Lecture Notes: October 4, 2002

Technical Writing:
How to Translate Data into a Written Presentation of Your Findings

Quantitative Physiology: Cells and Tissues
Massachusetts Institute of Technology

Fall 2002

Goals of technical writing

Technical writing is a highly-specialized way of writing for technical audiences.
The goal in writing a technical report is readability (not self-expression).

Readability means:

- clear, simple prose that is not laden with jargon or vague expressions
- standard format so it is easy to locate data and to compare experiments (methodology, results, etc.)
- appropriate use of technical vocabulary
- effective document design and use of figures

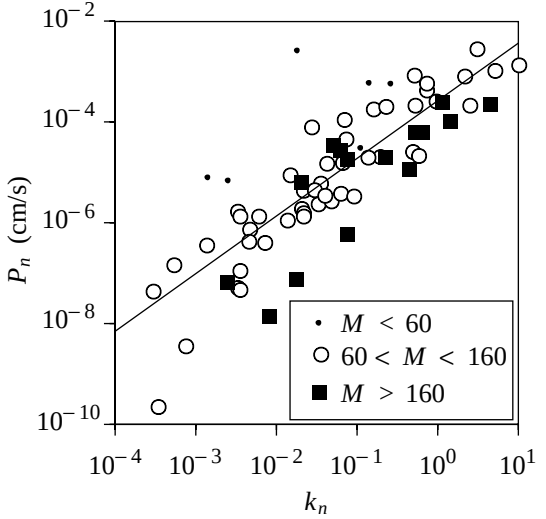
Why use a standard format?

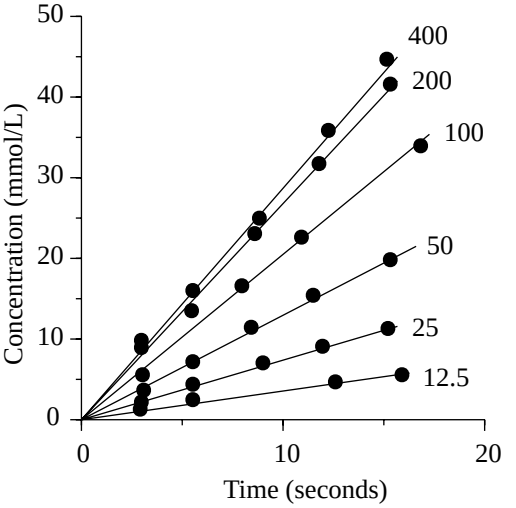
- easy to write? No.
- easy to read? Yes. Optimized for reading.
- good for science: disciplined approach to presentation forces writer to separate results from opinions

Step 1: Organize your data

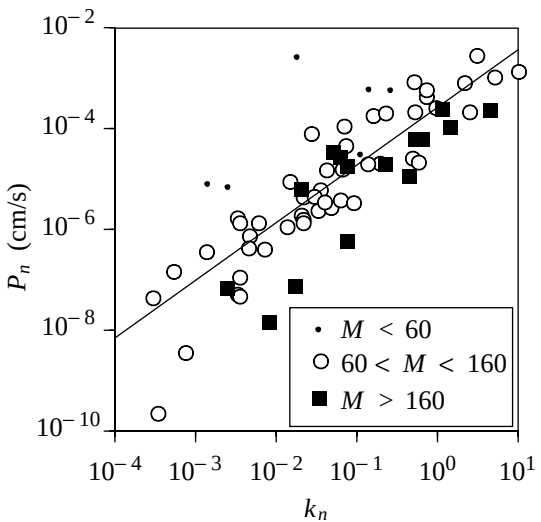
Start with figures

- assemble hard copies of your figures in a "story board"
- figure out the major technical theme of the report
- assess how each figure contributes to the major theme
- REVISE figures to focus on the major theme
  (develop figures that summarize the major them)





Step 2: Locate trends in your data, and isolate specific results



Determine 2-3 points that you want the reader to see in each figure.

- clear support for dissolve and diffuse theory
- lots of scatter ∴ dissolve/diffuse not the whole story
- big outlier = water ∴ water not transported by dissolve/diffuse

  – these are discussion points!
  – what to put in results?

