Technical Writing
ME 411 REPORTS

A powerpoint presentation developed by Dave Sailor

Your Audience

- At the very beginning… think about your likely audience.
- The level of motivation, and background required for a presentation depends greatly on the background of the intended audience.
- For this class – assume your audience has a similar technical background but has never seen the particular lab experiment that you are conducting.

Your Purpose

- Why am I presenting this work? What do I want the audience to get out of this presentation or paper?

- It's a good idea to formulate one or two simple "take-home messages" that you will try to impart to your audience.

Structure

- The structure of your presentation - either written or oral - is often dictated by others.

- With respect to oral presentations, you will often find yourself up against a strict time limit. In such a case it is important to rehearse your talk with a stop-watch in hand. Be sure that you can get your take-home message across without hurrying.

Word Selection

- Word choice is important. Project yourself as someone who has something important to say.
- Within the confines of your own personality you must strive to keep your words at an appropriate level for your audience.
- Do not use fancy or stilted language. At the same time, however, do not restrict yourself to simple and mundane modes of presentation.
- Choose your words such that they represent the most effective mode of communication for the intended audience.

- To facilitate optimum results in technical writing, endeavor to utilize uncomplicated phraseology.

Hmmm….

- To help you get the best results in technical writing, try to use simple language.

or...

- Use simple language to get the best results in technical writing.

Phrases

Don't include a lot of unncessary words! Keep things simple and short so that your readers can understand them easily. In the following list, replace the wordy phrase with the simple word or phrase that follows.

- **with regard to** → **about**
- **by means of** → **by**
- **in the event that** → **if**
- **until such time** → **until**
- **subsequent to** → **after**
- **an adequate number of** → **enough**
- **an excessive number of** → **too many**

Style

- There are several schools of thought on technical communication.
- Third-person past tense is generally accepted as the most formal grammatical style for technical reports. More recently, however, it is common to see 1st person (no person).
- In the case of this class, I am willing to accept either first or third person documents. Just be consistent in your writing.
- When you start working for a company you should try to determine the accepted format for internal reports.
- If you are writing for journal publication consult both the "Guide for Authors" and past issues.

More on Style

- Use of appropriate tense is often an area of confusion for students.
- There can (and should) be some mixing of past and present tense within a report.
- It is generally not a good idea to mix tense within a single paragraph or sentence.

Mixing Tenses

- The introduction section will focus on established theories and research that has been conducted in the PAST. This section is written mostly in the past tense. Near the end of the introduction you may decide to motivate the need for your research (and future research) and slip into present or future tense (Objective statement). Also, if you discuss an established fact it should be stated in present tense. For example consider the following statement:

Mixing Tenses

- The methods and results sections, on the other hand, will be almost completely in the past tense. This is work that you have completed. Exceptions include sentences where you simply give a "present tense" fact such as. "These results are shown in Figure 3." ... or in an active present tense voice ... "Figure 3 shows the results from...".

- The methods/procedures section of your reports should not be written as a step-by-step list of tasks. Rather, it should summarize the methods within the context of a paragraph of complete sentences.

- Your discussion and conclusions will start with a presentation of your findings (past tense) and may conclude with current observations (present tense) as well as a discussion of probable future work (future tense).

Common Report Formats

- There are a number of accepted formats for any type of document that you write.
- The commonly accepted standard for engineering reports is IMRaDC - Introduction - Methods - Results – Discussion- Conclusion/Summary.
- Your reports do not necessarily need to follow this format strictly, but should use this as a guideline, and contain all of the information discussed in the following slides.

Contents of a Lab Report for ME411

- Title page
  - Title – the name of the experiment or a slight variation that is representative of the content of the report
  - names of all team members (with affiliation – ME 411, PSU)
  - If discrete roles were assigned to each team member, indicate that in parentheses after the names
  - date
- Report (see following slides)
  - Sections contain: introduction/objectives, theory, methods, apparatus, results, discussion, and conclusions
- Bibliography (references)
  - List all references in a standard format.
  - All references should be referred to at the appropriate location in the report using a (name, year) format.
- Appendices
  - Detailed derivations and calculations
  - Error/uncertainty analysis
  - Original data

Format Example 1

- The following outline is good (although a little simplistic)
  - 1.0 Introduction (ends in objective statement)
  - 2.0 Methods and Apparatus
  - 3.0 Results
  - 4.0 Discussion
  - 5.0 Conclusions/summary

Format Example 2

- 1.0 Introduction
- 2.0 Theory
- 3.0 Methods and Apparatus
  - 3.1 Description of Models Tested
  - 3.2 Wind Tunnel Apparatus
  - 3.3 Calculation Procedure for Drag Coefficients
- 4.0 Results
  - 4.1 Data analysis procedures
  - 4.2 Drag Coefficients for the Hummer
  - 4.3 Drag Coefficients for the New Beetle
- 5.0 Discussion
  - 5.1 Comparison of aerodynamics of the vehicles tested
  - 5.2 Implications for fuel economy
  - 5.3 Implications for top speed

