STRUCTURE OF A TECHNICAL REPORT

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SUMMARY

The importance of writing good technical reports is emphasised. An outline scheme is proposed for use by undergraduates in the School of Mechanical Engineering, adaptable for all forms of technical writing. The structure of the report is explained, and the purpose of each section of the report is discussed. A systematic method for approaching technical report writing is given. It is hoped that by following these guidelines students will develop good report writing habits from an early stage.

CONTENTS

1. INTRODUCTION

1.1 Rationale for a Structured Technical Report

In addition to the analytical and design skills which you need to become a successful engineer, a number of other skills, known as transferable skills, will be required throughout your career. Amongst these, communication skills have been identified in a survey of graduates of this School as being of primary importance. The ability to communicate your ideas or findings to others is as important as the knowledge itself. The School embarked upon a series of initiatives aimed at improving both the verbal and writing skills of undergraduates. This paper deals with report writing.

The purpose of a report is to convey information factually, briefly, and clearly. Brevity is important; a report is not an essay. Clarity is achieved by subdividing the report into headed sections each with a definite part to play. There is no single "best" way to present a report. However, the School teaching committee has decided that it is in the interest of students that one particular form should be adhered to. The structure here is appropriate to any technical report, but may be modified by course organisers for particular types of report.

1.2 Aim and Objectives

This report aims to help develop good technical reporting practice. Specific objectives are

- to justify the importance of structured technical reporting,
- to describe and explain the structure of a technical report,
- to propose a suitable style for the layout of a report and
- to propose a logical approach to the writing of a report.

2. STRUCTURE OF A REPORT

2.1 Overview

At the outset, it is important to understand that the structure of the report results naturally from the necessity that it can be read at many levels. The level of detail of information that your immediate boss needs from a report is clearly going to differ from that which the managing director requires, but rather than writing separate reports for every level of management, it is clearly better to write a *structured* report *designed* to be read in different ways by different people.

There are four main parts to any report, and each of these has a different purpose:

- *Summary* or *Abstract*
- *Introduction*
- report core (*eg Theory, Description of Experiment, Results and Discsussion*)
- *Conclusions*

In addition there may be appendices attached to the end of the report. Table 1 illustrates who might read what parts of your report on your part of a large project. A brief outline of what material belongs in each section is given in the following subsections.

	Managing Director	Technical Director	Project Manager	Supervisor	Partner
Title	✓	✓	✓	✓	✓
Summary		✓	✓	✓	✓
1. Introduction			✓	✓	✓
2. Theory				✓	✓
3. Experiment				✓	✓
4. Discussion				✓	✓
5. Conclusions			✓	✓	✓
Appendix 1					✓
Appendix 2					✓

Table 1: Likely readership of parts of a technical report.

2.2 The "Summary" or "Abstract"

In as few words as possible the summary, which will head up the report, often appearing on the title page, lets the reader know the subject of the report, where the information has been obtained, and the key findings. Summaries are seldom longer than 250 words. For short reports, they may be as little as 100 words, and are usually written as a single paragraph of prose.

The summary should be a distillation of the key elements already noted in the *Introduction* and the *Conclusions* and should be readable in isolation of the body of the report, so avoid symbols, acronyms and jargon.

2.3 The "Introduction"

The material which you are about to present in the main body of the report must be set in context. Questions which the reader will ask include:

- why is this work being presented?
- where does it fit in with the World of Engineering?
- how does it relate to other work in the field?
- what are the aims and objectives of the project?

A typical introduction might be split into sections such as

1.1 Rationale / Motivations / Background / ...
1.2 Aim and Objectives

in order that the problem may be broadly presented first, followed by a clear statement of the planned contribution of the current work toward a solution.

2.4 The Core of the Report

This will be the main part of the report and provide all of the results and discussions which someone who wished to examine the work in detail would require. For example, a report on an experimental project would include:

- theory
- experimental method
- results
- discussion

However, a report on, say, an industrial visit would probably only have a single core section, whereas an honours project report might contain *theory, experiment, results* and *discussion* for each of *eg* three different experimental approaches or major parts of the project.

