Technical writing

• Journal paper
• Thesis
• Dissertation
• Report

• Project statement
• Project specifications
• Design memo, proposal, report
Elements of a Technical Report

• Title
• Abstract (Executive Summary)
• Introduction
• Theory and Analysis
• Experimental Procedures
• Results and Discussion
• Conclusion(s)
• Acknowledgments
• References
• Appendix
Writing Mechanics

- Check Spelling
- Check Grammar
- Minimize the use of Acronyms
- If Acronyms are necessary, always define them at the first use
- Number all equations, tables, and figures
- All tables and figures must have captions.
- All figures must have labeled axes
- All quantities must have units
- Try to avoid footnotes
Writing Style

• Depends on the audience

• More Lively Writing (usually preferred)
  – First Person, Active Voice, Past/Present Tense

• More Formal Writing
  – Third Person, Passive Voice, Past/Present Tense

• Never use slang
Writing Style

• **Use First-Person, Active Voice, Past Tense or Third-Person, Passive Voice, Past Tense**

  • **Not Recommended:** Clean the gallium arsenide substrates by boiling them in trichloroethylene.
  
  • **Not Recommended:** I clean the gallium arsenide substrates by boiling them in trichloroethylene.
  
  • **Acceptable:** The gallium arsenide substrates were cleaned by boiling in trichloroethylene.
  
  • **Recommended:** We cleaned the gallium arsenide substrates by boiling them in trichloroethylene.
Clarity: Word choice

I would never use a long word where a short one would answer the purpose. I know there are professors in this country who ‘ligate’ arteries. Other surgeons only ‘tie’ them and it stops the bleeding just as well.

Oliver Wendell Holmes (1809-1894), Dean of Harvard Medical School
• Improve your grammar and style
  – Read “The Science of Scientific Writing”
  – Quote: “If the reader is to grasp what the writer means, the writer must understand what the reader needs.”

• Organize your paper
  – Read “Critical Reading Towards Critical Writing”
  – Quote: “… ask "How does this text work? How is it argued? … How does the text reach its conclusions?”
Organization

Figure 7  Overall organization of the research paper (Hill et al., 1982).
Writing the Report: An Approach

- Results come first
  - Your results are the heart of your paper
  - Begin by analyzing and understanding your data
  - The results section includes:
    - Figures/diagrams/plots (labeled, captioned and titled)
    - Data you didn’t expect
    - Your description of your figures
    - No interpretation or conclusions

Material from J. Stickgold-Sarah
Writing the Report: An Approach

• Results section:
  – Use tables and graphs
  – Consider moving large quantities of raw data, detailed derivations, or code to an appendix
  – Methods of plotting which produce well delineated lines should be considered
  – Results should be critically compared to theory
  – Consider limitations in the theory and engineering tolerances
Writing the Report: An Approach

- What happens in the discussion?
  - The Discussion ties back to the Introduction
  - Talk about how and why you did or didn’t confirm your hypothesis
  - Unexpected results
  - Speculate here!
  - Claims are grounded in results and background material in Introduction

Material from J. Stickgold-Sarah
Writing the Report: An Approach

• Now you are ready for the introduction
  – Brief background, enough to understand your **hypothesis**
  – State your hypothesis and your conclusion
  – Intro is not a substitute for the report, and so does not echo the abstract
  – Here is the place for context, relation to prior work, general objective, and approach

• Next: title, abstract, conclusions and other sections

Some material borrowed from J. Stickgold-Sarah
Title and Abstract

• Title gives understandable label for area of inquiry

• Abstract or Executive Summary:
  – Abstract is a mini-paper (often around 200 words)
  – Think of it as a substitute for the report for a busy reader: what if your reader has only access to the abstract?
  – Purpose, Findings, Impact
    • Sentence One: expand on the title
    • Sentence Two: why the work was done
    • Remainder: key results, with numbers as appropriate, conclusions, recommendations

Some material borrowed from J. Stickgold-Sarah
Checklist: Parts of an Abstract, Koopman CMU 1997

Motivation: *Why do we care* about the problem and the results?

Problem statement: What *problem* are you trying to solve? What is the *scope* of your work (a generalized approach, or for a specific situation)?

Approach: *How did you go about solving* or making progress on the problem? Did you use simulation, analytic models, prototype construction, or analysis of field data for an actual product? What was the *extent* of your work?

Results: *What's the answer?* Put the result there, in numbers. Avoid vague, hand-waving results such as "very", "small", or "significant."