Titles

- The report title is more important than most people think.
- If you are interested in researching a particular topic, you will learn to appreciate authors who take care in crafting the title of their reports and articles.
- Your task in choosing a title is to **use as few words as possible to clearly describe the content of the report**.
- Very few good titles can be expressed in fewer than 5 to 8 words. You should, however, seek to keep the total number of words in your title to a relatively small number - say less than 20.
- It is also a good idea to read through your title and think about how it might be interpreted. More often than not titles are too broad, suggesting the authors did a more comprehensive study than they actually did.

Abstracts and Executive Summaries

not needed for short reports

- The title is the first level at which a potential reader can filter out reports that he is or is not interested in reading. The abstract is the second level.
- The abstract is generally limited to 250 words (or so). It must be a self-contained description of the experiment.
- Generally, the abstract will discuss the reason for and methods behind the study.
- It will also include a short summary of the most important results and conclusions of the paper.

Introduction and Background

- Provide your reader with background information on the topic of your paper.
- This section helps to get the reader "up to speed" if necessary.
- Readers who are very familiar with the general subject matter may often skip this section
- If your study builds upon work of others or requires the use of accepted formulae, this information should be provided in the introductory section of your paper.
- Theory may be introduced here, in a separate theory section, or in the methods section, depending upon your writing style.

Methods

- The methods section is used to discuss the specific approach (methods) used in your study.
- Discussion of an experimental apparatus is often included in this section in which case the section heading becomes something like "Methods and Apparatus".
- If the apparatus is sufficiently complex, a separate section is devoted to the apparatus.
- Also, there may be several distinctly different approaches used in your paper. In this case, you might have section headings such as "Experimental Methods" and "Computational Methods".

Apparatus and Procedures

- While the discussion of the apparatus and procedure are sometimes lumped together, this is not a necessity.
- Rule of thumb for level of detail: provide sufficient details so that a competent researcher could reproduce the significant aspects of your results.
- You'll often hear this referred to simply as "reproducibility".
- Produce and include **one or more original schematics** or diagrams of the apparatus.
- If you use images from others you MUST give them credit.

Results

- Take time to investigate trends with your results and to look at many ways of presenting your results
- Often, a simple plot of Y vs. X will miss the important features of your experimental results.
- However you choose to present the data, present the results describing key aspects in the "Results" section, and reserve broader comments and insight for the Discussion section.
- If you have few data to present then it may be appropriate to combine the Results, Discussion, and Conclusions sections.
- Likewise, if you have a great deal of data, you may choose to create subheadings.

Discussion and Conclusions

- If you simply present your results without providing any insight you are missing out on an important feature of technical report writing.
- You must interpret the results. How do the results compare with expectations (past research, literature, common sense...)?
- Also, are there any limitations in your apparatus or methods?
- What are the implications of your findings?

References

- Okay to quote or extract information from other sources … as long as you give proper credit
- Citation within text: (author, year)
  - "… This phenomenon was first noted by Smith (1988) who found…"
  - "… most such facilities operate at efficiencies of 80% or lower (Smith, 1988)." [Smith (1988), Jones (2000)]
- Reference list at end of document
  - Must have complete citation … for example:

    Chow, W. S. and C. T. Leung 1996. "Neural Network Based Short Term Load Forecasting Using Weather Compensation." *IEEE Transactions on Power Systems* **11**(4) 1736-1742.
  - avoid web references where possible – best to use permanent documents (peer-reviewed literature and text books)

Figures and Tables

- Figures and tables are the heart of your report. Don't sell the data short.
- Be sure your figures are carefully crafted and convey the right information
- All figures must have figure captions
- Provide axis labels
- Use a descriptive figure caption or table heading

How to edit a report (one viewpoint)

- 1. Do the experiment
- 2. Plot the raw data
- 3. Investigate trends and explore various data presentation possiblities.
- 4. Write an appropriate outline
- 5. Write the paper fairly quickly
- 6. Let the paper sit for at least ONE DAY!
- 7. Read the paper again with a critical eye. Edit as necessary.
- 8. Skim through the paper looking ONLY at the figures and tables. Do they tell the story?
- 9. Ask someone else to review your paper.
- 10. Do a final spell check (just before you print).

