

Technical & Scientific Report Writing

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Organizing Scientific Research Paper

From Timothy Allen (2000) - expanding from a handout prepared by an unknown author distributed to students in Introductory earth science course at Dartmouth College.

- A scientific paper, whether it is a class term-paper or the publishable results of an experiment or investigation, should reflect the application of the Scientific Method.
- A Scientific paper should be well organized into sections (recommended here-follow), which are clearly delineated by appropriate headings and sub-headings.
- Papers used in literature review could serve as role models for how might organize the paper.
- Note that these articles usually contain lots of figures, charts, diagrams, tables, or other illustrations - often a scientist creates the figure she will use to illustrate her point, and then writes a paper around those figures!
- Finally, be aware that science progresses only by building upon the works of others. In order for this system to work well, however, scientists must give proper credit to the others from whom they have obtained ideas.

Components of a Research Paper

- Title and Abstract,
- Introduction,
- Body,
- Figures,
- Conclusions,
- References Cited.

The Title

- For papers that will be published for other scientists to refer to, the title and abstract are very important.
 - Other scientists will first notice a paper in the table of contents of a journal, conference proceedings, and will be deciding on the basis of the title alone whether to look further at that paper.
 - “The Title Should be the Fewest Possible Words that Adequately Describe the Content of Your Paper.” [Day 99, p.8]. In other words, it should be descriptive, and the keyword here is adequate.

The Abstract

- After having been attracted by the title, if other scientists want to go further, their next step would be likely to read the abstract, and look at the figures. The qualities of an abstract are best summarized by Landes (1951):

*“The abstract is of utmost importance, for it is read by 10 to 500 times more than read the entire article. It should not be a **mere** recital of the subjects covered, replete with such expression as “is discussed” and “is described.” It should be a condensation and concentration of the essential qualities of the paper.”*

- Although the abstract appears first in the report, it is usually written last.


The Abstract

- An informative abstract is single-spaced and 100-250 words.
- It includes the following information: project, method, results, and conclusions.
- It does NOT include citations, acronyms, equations, abbreviations, background or discussions of future research.
- It stands alone; a reader should be able to grasp the key results of the entire project from reading the abstract.
- Abstracts are written for an expert audience; thus they use more technical language.
- Abstracts are placed at the beginning of a document.

“Executive Summary?”

- is just what it says it is: a summary of the entire document directed at the executive - who may or may not be a technical expert and may not read the rest of the document but has to be able to understand the document based on this one page.
 - usually a page or less
 - on a separate page.
 - appears after the Table of Contents and the List of Tables and Figures.
 - is double spaced.
 - has no reference citations.
 - rare to have graphics in an executive summary.
 - summarizes background and significance, key concepts, schedule, budgets, and concluding recommendations and/or proposals.
 - the language in an executive summary is for the general, educated reader, not for the technical expert.
- **Suggestion:** Write the executive summary last. It is not an introduction. It’s a entirely separate section of the document that summarizes the entire report or proposal.

Introduction

- Should provide sufficient background information to allow the reader to understand and evaluate the paper better.
 - A good introduction will:
 - State the topic of the paper,
 - Provide enough background information to orient the reader,
 - Review previous work on this problem,
 - Describe the methods used in the research, and
 - Briefly state the principal results or conclusions.
- ❖  It is in the Introduction that you should present the basic questions that you are asking, what the observations are that led to those questions, and what hypotheses were that you set out to test.

Body of the Paper

- The body of the paper should deal with the research topic in a clear concise way.
 - Use subsections with appropriate headings as needed.
 - The ideas presented in the paper should be organized in a logical and consistent order, and the discussion should flow from thought to the next.
 - Strive for correct grammar, spelling and a clear style.
 - A writer never achieves this goal with just one draft.
- It is in the body where you describe the observations and information, the data, you obtained from the experimentations you conducted, as well as describing the experiments themselves.
- An experiment can include going to the library to look up information as well as going out into the field and making your own detailed observations. If you do conduct a controlled experiment in either a lab or field setting, you need to describe your procedures well enough so that it could be reproduced by another scientist.