2.4 The "Conclusions"

The conclusions should be a condensed version of the intervening sections giving the key findings of the work. No new scientific argument should be presented here – everything should have already been discussed in the "Discussion". Conclusions should be closely related to the objectives which were stated in the introduction.

For larger projects, this section may need to be entitled "Conclusions and Recommendations" and be subdivided into these two subsections.

2.5 Appendices

If there is information which is not of immediate use to the reader, or for some other reason is difficult to incorporate in the body of the report, then it should be consigned to an appendix. Typical appendices are:

- references (always the first appendix)
- long mathematical derivations
- large design drawings (but key diagrams should be put in beside the relevant text)

All material in appendices should have at least one reference to it from the main text, otherwise it is completely adrift and its inclusion is worthless.

3. HOW TO BEGIN

Ideally, the first thing to be written should be the table of contents. Write down the headings, then sub-headings of your report. Then note, briefly, perhaps as a series of bullet points, what the content of each section is to be. What then remains is to turn the bulleted lists into prose under each heading.

Start writing with the introduction. Ideally, you will have done background reading on your project before commencing the work, visiting the institution, attending the lecture, etc.. If you have, you will certainly have gained more from the experience. Carrying out the project will normally encourage you to read further into the background literature on the subject. All of the information which you have gathered should go into the introduction. It should

naturally follow that most of your references are generated during the writing of the introduction. Finish the introduction with the aim and objectives of the project.

The core of the report may now be written, with as much detail as is required for the reader to understand everything which was done. Appendices are generated during the writing of the core of the report. The conclusions will then wind up the report, by stating concisely the most important aspects of the results and discussion. The conclusions are not new material. They are simply a condensed form of the earlier sections. Ideally, someone who wishes to become familiar with your work without knowing the fine detail should be able to do so by reading only the introduction and the conclusions.

Finally, the summary may be written. This is not new material either, and should be able to be written by taking the key points from the introduction and the conclusions.

Appendix 2 to this document is a copy of the proforma used in the assessment and feedback process for the ME2 technical reporting exercises. It is appended here as it should form a useful checklist against which you can compare your report before its submission. Appendix 3 is a copy of a handout, enlarged every year, which aims to highlight areas which consistently prove troublesome. As with the proforma (appendix 2), a read of this document before writing and a reread before submission could prove useful in ironing out the majority of weaknesses in the report.

4. LAYOUT OF THE REPORT

4.1 Introduction

The purpose of structuring the report is to make it accessible to likely readers. The purpose of layout is to enhance the ease with which the reader can find their way about. With currently available word processors it is possible to use a variety of different methods to enhance the report (eg bold characters and bullet points). Appendix 1 gives a suggested layout, with letter sizes and spacings. You will note that the document you are reading now conforms to this layout.

4.2 Diagrams and Tables

These should be numbered according to their section and placed as close as possible to the text which refers to them. Diagrams are numbered separately from tables as Figure 3.1, Figure 3.2, etc and Table 3.1, Table 3.2, etc. In short reports, diagrams and tables may be numbered sequentially through the report rather than by section. Diagrams and tables are rarely numbered by sub-section. Graphs are just a form of diagram and should be given a figure number in sequence with other diagrams. In addition to a number, where possible, diagrams, graphs and tables should be given a useful caption.

4.3 Equations

Equations should also be numbered sequentially, by section (rarely by subsection), and referred to in the text. In short reports, equations, like diagrams and tables, may be numbered sequentially through the report. Equations may be hand-written although typesetting is preferable. Remember that long derivations should be consigned to an appendix.

4.4 References

Referencing is a most important aspect of reporting. Typically, you need to put your work into the context of an existing body of knowledge. Also, you may wish to use material from sources other than your own, *eg* a figure from a book. Correct referencing is also among the most difficult of reporting skills to master.

References should appear in the text in one of two forms, depending on whether the author's name crops up naturally, eg

> According to Smith (1955) the cart comes before the horse.

or

> It is well known that the horse comes before the cart (Saddler & Wright, 1923).

If the publication has more than two authors then the form (Baldwin et al, 1993) should be used.

When using material directly from another publication, *eg* a figure from a book, this must be clearly acknowledged, *eg* a caption might read

> Figure 2.4: A cart and horse in conventional arrangement (after Smith, 1955).