Results are unambiguous truths.
Determine 3-4 unambiguous truths to describe in Results.
These unambiguous truths should support your discussion points.

Plan Methods section: what methods did you use to determine the unambiguous truths?

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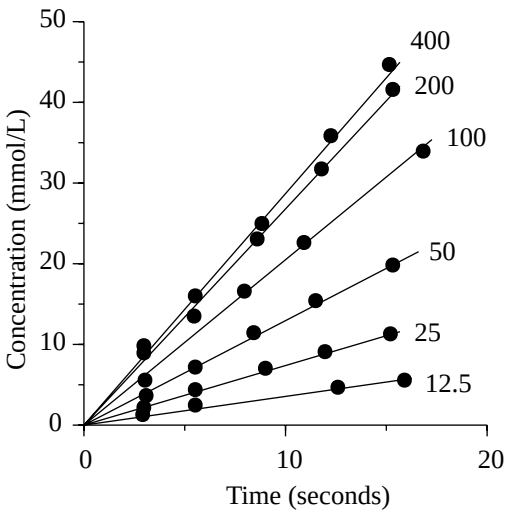

Methods
- measuring concentration
- fitting straight lines to data

Results
- each dot represents ...
- the lines represent ...

} caption

- for each cell, concentration increases nearly linearly with time
- slope of "25" line approximately double that of "12.5" line
- slope of "400" line approximately equal to that of "200" line

Discussion
- small concentrations → Fick's law
- large concentrations → saturation
- not consistent with dissolve and diffuse model

Step 3: Develop a plan to write the report

- Divide the work based on each team member's skills

- If you divide the writing process, use the following division for better coherency in your work:
  - writer 1: Methods + Results
  - writer 2: Discussion + Introduction
  - together: Title, Abstract, References, Proofreading

- Revise: read each other's sections and modify to build coherency.

- The best reports
  - Introduce a topic
  - describe Results of research on the **same** topic
  - present a Discussion of how the research advances the **same** topic
  - only describe Methods that were actually used to determine Results

} all sections interact

Step 4: Draft the report

Methods

The Methods section describes the FINAL APPROACH that you took to your experiment. The methods should be organized topically and detailed thoroughly such that a reader could reproduce your experiment.

SAMPLE (to show topical organization)

3.1 Experimental Setup
The dissected nerve was placed in the chamber, properly secured, and the chamber was covered according to the procedures outlined in the lab manual [1].

3.2 Experimental Procedure
The control experiment consisted of five measurements of the CAP in the absence of an external resistor. Their waveforms were recorded and saved. An external resistor was then placed in parallel with the nerve by ...

3.3 Data collection and Error Analysis
The waveforms were analyzed using MATLAB. The minimum and maximum voltages of each waveform, as well as the time to reach tese values, were calculated ...

Results

The Results section DESCRIBES but does not interpret the major findings of your experiment. Present the data using graphs and tables to reveal any trends that you found. Describe those trends. Negative results are results and are worth including in your report.

SAMPLE RESULTS

3.1 Alcohol Concentration of 0.06%

The response peaks decreased as the nerve responded to a small amount of alcohol over time (Figure 3). The amplitude of the impulse is plotted for 2, 4, and 6 minutes after application of the 0.06% solution. These times were chosen because there was a distinct change in the amplitudes at these times. The amplitude finally reached its maximum value 6 minutes after the initial application, after which it began to return to normal. The first positive peak was due to the stimulus artifact (and can be ignored), therefore the alcohol contributes to the remainder of the peaks and the response of the nerve.