Illustrations

- Figures - Charts, Tables, Diagrams, Photographs, etc - can be extremely helpful to a scientist to communicate ideas, observations, or data to others.
- Many scientists outline their paper by deciding on what figures, graphs and tables they need in order to convey their story, and then fill the text around these figures.
- The importance of figures in conveying scientific ideas cannot be overemphasized (cf. role models).
- All figures must be neat and legible, should have a caption, and should be referenced from within your text of your paper (!!).
- If a figure is reproduced or copied or adapted from another source, that source must be properly acknowledged in the caption, and listed among other references

Conclusions

- Discuss your findings in a way that leads logically to your conclusions.
- State the evidence for each conclusion as clearly and concisely as possible.
- Be sure to point out any exceptions to your general conclusions, discuss the assumptions you have made, and recognize any unresolved issues or cases.
- It is in the conclusions that you discuss whether or not the observations and information you collected from your experiments validate the hypotheses you started with, answering your original questions.

References

- Where all the references cited in the paper are fully listed.
- Often the most important and useful section of a scientific paper.

“There are many different formats for reference citations, but perhaps the simplest is to indicate the author’s last name and the year of publication.” Hansen (1991)

- Preference: Council of Biology Editors (CBE) Scientific Style, 1994.

➤ Details to be discuss as classroom exercise.

References

Council of Biology Editors, 1994, *Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers*. 6th edition, Cambridge University Press, New York. 825p.

Day, R. A., 1979, *How to Write and Publish a Scientific Paper*. ISI Press, Philadelphia, 45p.

Hansen, W.R. (ed), 1991, *Suggestions to authors of the Reports of the US Geological Survey*. 7th edition, US Gov. Printing Office, Washington D.C., 311p.

Landes, K.K., 1951, A Scrutiny of the Abstract, *Bulletin of the American Association of Petroleum Geologists*, Vol. 35.

Citing References in Research Papers

- In the practice of scientific research, most research topics are built upon the state-of-the-art of related domains. Related works are consulted, analyzed and reviewed to refine a research problem. Bibliographic search or literature review is essential, not only at the start of a research, but also during the process of any research.
- It is important to properly and appropriately cite references in order to acknowledge the sources and give credit to the authors from whom the work is used in your paper.
- Sciences move forward only by building upon the work of others. There are however, other reasons for citing references in scientific research papers. Citations to appropriate source show that you are aware of the background and context into which a research topic locates, and they help “solidifying” the arguments used in the paper to demonstrate the evidence of its rationale.
- References are used, in the practice, by interested readers or reviewers, as a complement to the abstract of a research paper.

Citing References

- Should acknowledge a source
 - Anytime a fact or an idea or any direct quotation is used or referred to.
 - Anytime a fact or idea is summarized or paraphrased.
- Source to be acknowledged
 - Not only limited to books, journal and/or conference articles, but also figures, illustrations, or graphical materials either directly or in modified form.
 - Internet sites, computer software, written and e-mail correspondence shall be used with care.
 - References shall be in any case “**traceable**” i.e. in a way that other researchers can find the cited references.
 - Internet sites are not usually edited and maintained for “traceability.”

Citing References

- Three formats:
 - Mention the author(s) by last name(s) in the sentence and should give the year of publication in parenthesis e.g. “Crowley et al (1989) developed the idea of ridges and peaks as image features.” (rule of thumb: more than two authors, use *et al.*)
 - Give the facts and ideas mentioned by the author(s) and then attribute these facts and ideas by putting last names and date in parenthesis eg “Ideas of ridges and peaks were previously developed (Crowley et al, 1989).
 - Quote the author exactly. Be sure to put the quotation between the double-quotes (“”) and then list the names, date, and page number in parenthesis e.g. “Ridges and peaks are image features that can be used as complement to segments and regions.” (Crowley et al, 1989, p. 234).