Conclusions: *What are the implications* of your answer? Is it going to change the world (unlikely), be a significant "win", be a nice hack, or simply serve as a road sign indicating that this path is a waste of time (all of the previous results are useful). Are your results *general*, potentially generalizable, or specific to a particular case?
Example: Savage, S. Eraser: A Dynamic Data Race Detector for Multithreaded Programs. ACM Transactions on Computer Systems, 15 (4) 391-411

**Describe** your field:
Multithreading has become a common programming technique.

**Explain** why your problem matters
Unfortunately, debugging a multithreaded program can be difficult.

**Summarize** prior research:
The difficulties with using threads are well summarized by John Ousterhout.

**Propose** your solution:
In this article we describe a tool, called Eraser, that dynamically detects data races in multithreaded programs
Conclusion

- Similar to abstract or executive summary
- Must be concise
- Reinforces key ideas formed in discussion
- Includes recommendations for future work, such as implementation of a design
- Indicates the validity range of the results (general, generalizable, particular)
Theory and Analysis

• Briefly describe the theory relevant to the work
• Provide design equations
• Include calculations and computer simulation results
• Provide values for all key parameters
Experimental Procedures

• Describe Apparatus and Materials
  – Diagram of apparatus goes here (add a photo)
  – Open with an overview of the experimental design

• Show test setups

• This section should allow any electrical or computer engineer to duplicate your results:
  – Repeat experiment
  – Validate experimental design

Some material borrowed from J. Stickgold-Sarah
Figures and Tables

• Every figure must have a caption
• All tables must have a title
• Figure/tables are placed after they are mentioned in the text
  – All must be mentioned/discussed
  – Summarize their data in the text
• Make figures/tables first, and then insert into the text
• Put the figure/table number beside its title, and put this in a standard location
• Don’t start a sentence with an abbreviation: Figure vs. Fig.
Tables, Graphs, and Figures

- Every figure must have a caption.
- Each table must have a title.
- Figure/tables are placed after they are mentioned in the text.
  - All must be mentioned/discussed.
  - Summarize their data in the text.
- Make figures/tables first, and then insert into the text.
- Put the figure/table number beside its title, and put this in a standard location.
- Don’t start a sentence with an abbreviation: Figure vs. Fig
Table 1. Material Properties for GaAs, InAs, and the alloy InₓGa₁₋ₓAs.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>GaAs</th>
<th>InₓGa₁₋ₓAs</th>
<th>InAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>a (nm)</td>
<td>0.56534</td>
<td>0.56534 + x(0.04050)</td>
<td>0.60584</td>
</tr>
<tr>
<td>b (nm)</td>
<td>0.39976</td>
<td>0.39976 + x(0.02864)</td>
<td>0.42839</td>
</tr>
<tr>
<td>Y (GPa)</td>
<td>124</td>
<td>124 – x(45)</td>
<td>79</td>
</tr>
<tr>
<td>G (GPa)</td>
<td>32</td>
<td>32 – x(13)</td>
<td>19</td>
</tr>
<tr>
<td>ν</td>
<td>0.31</td>
<td>0.31 + x(0.04)</td>
<td>0.35</td>
</tr>
<tr>
<td>θ (degrees)</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>λ (degrees)</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>φ (degrees)</td>
<td>35.26</td>
<td>35.26</td>
<td>35.26</td>
</tr>
</tbody>
</table>

Table 2.15. Surface Free Energies for the Low Index Faces of Cubic Crystals at 300K, in erg/cm².

<table>
<thead>
<tr>
<th>Material</th>
<th>γ(001)</th>
<th>γ(011)</th>
<th>γ(111)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1900</td>
<td>1300</td>
<td>1100</td>
</tr>
<tr>
<td>Si[29]</td>
<td>3600</td>
<td>2500 (1900)</td>
<td>2100 (1400)</td>
</tr>
<tr>
<td>Ge</td>
<td>3000</td>
<td>2100</td>
<td>1200</td>
</tr>
<tr>
<td>α-Sn</td>
<td>1700</td>
<td>1200</td>
<td>1000</td>
</tr>
<tr>
<td>GaP[29]</td>
<td>2800</td>
<td>2000 (1800)</td>
<td>1600</td>
</tr>
<tr>
<td>GaAs[29]</td>
<td>2400</td>
<td>1700 (860)</td>
<td>1400</td>
</tr>
<tr>
<td>InSb[30]</td>
<td>1300 [1100]</td>
<td>900 [750]</td>
<td>800 [600]</td>
</tr>
<tr>
<td>ZnS</td>
<td>1500</td>
<td>1100</td>
<td>900</td>
</tr>
<tr>
<td>ZnSe</td>
<td>1400</td>
<td>1000</td>
<td>800</td>
</tr>
<tr>
<td>ZnTe</td>
<td>1300</td>
<td>900</td>
<td>800</td>
</tr>
<tr>
<td>CdTe</td>
<td>450</td>
<td>320</td>
<td>260</td>
</tr>
<tr>
<td>HgS</td>
<td>800</td>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td>HgSe</td>
<td>800</td>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td>HgTe</td>
<td>800</td>
<td>600</td>
<td>500</td>
</tr>
</tbody>
</table>

Note: The values in parentheses were determined experimentally, and the values in square brackets were calculated using the heat of sublimation. Other values were estimated using the elastic moduli.