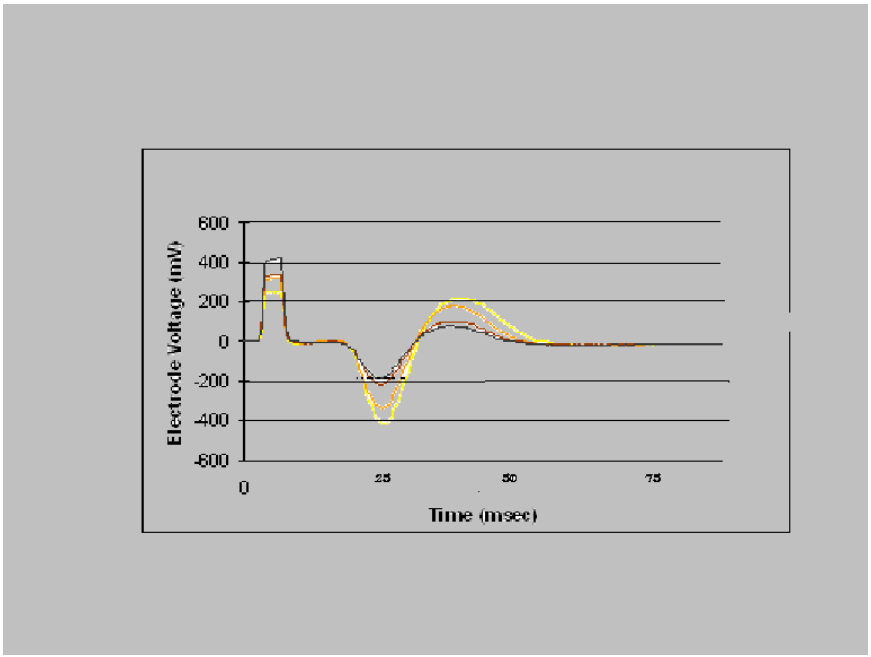

Figure 3: The stimulus response from an addition of 0.06% alcohol. The maximum value reached is a decrease in the absolute magnitude of the peak and occurs after the alcohol is allowed to settle for 6 minutes. The offset was added in order to center the resting potential at 0.

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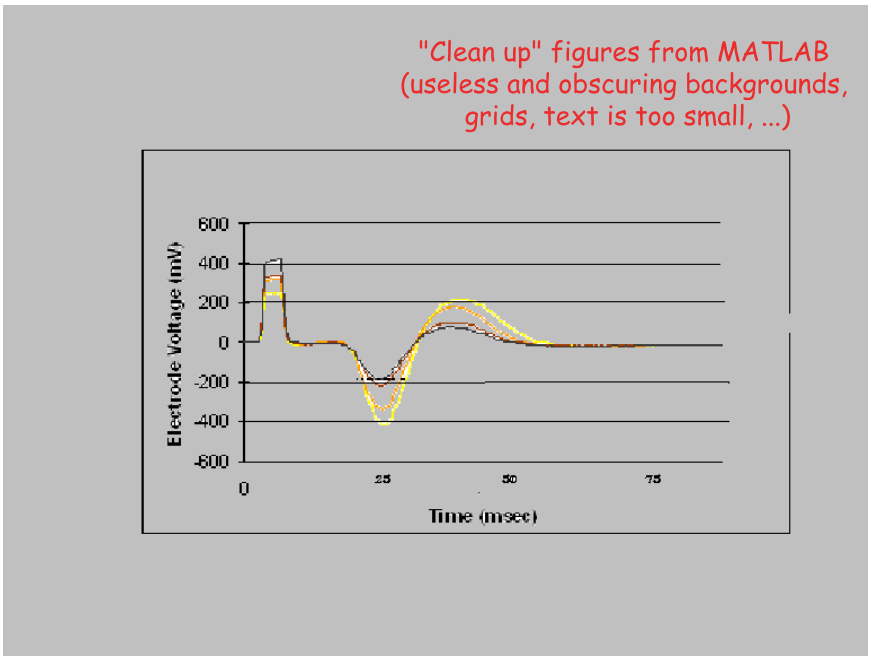