Page number is needed in direct quoting citation, or if the source is very long and the cited specific fact or idea can only be found on a specific page.

Direct quotations that are more than four lines long should be set off from the rest of the paper by the use of narrower margins and single spaced lines.

Citing References

- Some (unwritten) rules:
 - No references in abstracts. Abstract must be self-explained but concise and short (less than 300 words).
 - Number of authors to be cited:
 - Less than two: cite all e.g. (Tran-Le and Pham, 2006),
 - More than two: cite first author and the rest e.g. (Tran-Le *et al*, 2006).
 - Personal verbal communication:
 - For the first citation, cite origin of author, e.g. (Tran-Le, Software Engineering Lab, HCM University of Technology, personal communication, 2005),
 - For subsequent citations to the same person just cite the author e.g. (Tran-Le, personal communication, 2006).
 - Personal communications are generally not listed in the Bibliography section. Unpublished reports, manuscripts should be.
 - Source from no individual identifiable authors shall be cited to the name of the organization to which the source is attributed e.g. Internal procedure for publishing scientific papers (HCM University of Technology, 2005).
 - Internet source without any identifiable author or date, simply use the URL address directly in the text e.g. *fact F* (<http://xxx.yyy.edu/nnn/fact.html>).

Details of Reference Lists (Bibliography)

- Important: **traceability** of any listed reference.
- Formats:
 - Books: Names, Date, *Book Title*, Publisher, City, n. pages

Two or more authors: first author and last author.

 - In-Book Chapters: Names, Date, Chapter Title, in Authors or Editors, *Book Title*, Publisher, City, pp. nnn-mmm.
 - Journal Articles: Name, Date, Article Title, *Journal Title*, Volume number, Issue number, pp. nnn-mmm
 - Conference Papers: Name, Date, Paper Title, in *Proceedings of the Conference (full-name), acronym (e.g. RIVF'06), City*, pp. nnn-mmm.
 - Technical Reports: Name, Date, *Report Title*, Organization, Technical Report Number, n. pages.
 - Internet Sources: Name, Date, Title, *Organization and Report Title*, URL (date)

Dr. Allen's Recommendations

Excerpt from Allen, Timothy 2000 - <http://kilburn.keene.edu/Courses/References/Papers/PetPeeves.html> (August 2000).

- Cite references anytime a fact, idea, or illustration is used.
- Care about pronouns (he, she, it, they). Make sure that it is clear to what the pronoun refers.
- Watch out for incomplete sentences, or worse yet, technically incomplete thoughts. These are often associated with the misuse of pronouns.
- Subjects and verbs should agree.
- Make sure that quotations are correct.
 - If you have doubts, check out right away (this is mine, not Allen's!)

Citing Sources And List References

- List references
 - American Psychological Association (APA)
 - Modern Language Association (MLA)
 - Chicago Manual of Style (CMS)
 - Council of Biology Editors (CBE)
 - IEEE Citation-Sequence System (IEEE)

CBE vs. IEEE

CBE

- Purpose: minimize number of keystrokes - by typist
- General Structure:
 - Sequence number-
>subscript
 - Separate: comma
 - Name of author -
abbreviate
 - Title – not underline –
italicize
 - Page: p (begin-end, total)
 - Date Format: <Y> [m-d]

IEEE

- Purpose: brief and concise
- General Structure:
 - Cite – running text >
subscript
 - Separate: comma
 - Author: regular name - and,
&
 - Title: underline, italicize
 - Page: p. or pp. (begin –
end)
 - Date Format: d-m-Y

Guideline

CBE

- Placement: after reference
- Endnote-Footnote: table(n)
- Number-list:
 - Content Guideline: include all
 - Page Format: title-ordering-spacing-indentation
- Book:
 - Same
- Journal Articles