Technical Writing – common issues

- Title pages
  - Descriptive titles
  - Names, affiliations, who did what, dates (for individual reports make YOUR name stand out)
- Numbering
  - Pages, figures, tables, equations
- Introduction
  - Provide some context – when/why are strain gages used?
  - Overview of theory for gages – strain → resistance change → circuit
  - Overview of theory for beams
- Apparatus
  - Figure can include picture, but defining dimensions is rather important especially for the beam expt.
  - Pictures of every little item (e.g., weights, strain gage mounting supplies) not needed

Technical Writing – common issues

- Procedure section
  - Not a list of tasks to be done
  - Use past tense (what DID you do?)
- Figures
  - Figure #s with descriptive captions
  - Key figures in body of report not in appendix
  - Axis labels with units
  - Referenced in text : look for interesting behavior!
  - Measured vs. theoretical → 2 sets of data (strain vs. load) or 1 set (strain_m vs strain_t)
  - Font sizes in figures should be similar to those in text. If smaller, must be readable!

Technical Writing – common issues

- Equations
  - Number at right side – e.g., (1)
  - Eqn editor, Mathcad, Matlab…
  - Font size similarity
  - Within body of paper do not include long-hand expansions of equations (including data values in intermediate steps)

Original:

"Our first process with the results we obtained was to organize the data and calculate the actual head that the pump produced at each flow rate and motor speed. The head was calculated by determining the difference between the inlet and the outlet pressure."

Revised:

"The pressure head produced by the pump at each flow rate and motor speed was calculated."

Original:

"The head coefficient vs. flow coefficient plot in Figure 9 shows that all three pumps converge on a single line."

Revised:

"Figure 9 shows the results for the three pump speeds converge when plotted in non-dimensional form (head coefficient vs. flow coefficient). In fact, the data are consistently within 5% of the corresponding best fit line through the consolidated data set."

Original:

"The graph indicates a large discrepancy between the calculated and theoretical values."

Revised:

"Figure 3 indicates an average discrepancy of 16.5% between the calculated and theoretical values. This discrepancy, however, is within the estimated measurement uncertainty of +/- 20% (see Appendix A)."

Original:

"Once we determined the power output and input of the motor, calculating the efficiency was easy."

Revised:

"The efficiency of the pneumatic motor was calculated as the ratio of power output (Eqn. 1) to power input (Eqn. 2)."

Original:

"From these equations and data collected during the experiment tables and graphs were created to relate the motor speed (RPM) to the horsepower at that corresponding speed."

Revised:

"Equation (2) was used to relate motor speed to horsepower for the 30 and 40 PSIG data sets. These results demonstrate the existence of a peak in the relationship between horsepower and motor speed (see Figure 4). For the 30 PSIG case this peak is 0.25 HP at 2000 RPM. For the 40 PSIG case the peak is 0.34 HP at 2400 RPM."

Grading Worksheet for ME 411 Laboratory Reports

Student (s): _____ _____ _____

_____ _____ _____

Experiment # _____ **Points** _____ **out of 100**

Preliminary Pages (5pts)

Title is descriptive (main point clear) yet brief (3pts) _____
Title Page lists authors, class, lab section, and date (2pts) _____

General Text of Report (25pts)

Proper grammar and professional writing style are used (5pts) _____
Prose is free of spelling errors (2pts) _____
Prose is clear, concise, and specific (10pts) _____
Content is organized into sections that facilitate interpretation by readers (2pts) _____
Report is within page limits (1pt) _____
All pages are numbered and have adequate margins (2pts) _____
References provided as appropriate (including source of data) (3pts) _____

Introduction (8pts)

Motivation for the study/report is well developed (2pts) _____
Background information/theoretical development sufficient (3pts) _____
Objective of **the report** is clear and well defined (3pts) _____

Experiment and Methods (15pts) (sufficient to reproduce the results)

Key components and function of apparatus are described (4pts) _____
Procedure is clearly described (not just a bullet list of "do this" items) (5pts) _____
The range and accuracy of measurement variables is well defined (2pts) _____
Apparatus figure (schematic or labeled picture as appropriate) (4pts) _____

Results, Discussion, and Conclusion (26pts)

Results of analysis are presented clearly and are accurate (4pts) _____
Significance of results are discussed in the report body (4pts) _____
Appropriate use of uncertainty analysis and significant figures (4pts) _____
Plausible explanations given for discrepancies in results (5pts) _____
Conclusions are justified and represent a thorough analysis of results (4pts) _____
Evidence of higher level of thinking demonstrated (5pts) _____

Figures, Tables, and Equations (25pts)

Plots/figures are clear, legible, and labeled appropriately (6pts) _____
Graph axes and table column headings have meaningful labels and units (3pts) _____
Tables and figures have meaningful captions (stand alone) (4pts) _____
Main points of figures and tables discussed in report text (5pts) _____
Equations are correct, numbered, and professionally formatted (4pts) _____
Mathematical symbols are defined in words and units are clear (3pts) _____

Appendix (4pts)

Appendices are called out in the report body (1pts) _____
All appendices include a detailed introductory statement (1pts) _____
Raw data and summary calculations included and well documented (2pts) _____

Common Markings

Sp? or word circled = spelling error

Huh? = this sentence is so convoluted that I am afraid to hazard a guess what it means.