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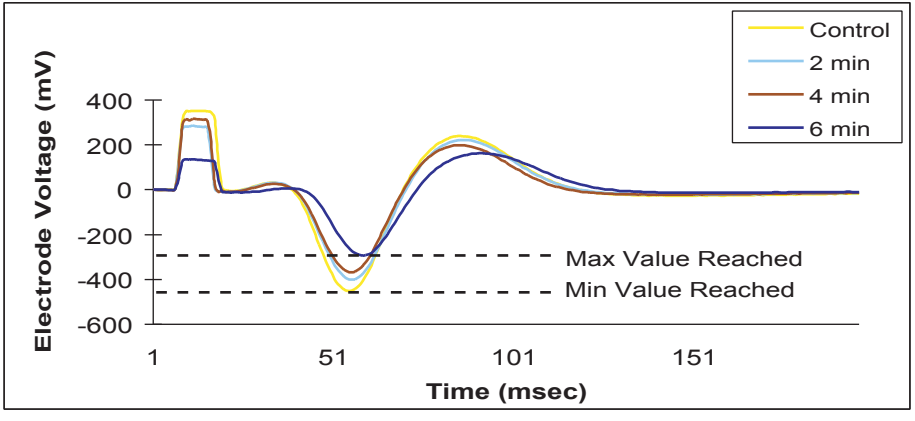

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Discussion

The Discussion offers your interpretations and conclusions about your findings. Use evidence from the results to support your discussion. Explain limitations: questions left unanswered, major experimental constraints, lack of correlation, negative results.

- How do your results relate to the goals of the study, as stated in your introduction?
- How do they relate to the results that might have been expected from background information obtained in lectures, textbooks, or outside reading?

SAMPLE DISCUSSION

The results confirm that the peak negative amplitude decreases with higher concentrations of alcohol. Furthermore, there is a limit after which the nerve no longer generates a compound action potential. These basic observations lead to two fundamental conclusions. First, as a larger percentage of alcohol is consumed in the blood, the function of the nerve is impaired drastically, particularly after the level exceeds 0.08%. Second, . . .

Beyond these basic findings, our results suggest how the function of the nerve is impaired by larger alcohol concentrations. We find that a logarithmic relationship exists as determined by the graphing methodology in Section 2.4. Figure 7 below illustrates this trend:

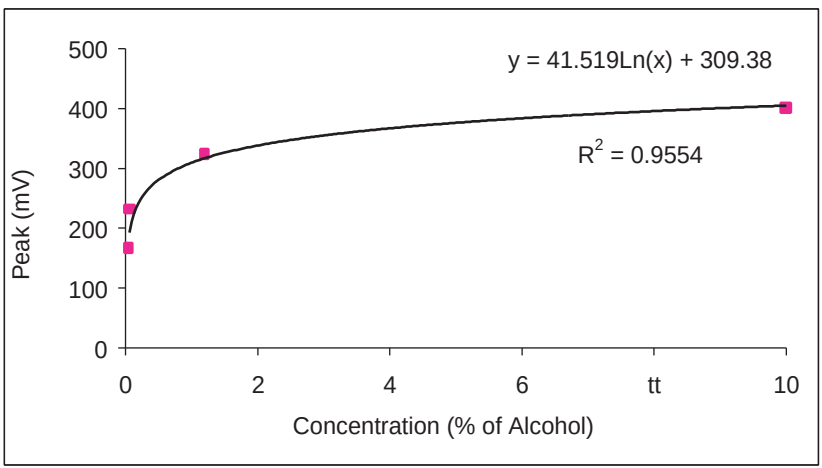

Figure 7: Peak vs. Concentration

Introduction

The introduction (no more than 1 page) explains the rationale for **your** study (not a summary of 6.021J). The Introduction follows a funnel style, such that readers can easily follow the link between the problem, prior research, and your research question.

- What is the problem you want to address?
- How does this experiment relate to other research?

SAMPLE 1 (good? bad?)

Hot weather reduces performance levels of atheletes, especially those in endurance sports. In the extreme, heavy exercise in desert conditions can lead to cognitive disorientation, convulsion, stroke, and death. These reactions to heat could result because heat directly affects neurons, respiration, circulation, or any of a large number of other physiological systems. In this report, we investigate the possibility that heat has a direct effect on neural conduction.

SAMPLE 2 (good? bad?)

