another institute), etc.

Nomenclature and Abbreviations [Nomenklatur und Abkürzungen]

Define all symbols and abbreviations used in the report (if not already done in the text after their first appearance, or in addition to the text). This section can also be placed at the very beginning of the report.

References [Literaturangaben]

Listing of the published works that you used. References should be complete (the "traceability" principle: any reader should be able to find them). See examples below.

Should contain only the works cited in your text and *not* other publications. If you wish to mention some other useful sources of information (to help, for example, future work: either include them here as "Additional Interesting References" or manage to make a global reference to them in the text (Example: *Additional information on this subject can be obtained in Refs. [23-28]).*

Appendices [Anhänge]

Appendices contain information or data that are needed for completeness but can be skipped during a first reading of the report. For example, all the actual data collected (and how/where they have been stored, if necessary), or the long derivation of an equation used in the report, or the materials properties used in your analysis and their sources.

Facts, Opinions, Traceability [Tatsachen, Meinungen, Nachvollziehbarkeit]

A clear distinction should be made between facts and opinions. Opinions should be kept to a minimum (unless you are clearly writing an "opinion paper.")

All facts reported should be based/supported by either:

- experimental evidence gathered, theory developed, or calculations performed during your project.
- "references" or "citations" to previously published work (journal articles, other reports, books, etc.).

When unpublished information must be used, it is referenced as "personal communication." (Example: the unpublished results of a previous experiment that were made available to you.)

Only things that are normally known to every person to whom this report is addressed and are well accepted (e.g., Newton's law of gravity, the conduction equation, etc.) need not be referenced. Typical wording: *Using Newton's law of gravity...*

If an unusual expression of a well known physical law is used, however, it is still necessary to cite a source for it (e.g., a standard, generally available textbook. Example: *using the following form of the mass conservation principle (Baer, 1999)...).* In general, avoid citing "Vorlesungsunterlagen" - you are not writing only for the persons who have followed the same courses.

The reader should be able to clearly distinguish between new information generated from your work and already available information repeated in your report; this is accomplished by proper wording. Typical examples:

- *in our experiments we observed that.../ the experimental work has shown that...*
- *our calculations show... /the calculations outlined above have shown that...*
- *during this study we found that...*

Only when the source of the statement is obvious from its context, one does not need to identify its origin. For example, each step of a long derivation does not need identification.

Any statements that are not findings or facts (as defined above) should be clearly identified as such with proper wording. Examples:

- *in our opinion, red air bags are not a good idea*
- *our experiments strongly suggest that...* (they do not prove it, but we have good reasons to believe that it is true)

If you follow the rules given above, all statements in your report should be "traceable" to their origin, that is, your calculations or your experimental measurements, or the published information that you used and cited. A third person reading your report should be able to repeat or reconstruct everything you did using only your report and information contained in the references. Sufficient (but not too much) detail should be given in the report for this purpose. (It may take the reader a long time to reconstruct your work, but this should in principle be possible).

Where to put what. What to include in your report

[Welches Material wohin gehört, was erwähnt und was weggelassen werden soll]

The new information that you generated should at least be summarized in the main body of the report. If the main body is becoming too long and detailed, the details can be put in Appendices (Footnote c)

You need not repeat all the background information necessary in your report, especially if it is easily and clearly available elsewhere. Repeat only the minimum necessary for making your report readable and to some extent comprehensive and self-contained. (There is a difficult balance to be reached here; if you are not sure, ask your advisers.) For example, you should clearly not include the basic derivation of the conduction equation [Wärmeleitungsgleichung] if you simply used it. (Such a derivation belongs to a textbook on heat transfer.) The quality of your report will not be improved by filling it with equations that are not needed; it will not be judged on its length, but rather on its readability and importance of *new* information contained.

Style and format [Stil und Darstellung]

Your style and format should be consistent throughout the report. (For example, always write *equation (1)* or *Eq. (1)* but do not mix the two alternatives.)

Use either the first *person (I* or *we performed the following experiment...)* or the passive tense *(The following experiment was performed...)* but avoid mixing the two styles.

Use **simple language**; don't try to impress the reader with complicated sentences. Avoid (in English at least) long sentences. Don't include any word or sentence that does not "bring anything." (Ask yourself the question: is this needed for better comprehension or clarity? does it "bring" anything? - if the answer is "no," delete).

The report should be **readable "linearly**," from beginning to end, without the reader having to go back and forth or navigate between main body and appendices. In writing your report you may have "clicked" back and forth, but don't expect the reader to do this. Construct the report in a way avoiding excessive references to information "given below." Remember that you are writing to convey your results as "comfortably" as possible.

The report should be **logically subdivided** in chapters (or sections for shorter documents), sections, and subsections (of more or less similar length) to help reading. Number the chapters, sections, subsections, etc. in a logical way, preferably using a decimal system: Chapter 1, Section 1.1, Subsection 1.1.1, etc.