Common errors

1. What is the main point of the report? Is it a methods paper, a comparison between theory and experiment, experimental discovery, or theoretical development? The title to should indicate the primary focus (what you are supposed to get out of it) of the report.
2. Can it or can it not be? It either is or isn't, there is no can.
3. Be specific. Don't use vague words such as small, large, some, few, etc. Just state the actual number or range.
4. Poor word choice/incorrect word or odd word choice. Does the word meaning really fit?
5. Appendices need to be mentioned in the body of the report. Plus, all appendices need an introductory paragraph describing what is in the appendix.
6. Enough with the prepositional phrases. If too many phrases follow each other it is confusing as to what noun each phrase is modifying. Also, is the modifier misplaced? Is it modifying the word it is supposed to?
7. Can the proposed errors be quantified? Do we know how much of an effect these would have on the results? A few %, 50%, 100%?
8. The word "allowed" implies permission was granted. Permission isn't granted by inanimate objects.
9. Call out figures and tables in the report body as Figure X at the start of a sentence and Fig. X within a sentence. Tables are always Table X. Discuss in the report body what the figure/table is showing. Figures and Tables should be numbered (1,2,3...) as they appear in the report. You do not need to say a figure or table is below or above. It has a number, use it. The text describing a figure/table is located before the figure/table appears in the report.
10. What is the main point of the figure/table?
11. And the point of this is? Every sentence, paragraph, and section should have a point.
12. You are implying that the subject in the sentence is doing something when it actually can't do anything because it is an inanimate object.
13. Casual speak. Not really professional phrasing. The word "you" should never occur in a report.
14. The use of hard words (never, always, etc.) should be avoided.
15. Are the results within error?
16. Inappropriate use of significant figures. Can you really measure a value to the precision implied by the number significant figures reported?
17. Redundant. Combine these sentences/sections
18. Don't abbreviate, spell out.
19. Proper citation of reference is needed.

20. Obvious to the point of being meaningless. Irrelevant comment.
21. Verb tense or verb/noun mix up.
22. Number every equation and put equation on its own line.
23. See previous figure/table for same comments.
24. Define variables/terms
25. Label figure
26. Meaningless detail. The information provided is expected.
27. This is written as instructions. It should be what you did.
28. Cite reference where equation was developed.
29. If equation is following sentence it is mentioned in, it doesn't need to be called out in that sentence.
30. Procedures are not presented as bullet points. Use paragraph form.
31. Describe equation presented with words.
32. Specify accuracy of measured variables, how the value is being measured, and what the measurement was (possible range?)
33. Summary/conclusion should not include Figures and detailed discussion.
34. Grammar/syntax error
35. Wordy
36. Unnecessary detail. Is it relevant to reproducing the results?
37. Are these details (or is this level of detail) necessary to reproduce the results?
38. Figure/table issues
    a. No figure caption or insufficient figure caption. The figure caption should include the key points of the figure to be noticed. A figure caption is required for every figure and should be located below the figure and start with "Figure X. *caption here*".
    b. No Table caption or insufficient table caption. A table caption is required for every table and should be located above the table and start with "Table X. *caption here*"
    c. Legend should be inside the plot area and the graph expanded so that it is easier to read.
    d. Data points are not connected with lines. Theory and computational results are given by lines.
    e. Missing or non-descript axis label. Further detail is needed to completely define the axis.
    f. Units needed on the figure axis or if present an alternate unit would be better (for example instead of having 0.0008 on the axis with meters as the unit use 0.8 with millimeters-mm as the unit.)
    g. Title is unnecessary as it is redundant with the figure caption. If a title is included it should be unique. Usually titles are only necessary when you have multiple plots in a single figure.
    h. If more than one data set, or more than one item (data, computation, theory) is being shown on a figure, a legend is required to identify separate data, theory, or computations.

i. Adjust the axis range so that the graph shows the actual region of interest of the data. Don't waste valuable space.
j. Variables or abbreviations are used in the figure but not defined. It is best not to use a variable/abbreviation but to spell out a parameter/term. For example don't use μ but write out viscosity. μ may have different meanings to different readers.
k. Axis labels should not run through the middle of the plot. Put labels on the side and bottom of the plot.
l. No border around the entire figure
m. Font or data points are too small. They need to be bigger. Font should be 10pt and symbols should be large enough to see easily.
n. If a curve fit is applied to data then the fit (curve equation and R^2 value) is included; you wouldn't be showing the curve fit if it wasn't important.
o. Symbols should be distinct and visible at all times. Use open symbols if data falls on top on each other because a filled square will completely cover a filled triangle or diamond.