The sciatic nerve is a peripheral nerve that connects proximally to the spine and distally to the phalanges (toe). It conducts both afferent and efferent messages through both myelinated and unmyelinated fibers. Conduction velocities are typically bigger for myelinated fibers than for unmyelinated fibers. Electrically evoked responses are called compound action potentials (CAPs), and respresent a powerful tool for neurological studies.

Step 5: Edit for completeness and organization. Select a title.

- Is all relevant information included?
- Are there irrelevant sentences, paragraphs, sections, plots, ...?
- Where might readers have questions?
- Is each section divided logically using subheadings?
- Does the information link clearly across sections?

Title

- Informative, specific, understandable at a glance
- "The Effect of . . ." titles usually are not specific enough because they do not isolate the variable you are testing or the effect you observed

SAMPLE TITLES (some good, some bad ... which are which?)

- The Compound Action Potential of the Frog Sciatic Nerve

- Amplitudes of Compound Action Potentials Show Saturating Dependence on Input Amplitude

- The Effects of Ethanol on the Compound Action Potential of a Frog Sciatic Nerve

- Nonlinear Increase in the Amplitude of the Compound Action Potential of the Frog Sciatic Nerve as a Function of External Resistance

Step 6: Write the abstract. Add End Matter and TOC.

Abstract

The abstract is a one paragraph (<150 words) summary of the report, including the summary of methods used, the principal results, and conclusions. For 6.021J use an informative abstract, i.e., an abstract that includes results of your research.

SAMPLE ABSTRACT

For marathoner runners, exposure to hot and humid conditions has ultimately led to less-than-ideal race performances. The effect of temperature on the body and especially working muscles is an area of interest for runners and physiologists alike. In fact, muscle contractions result from action potentials. In this experiment, the emphasis was placed on determining the effects of temperature on action potentials. Trials were conducted such that the application of Ringer's solution upon the nerve alternated between using solution at room temperature and solution at 90^{o}F. A voltage stimulus was then given to the nerve under both room temperature conditions and 90^{o}F conditions, and the CAP was recorded. It was found that an increase in temperature led to a larger and earlier compound action potential.

End Matter

- Works Cited - IEEE style
- Appendices
  - notes taken during laboratory session
  - final proposal
  - copy of your critique of peer report
  - peer critique of your report
  - technical staff critique of your report
  - writing staff critique of your report

Step 7: Proofread

- Proofread a printed copy of your report.
- Each partner should proofread the report.
- Check page numbers and page breaks.
- Are all elements printing correctly?
- Check section numbering.

Writing Resources

6.021J Report and Proposal Guide
Available at the course homepage

The Mayfield Handbook of Technical and Science Writing
http://web.mit.edu/course/21/21.guide/www/home.htm

Grade for Frog Laboratory Report

First draft (10%).
A: complete first draft, acceptable as final draft.
B: significant work, but not acceptable as final draft.
C: few results, few graphs, incomplete descriptions, missing sections.

Critique (5%).
A: helpful high-level comments (e.g., suggesting major restructuring, new figures, ...)
B: helpful low-level comments (e.g., grammar) but few helpful high-level comments.
C: few helpful comments.

Protocol (5%).
A: sufficient information to recreate experiment.
B: more than a dozen significant events recorded.
C: fewer than a dozen significant events recorded.

Report Structure (10%).
A: all information is well organized in proper sections.
B: overall organization is understandable but could be improved in one section of the report or in minor instances throughout the report.
C: misplaced information in more than one section of the report, incorrect citation style, and/or repeated organizational problems that interfere with report coherence.

Clarity and Conciseness of Exposition (10%).
A: content of each paragraph is readable with clear, simple prose and appropriate use of technical language. Each graph clearly supports the prose.
B: content of report is readable with minor slips in clarity or a single unclear section.
C: repeated wordiness or lack of clarity, poor presentation of visual information, and/or an acculmulation of stylistic errors that vinterfere with report readability.

Clarity and Conciseness of Technical Information (10%)
A: technical flow is clear: introduction motivates a topic, results focus on that topic, conclusions follow from results, relevant methods are described.
B: no more than one major lapse in technical clarity.
C: more than one major lapse in technical clarity.
Reports should be less than 10 pages long, unless there are good reasons for additional pages.