In the appendix these would appear in alphabetical order as:

> Baldwin, M., Turpin, E. & Wilton, D. (1993), Long-Term Stability of Soap Films, Wetherfield Publishers Ltd.
>
> Saddler A.J., & Wright B. (1923), "Design rules for cartwrights", J Horse-drawn Vehicles, **26**, pp104-190.
>
> Smith, W.J.E.T.B. (1955), "Philosophical misconceptions", Phil Tran, **106**, pp 23-24.

Note that a book or journal has each word beginning with upper case; a paper title appears in quotes and does not have capitals; and abbreviations are used for common words such as J.= Journal, Tran.= Transactions, Proc.= Proceedings of, Int.= International, Conf.= Conference. The bold figures indicate the volume of the journal. Page numbers should always be noted and given. ISBN numbers should be given at the end of a reference whenever possible.

Other material could have come from an exchange of letters / email / conversation with someone, referenced as

> Alder, G.M. (1999), *private communication*

Naturally, this is rather unsatisfactory for the reader, since they cannot access the source simply. Material gleaned from the internet may be referenced by http address, but this is also most unsatisfactory as it is not a permanent, published record.

5. CONCLUSIONS

1. Good reporting is as important as good engineering. The purpose of the report is to inform the reader, clearly and concisely.

2. The report is structured in such a way as to allow different readers to access readily the level of detail appropriate to their needs.

3. Good layout helps the reader.

4. The writing of a report is a straight-forward exercise, which will occur naturally if the above guidelines are followed.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of .... . The financial support of .... is also gratefully acknowledged.

APPENDIX 1: LAYOUT GUIDE

The following guide may seem onerous at first, but you will soon get the hang of it , and the end result will be better presentation.

(Character point size is 11pt throughout, unless otherwise indicated)

TITLE

(note large point size, eg 16pt and bold)

Name
affiliation of author
Date of Writing

SUMMARY

new page

CONTENTS

(*giving section numbers, headings and page numbers*)

1. INTRODUCTION

(*bold, caps, 14pt*)

2. THEORY

2.1 Sub-heading

(*bold, standard font - 12pt*)

2.1.1 Sub-sub-heading

(*bold, standard font - 11pt*)

Sub-sub-sub-heading
(usually un-numbered, not bold, standard font – 11pt)

3. EXPERIMENT

4. DISCUSSION

5. CONCLUSIONS

new page

APPENDIX 1 - REFERENCES *(normally)*

APPENDIX 2 -

note - if the sections are long it is as well to start each one on a new page

APPENDIX 2: ME2 TECHNICAL REPORTING EXERCISE - ASSESSMENT PROFORMA

This proforma is designed to summarise feedback and save me some writing. Please also see comments in the report itself. All comments listed are intended to be constructive. Please discuss any areas of concern with me.

These sheets can also be used by you to "self assess" your work before its submission. How many of the comments could be applied to your report?

Structure v.good 1 2 3 4 5 v.weak

- Reread handout "Structure of a Technical Report"
- Remember that the report is designed to be read to different depths and repetition of material is inherent in the structure, ie, the "conclusions" are a distillation of key elements of the "discussion"; the "summary" is a distillation of the key elements from "conclusions" and the "introduction".
- Number sections and subsections.
- Give graph(s) figure number(s) and refer to them via this number.
-

Layout v.good 1 2 3 4 5 v.weak

- Review handout "Structure of a Technical Report". The technical report should look very similar to this.
- Current practice uses a blank line between paragraphs, and no indentation of the first line in a paragraph.
- Current practice is against underlining of section and subsection headings.
- Current practice favours the use of italic or bold face for emphasis rather than underlining (old practice from typewriters).
- Use a normal size of type, eg 11pt.
- Use single (or 1.5) line spacing - double spacing is usually to allow for comments / alterations to be inserted by hand.
- Layout of equations could be improved - look at *eg* text books for examples.
-

Summary v.good 1 2 3 4 5 v.weak

- Summary should be precise in summarising objectives **and** key conclusions.
- Put the important numbers in the summary - be quantitative whenever possible.
- Summary should be readable in isolation of the rest of the report - don't include references to sections, figures, graphs etc., or use terminology or symbols whose meaning is not apparent.
-