IEEE

- Placement: after reference
- Endnote: table(y)
- Number-list:
 - Content Guideline (same)
 - Page Format: title-ordering-spacing-indentation
- Book:
 - Same
- Journal Articles

Dissertation Writing

- Timo's Reviews of Research and Dissertation Advice Guides, Prof. Timo Salmi, ©2005, <http://www.uwasa.fi/~ts/opas/intd/resgui.html> (May, 2005):
 - List of good research management guidebooks with Prof Timo's comments. Directed at Doctoral students but also applicable for MS Thesis phase.
 - 27 reviewed guidebooks including research in educational and social sciences, economy, business study, managements, finance, accounting, etc. but few focus on scientific research. Some recommended reviewed guidebooks are in Finnish!

Dr. Duong's Recommendations

- Draft your “story-board” - the logical sequence of the story you are going to tell.
 - What is the purpose of your paper? What are the key elements constituting your paper? Are them worth telling?
 - Who's the intended audience? Information can be represented by an iceberg, what is the level of water with respect to the depth of the iceberg?
- Don't use ideas or concepts before they have been introduced.
 - Explain the elements of your story. If they haven't been introduced, describe them (use facts and ideas from other sources - cite references).
- Acronyms shall be preceded by complete description,
 - eg HCMUNS - shall be quoted “Ho Chi Minh City University of Natural Sciences (HCMUNS)” at the first time it is used in the paper.
- Figures and graphs are self-explain illustrations but they should be an integral part of the paper.
 - Don't just attach the figures to a paper. Discuss the figures in the body of the text. Raise yourself the question “why the figures are as such?”

An Un-copyrighted Guide

- Writing a PhD dissertation in an experimental area of Computer Science could be difficult!
- Principal Advices:
 - A Thesis is a hypothesis or conjecture.
 - A PhD dissertation is a lengthy, formal document that argues in defense of a particular thesis.
 - A doctoral research work must be “original” and “substantial.” The research performed to support a thesis must be both, and a dissertation must show it to be so. In particular, a dissertation must highlight original contributions.
 - Scientific method means starting with a hypothesis and then collecting evidence to support or deny it. The most difficult aspect of writing a dissertation consists of organizing the evidence and associated discussions into a coherent form.

Advices to PhD Candidates

5. The essence of a dissertation is critical thinking, not experimental data. Analysis and synthesis form the heart of the work.
6. A dissertation concentrates on principles: it states the lessons learned, and not merely the facts behind them.
7. In general, every statement in a dissertation must be supported either by a reference to published scientific literature or by an original work. Importantly, a dissertation must not repeat the details found in public sources; it uses the results as fact and refers the reader to the source for further details.
8. Each sentence in a dissertation must be complete and correct in a grammatical sense, no contractions, no slurs or slang, no undefined technical jargon. The words must convey exactly the meaning intended, nothing more and nothing less.
9. Each statement in a dissertation must be correct and defensible in a logical and scientific sense. The discussions in a dissertation must satisfy the most stringent rules of logic applied to mathematics and science.

Writing Dissertation

- All scientist need to communicate discoveries; PhD dissertation provides training for communication with other scientists.
- Writing a dissertation requires a student to think deeply, to organize technical discussion, to master arguments that will convince other scientists, and to follow rules for rigorous, formal presentation of the arguments and discussion.
- **Writing dissertation is the most important and beneficial phase of a Doctoral research.**

To Avoid

- To avoid:
 - **Adverbs** - avoid overly used adverbs. Use strong words instead.
 - **Jokes or Puns** - any scientific research document is a formal document.
 - **Moral judgments** - words such as *bad, good, nice, terrible, stupid, true, pure, etc.*
 - **Extremes** - e.g. *perfect, ideal solution, obviously, clearly* (sense of judgment)
 - **Imprecision** - e.g. *today, nowadays, modern times* (today is tomorrow's yesterday), *soon* (how soon?), *seems, seemingly, would seem to show* (any facts to show the evidence? Markov evolution?), *few, most, all, any, every, much, many, number of* (how many? Quantitative statement is preferred.)
 - **Vagueness** - e.g. *lots of, kind of, type of, something like, just about, number of,*
 - **Could be vague** - e.g. *In terms of, different* (to what?)