Conceptual Correctness (20%).
A: interpretations of results are technically correct.
B: interpretations are not well supported.
C: major errors.

Insightfulness (30%).
A: Clever experimental design or imaginative analysis.
B: Clear understanding of your experiment and analysis.
C: Standard experiment; unmotivated measurement and analysis.

Phase II Writing Requirement Cover Sheet

6.021J Quantitative Physiology: Cells and Tissues

In order to receive Phase II credit for 6.021J, please read and complete the following requirements:

- Phase II credit for this subject is only available for Course 6 students. If you are not a Course 6 major and wish to receive credit for your work in this subjecct, please see your advisor.
- Reports must receive a "B" or better in order to be used for Phase II credit.
- Phase II papers should include, at least, 1800-2500 of single-authored words (8 double-spaced pages).
- If you meet the above criteria and wish to submit your work for Phase II credit, please include a Work Plan for both reports, documenting your writing work. Attach this Work Plan to the graded final copies of your reports and return to Mya Poe, Office of the Writing Requirement.

Deadline for submisions: Registration Day, Spring Semester, 2003

6.021J AUTHOR GUIDELINES

CONTENT: A lab report in 6.021J Quantitative Physiology is a description and analysis of your research. The primary audience of your report is other 6.021J students. It is expected that your research was jointly conducted and authored. We do not expect you to reach grand theories or expect all your research to be successful. We do expect you to offer a rationale that explains why this research is relevant, provide a detailed and accurate methodology description, disclose your results, and discuss reasons why your experiment succeeded or failed by linking that discussion to your results and methods.

STYLE: We prefer an informal but not colloquial style of writing to a textbook style or jargon-laden prose. You may use occasional instances of personal pronouns in your report. Your readers, the students and faculty of this course, all have some background in this subject, but only a very small percentage are experts. A clear conceptual discussion is far better than a plethora of technical details that have no over-arching meaning or organization.

MANUSCRIPT FORMATTING: All pages should be numbered, beginning with the first page of the report body. Please include a Cover Page that includes authors' names as well as title of your report and submission date. Please include your Abstract on this Cover Page. Do not number the Cover Page. Every report needs to include in the body the following major section headings: Introduction, Methods, Results, Discussion. Within each of these sections, you may use more descriptive subheadings. A Table of Contents is optional.

LENGTH: Please limit your reports to 3,500 words. We prefer single-spaced texts with clear page breaks. Appendices are not included in the word count limit. Avoid lengthy Appendices as most readers will not read them carefully.

FIGURES: We recognize that sometimes "a picture is worth a thousand words," but avoid the gratuitous use of figures in your results. Five to 10 figures should be sufficient for your report. Use figures to synthesize results and show trends or comparisons across findings. Integrate your figures with your text to create a "story" between text and figure. Large figures should not run across pages. Each figure needs to be numbered and include a caption and label. Please "clean up" your figures from MatLab by removing unnecessary grid lines and shading. In addition, please make figures legible by using a 10 or 12-point font size for captions and axis labels.

REFERENCES: You need at least one reference for your report. Most 6.021J students reference the Weiss text. Many reports also include references to research in the Introduction.

FURTHER RESOURCES: 6.021J has its own Report and Proposal Guide which is available online at the 6.021J course homepage. This guide is a supplement to the MIT style guide, The Mayfield Handbook of Technical and Scientific Writing (available at http://web.mit.edu/course/21/21.guide/www/home.htm)

SUBMISSION OF MANUSCRIPTS: Please see course handouts for report due dates. All papers due by noon EST to the 6.021J course secretary, Janice Blazer.
First Drafts: Include three copies of your report. Copies will be distributed to peer reviewers as specified in lecture. All reviews are returned during the writing clinic. Please make sure that your review of your peer's report is complete and ready to be returned at the writing clinic.
Final Reports: (7 items) Include one clean copy of your report, the three reviewed copies of your report, a copy of the report you critiqued, a copy of your lab protocol, and proposal. Clip or bind all materials together.