Introduction v.good 1 2 3 4 5 v.weak

- Reference other sources according to the standard method described in the hand-out "Structure of a Technical Report".
- Rather thin on background / context / applications...
- Any references? Reference sources of further background material *etc.*
- Objectives should be stated in this section.
-

Theory v.good 1 2 3 4 5 v.weak

- Too much jumping into and out of appendices disrupts the flow. Short derivations can stay in the main text.
- Theory too sketchy - a reader unfamiliar with the experiment would be left confused.
- Reference the source of any equations not derived. Note that this can be relaxed for equations which your intended readership should be very familiar with, *eg* Bernoulli.
- Use standard format for references - see handout
- Use diagram(s) to clarify explanations
- Make clear the relationship between the theory and the experimental objectives
-

Experiment v.good 1 2 3 4 5 v.weak

- Avoid lists of instructions - the reader is unlikely ever to carry out the experiment. Rather, explain how the apparatus enabled the necessary measurements to be taken.
- Clearly relate procedure to the objectives.
- Use diagrams to support descriptions - usually much clearer and can save 100s of words.
- Describe the tests or series of tests carried out.
-

Results and Discussion v.good 1 2 3 4 5 v.weak

- Make the source of error bounds clear.
- Quote units with every quantity (unless dimensionless, of course).
- Calculation of combined errors in error - refer to hand-out "Treatment of Experimental Error".
- Error bounds are **estimates** only, so only 1 (2 max.) significant figures in the value of the error bound can be justified.
- Quote results only to a precision justified by the size of the associated error bound.
- A good graph with clear error bars removes the need for tables of results.
- Large tables of results should be placed in an appendix.
- Be **quantitative** whenever possible, *eg* the measured data agreed with predictions to within X%; the value of W was X±Y.
- Is the discrepancy between predicted and measured quantities significant?
- What were the most likely causes of a discrepancy?
- Do you believe the data or the model? Why?
- Don't forget to discuss the obvious - the basic findings.
- Everything that is going to appear in the "conclusions" must be presented and discussed in this section first.
-

Conclusions v.good 1 2 3 4 5 v.weak

- Reread hand-out "Writing Conclusions"
- Conclusions should "stand alone" - don't refer back to material (eg graphs) in foregoing report.
- Make conclusions **quantitative** whenever possible.
- Quote result(s) **and** associated error bound(s).
- What was the expected / theoretical result?
- What was the discrepancy between measured and predicted results? Was this within or outwith error bounds?
- Suggest reason(s) for discrepancy.
- Conclusions are not complete.
- Conclusions should be written as a series of **brief** statements.

- Don't editorialise - ie, don't make subjective statements.

Writing Style v.good 1 2 3 4 5 v.weak

- Impersonal third person passive form should normally be used, "... it was shown that...", "...the flow rate was measured...".
- Avoid informal language or constructions in a formal report.
- Stick to plain English - formal - yes, but not unnaturally over-formal.

Grammar v.good 1 2 3 4 5 v.weak

- Misplaced, superfluous or missing commas - rereading aloud should help in identifying these problems.
- Occasional non-sentences - rereading aloud should help in identifying these problems.
- Confusing and/or over-long sentence(s). Rereading aloud as written should identify any awkward or confusing passages.
- Apostrophes denote possession, or missing letters (*eg* don't). They **never** denote a plural.
- "Its", as in *belonging to it*, has no apostrophe. "It's" = "it is"

Spelling v.good 1 2 3 4 5 v.weak

- Use spelling checker.
- Typos. Take care.

Graphs v.good 1 2 3 4 5 v.weak

- Don't crush graph to very edge of paper - axis labels get squeezed or lost.
- Each axis should have a label in words, with a symbol and units where appropriate.
- Show error bars, or state that they are too small to be drawn.
- Make a clear distinction between a best-fit line through measured data and a predicted line, eg by labelling lines on the graph.
- Don't join measured points with lines - real functions vary smoothly.
- Don't plot theoretical "points" - only a line / curve. In general, there is nothing special about a particular point on a theoretical line.
- Draw axes from a true zero, or indicate clearly that this is not the case.