Graph: examples

Figure 5.66. Threading dislocation density versus epitaxial layer thickness, for several mismatched heteroepitaxial material systems. The data are from Sheldon et al.\textsuperscript{189}, Ayers et al.\textsuperscript{182}, Akram et al.\textsuperscript{183}, and Kalisetti et al.\textsuperscript{184} as indicated in the legend.

Figure 2.4. Zinc blende crystal structure. The white and black atoms belong to the two different sublattices (e.g., Ga and As).


Figure 2.25. Plastic dual in-line package (PDIP) with 20 pins.

Numbers-1

• In general, write out numbers below 10.
  o One trial run (not 1 trial run)
  o Nine transistors (not 9 transistors)

BUT

  o 2 meters, $3 (numbers with units)
  o Page 3 (page numbers)
  o 5% (percentages)
Numbers-2

• With several numbers in the same section, we generally use numerals for clarity.

Example:

The full-scale system contains 2 microprocessors, 15 resistors, and 6 capacitors.

(But, one could write: two microprocessors, five resistors, and six capacitors.)
Numbers-3

• Write large numbers in an easy-to-understand format.

Examples:

2 million smartphones instead of 2,000,000 smartphones (but 2,345,897)

2 kHz (rather than 2,000 Hz)
Numbers-4

• Place a hyphen between a number and a unit when they modify a noun.

Examples:

A 15,000-volt transmission line

A 5-foot-long banner
Numbers-5

• Write fractions and decimals as numerals.

Examples:

0.92 (not zero point ninety two)

¼ (not one-fourth)
• Do not inflate the accuracy of your number.

**Example:**

0.92 – depending on the actual quantity accuracy *(not 0.92341560 as may pop out of your calculator)*
Numbers-7

• Use the singular form when fractions or decimals less than one are used as adjectives.

Examples:

0.92 pound (not pounds)

¼ mile (not miles)
Numbers-8

- If a number is an approximation, write it out.

Examples:

(Roughly) twice the pressure

(About) half a glass of water (*not* 0.5 glass of water)
Do not begin a sentence with a numeral. Rewrite it instead.

Example:

No: 2,000 students were present in the room.

Yes: There were 2,000 students in the room.
We used 3 potentiometers and 4 op amps in our design.

We used three potentiometers and four op amps in our design.

The overall gain of our circuit was three.

The overall gain of our circuit was 3.0.
Acknowledgements

• Keep track of those to be acknowledged-keep a diary so that you don’t forget anyone
• Include: your sponsor, outside sources (companies or agencies), other departments on campus, individuals outside of your team who have helped, any scholarships received
• Be brief
References

• Various formats have been developed. Pick one you like such as the IEEE Transactions format
• Decide on a sequence, such as the order they appear in the text
• Always give full references such that others may find the item

Bibliographic software tools: endnote, refworks, mendeley, etc automatically create bibliographies in any desired order (and format
References (examples)


Plagiarism

- Never take the work of others without giving proper credit
- Never take verbatim sentences/paragraphs from the literature
- If you feel that you must use verbatim material, use quotation marks and a reference. Do this sparingly!
- There are search engines that can find if material has been stolen. Professors fail students who do this. Additional disciplinary action may follow.
Top Quote from ECE Engineering Reports.

#3 “…the power rating was doubled by about a factor of 2.5…” Joe Doe, Spring 2000

The names have been changed to protect the innocent.
References

Sample 1: This experiment will determine what will make enzymes effective and what will make them ineffective. We tested different samples of enzymes in a spectrophotometer and recorded their absorption rates. Six samples were placed in the spectrophotometer but two contained no enzyme; these acted as blanks for the other samples. The four remaining samples contained Catecholase ranging from 0.5 ml to 1.75 m. The second half of the experiment contained four test tubes with a constant amount of Catecholase, but the pH levels ranged from four to eight. It was found that if the enzyme was present in large amounts, then the absorption rate was high, and if the pH level ranged from 6 to eight then the absorption rate was high. Therefore it can be said that enzymes work well in neutral pH levels and in large amounts.
Sample 2: This experiment was performed to determine the factors that positively influence enzyme reaction rates in cellular activities since some enzymes seem to be more effective than others. Catecholase enzyme activity was measured through its absorption rate in a spectrophotometer, using light with a wavelength of 540 nm. We compared the absorbance rates in samples with varying enzyme concentrations and a constant pH of 7, and with samples with constant enzyme concentration and varying pH levels. The samples with the highest enzyme concentration had the greatest absorption rate of 95 percent compared to the sample with the lowest concentration and an absorption rate of 24 percent. This suggests that a higher concentration of enzymes leads to a greater product production rate. The samples with a pH between six and eight had the greatest absorption rate of 70 percent compared to an absorption rate of 15 percent with a pH of 4; this suggests that Catecholase is most effective in a neutral pH ranging from six to eight.