In organizing the main body of the report avoid excessive "nesting" of the sections, subsections, etc.

(avoid section numbering with more than, say, three digits: not more than 3.2.5). The titles of the various sections should be meaningful and should apply to the whole contents of the section - do not smuggle irrelevant material in a section because you do not know where to put it. The number of subsections in a section should approximately reflect the importance of that part of the report (e.g., do not create ten subsections for the introduction and only a couple very large ones for the main body of the report).

All **figures, tables and appendices** should be referred to or cited somewhere in the report. Don't expect the reader to discover the appendices by turning the pages. Number figures, tables, equations (if necessary) and appendices in their order of appearance in the text.

All figures, tables and appendices should have a descriptive title or "caption" (not only *Fig. X*). Keep the captions relatively short but use them to convey as much information as possible. If possible, the figures and the captions taken together should be self explanatory (for the person looking through your report).

Define all **symbols** (and abbreviations) used (especially unusual or non-standard ones) in the text following their first appearance or in the **Nomenclature** section.

References [Quellenangaben]

All references and citations should follow a standard uniform format. The two main recommended alternatives are:

Alternative "brackets and numbers"

In the text [1], [2] etc. (or superscripts[1,2]) in their order of appearance (a pain!); numerically ordered listing in the References. Example:

Modern steam generators produce steam at about 250 bar and 500 C [1]. Their superheater tubes often suffer from a strange disease first identified by Ericson et al. [2]. The main symptoms of this disease are cracks [3], loss of weight [4], and ....

References

1. F. Author, *Modern Steam Generators*, Pergamon Press, Paris (1998).

[Author(s), *Title of book*, Publisher, City published, (Year of publication)].

2. J. Ericson, P. Smith and J. Johnson, "A Strange Disease Observed in Steam Generator Tubes," *Journal of Strange Machines,* **25** (11), 245-256 (1996).

[Authors, "Title of Article," Volume (number), pages (year of publication)].

3. A. Ethstudent, "A Beautiful Report on Cracks in Tubes," ETH, Institute for Strange Research report ETH/ABC/356 (September 1997).

4. B. Weightwatcher, "Loss of Weight in Tubes," ETH Dissertation No. 123456 (1999).

Alternative "names and year"

In the text the name(s) of the authors followed by the year of publication in parentheses (makes the text a little longer); in the References section the works ordered alphabetically (more convenient and useful).

Modern steam generators produce steam at about 250 bar and 500 C (Author, 1998). Their superheater tubes often suffer from a strange disease first identified by Ericson et al. (1996). The main symptoms of this disease are cracks, as discussed by Ethstudent (1997), weight loss discovered by Weigthwatcher (1999), and ...

References

Author, F. (1998) *Modern Steam Generators,* Pergamon Press, Paris.

[Author(s) (year) *Title of book*, Publisher, City published].

Ericson, J., Smith, P., and Johnson, J. (1996) "A Strange Disease Observed in Steam Generator Tubes," *Journal of Strange Machines,* **25** (11), 245-256.

[Authors (year) "Title of Article," *Journal*, **Volume** (number), pages].

Ethstudent, A. (1997) "A Beautiful Report on a Strange Disease," ETH, Institute for Strange Research report ETH/ABC/356.

Weightwatcher, B. (1999) "Loss of Weight in Tubes," Swiss Federal Institute of Technology - Zurich (ETHZ), Dissertation No. 123456.

If there are only two authors, cite them both in the text: *Badguy and Goodguy (1998)* or *(Badguy and Goodguy, 1998)*. For more than two authors use some Latin: *Badguy et al. (1998)* or *(Badguy et al., 1998)*. In the References section preferably list all authors.

Footnotes

(a) The author is indebted to M. Andreani and to H.-M. Friess for comments and constructive suggestions.

(b) Your comments to this document regarding possible improvements will be appreciated; after all we are trying to give guidance on good writing… Please mark your copy and return it to the author.

(c) If you have collected important data that should not be lost, it may be useful to state (e.g., in an Appendix) where, how, and in which form these data were stored (a list of files and their contents).

Additional Recommended Reading

The following books (all available in the LKT Library) can help you improve your writing:

V. Booth, *Communicating in Science*, 2nd edition, Cambridge Univ. Press (1993).

R. A. Day, *How to Write & Publish a Scientific Paper*, 3rd edition, Cambridge Univ. Press (1988).

D. Porush, *A Short Guide to Writing About Science*, Harper Collins College Publishers (1995).

R. A. Rathbone, *Communicating Technical Information*, 2nd edition, Addison-Wesley (1985).

C. H. Sides, *How to Write & Present Technical Information*, 2nd edition, Cambridge Univ. Press (1991).