Use of Appendices v.good 1 2 3 4 5 v.weak

- Reference other sources according to the standard method described in the hand-out "Structure of a Technical Report".
- References should be "appendix A" or "appendix 1".
- Short derivations can remain in main text.
- Material in appendices should be divided into numbered sections - "Appendix A", "Appendix C.1"...
- Material in appendices MUST be referred to from main text, otherwise it is completely adrift and its inclusion is worthless.

APPENDIX 3: COPY OF HANDOUT: "HINTS AND COMMON MISTAKES"

The University of Edinburgh
School of Mechanical Engineering

Technical Report Writing - Hints and Some Common Mistakes

Tom Bruce, March 1999

Over the course of the last four years, I've read some 400 technical reports. The overall standard (at least in the second exercise) is usually encouraging, but I find that I am making certain criticisms repeatedly. Clearly, these highlight areas of difficulty. In an attempt to improve your grades and save my ink, I'm hoping that this document will correct these recurrent errors before you make them!

Some comments are general; others relate to specific parts of the report and I shall attempt to divide them up along these lines. Beyond this, there is no particular order to the comments.

Summary

The summary should summarise the experimental objectives **and** the key findings, quantitatively where appropriate.

Remember: it should be possible to read the summary in isolation of the rest of the report, so don't include references to other sections, figures, graphs etc, or use any terminology or symbols whose meaning is not apparent.

1. Introduction

Try to set the work to be reported on in its engineering context. Mention any applications of the material covered by the experiment. If you can show some evidence of having referred to books in the library, it will strengthen this section considerably.

Reference other sources such as textbooks consulted according to the method described in section 4.3 of the *Structure of a Technical Report* handout (and not like this!)

Set out the objectives in this section.

2. Theory

Think about your reader. (S)he may not be familiar with the subject area. Give enough theoretical background so that sense can be made of the remainder of the core of the report (*Experiment, Discussion*). You may wish to reference the lab worksheet for lengthy derivations, or put these in an appendix. Short derivations are OK in the main text here - continually referring off to appendices can badly disrupt the flow.

3. Experiment

The reader is unlikely to ever actually carry out the experiment, so **avoid lists of instructions.** Rather, explain, with the aid of a diagram or diagrams how the apparatus worked - how did the apparatus enable you to make the necessary measurements?

Clearly describe the series of tests carried out.

4. Discussion

Report your results and observations. This is the place for error analysis. Do your results agree with what was expected, considering the error bounds that you have estimated? If not, what are the possible reasons for any discrepancy?

Tables of results, if included, should go in an appendix. Graphs can be included next to the relevant text. A good graph with error bars, following the guidelines in *Plotting Graphs*, may do away with the need to reproduce extensive tables of results.

5. Conclusions

This is the area which causes greatest difficulty and grief for you and me. ***Please*** review the handout on *Writing Conclusions*. Remember - the conclusions are a distillation of the material in the discussion, but should be readable in isolation of the "core" of the report.

Appendices

Appendix A should be the list of references, laid out in accordance with the guidelines in *Structure of a Technical Report*.

Graphs

I'm entirely happy with a good hand-drawn graph which conforms to the rules laid out in the "Plotting Graphs" handout. A colourful computer-generated graph which breaks all these rules will be penalised just as a poor hand-drawn graph would.

Other Common Mistakes:

Apostrophes (') denote possession, never the plural. The exceptions to the possession rule are hers and **its**. The latter is often incorrectly written "it's".

Reread your report carefully. Even one completely muddled and incomprehensible sentence can badly detract from the impression given to the reader. The placing of commas often causes difficulty - reading aloud what you have written *exactly as you have written it* should help to alert you to unnecessary or missing punctuation.

Use a spelling checker. As with muddled sentences, even the odd spelling disaster detracts from the impression created by your report.

Avoid using the 1st person, active ("I did...", "we did..."). Standard practice is to use the passive; "it was shown that...", "the experiment was carried out..." I don't really object to "we", but it's better that you get accustomed to the most conventional methods before branching out.