To Avoid

- Clumsy phrases:
 - “***you will read about ...***”
 - “***I will tell you ...; I will describe ...***”
 - “***We***” (who we are? Authors and readers? Can use “the authors ...”
 - “***Hopefully, the program would ..***” (program doesn’t hope nor would ..”
 - “***a famous researcher ...***” (such statements prejudice the reader.)
- Think twice:
 - “***should***” (who says so?)
 - “***must***”, “***always***” (any evidence?)
 - “***proof***” (ask a mathematician!)
 - “***show***” (need to provide evidence.)
 - “***can/may***” (when it can and when it may?)

Some advices

- Voice: use active constructions, minimize passive mode.
- Tense: write in present.
- Define negation early, e.g. say “no data block waits on the output queue” instead of “a data block awaiting output is not on the queue.”
- Grammar:
 - Be careful that the subject of each sentence really does what the verb says it does.
 - Saying “Programs must make procedure calls using the X instruction” is not the same as saying “Programs must use the X instruction when they call a procedure.”
 - All computer scientists should know the rules of logic. Use them in writing.

General recommendations

- Focus on results and not the people or circumstances in which they were obtained.
- Avoid self-assessment (both praise and criticism).
- References to published papers, not authors.
 - Use a singular verb to refer to a paper e.g. “Tran-Le and Duong [1] reports that ...”
 - Avoid using “The authors claim that ...” but “The paper states that ...”
- Drawing only warranted conclusions - are them conclusive?
- Don't make any abstraction (illusion?) of any commercial success of a idea/method in scientific research paper/dissertation.
- Science is no religion!!

Typical Organization of Dissertation

- Chapter 1: Introduction
 - Overview of the problem; why it is important; how other treated the problem generally; state the research hypothesis or specific question to be investigated. Make it readable by anyone.
- Chapter 2: Related Works (State-of-The-Art)
 - Including definitions of terms. Make the definitions precise, concise, and unambiguous.
- Chapter 3: Conceptual Model
 - Central concept underlying your work. Make it a theme that ties together all your arguments. It should provide an answer to the question posed in the introduction at a conceptual level.
 - If necessary, add another chapter to give additional reasoning about the problem or its solution.

Organization (2)

- Chapter 4: Experimentation/Simulation
 - Describe the experimental method used and the environment, scenarios that test your conceptual model (reproducible). Describe the results, and discuss the results.
- Chapter 5: Analysis of Experimental Results
 - Usually, experiments either emphasize proof-of-concept or efficiency (demonstrating that a method/technique provide better performance than those that exist) - Show the evidence!
- Chapter 6: Conclusion and Future Works
 - Summarize what was learned and how it can be applied. (be aware of your contributions: are them original and are the work substantial?)
 - Recommend future work to make your idea “better!”
- Abstract - Executive Summary (to write last!!)

Checklist & Revision Principles

The Five Drivers

- Accuracy
 - Stylistic Accuracy?
- Clarity
 - Contradiction with conciseness?
 - Structural clarify vs. coherence of relations?
- Conciseness
 - Be short and meaningful. What does it mean? Cut off?
- Coherence
 - Contradicts conciseness for relationships between elements?
 - Contradicts clarity in terms of style?
- Appropriateness
 - Audience and problem
 - Context and problem vs audience?

Purpose?

- Provide info
- Give instructions
- Persuade
- Prohibition

Organization

- Storyboard
 - What's in it?
 - Hypothesis?
- Drafting
 - Tree structure of topics

Revising

- Organization
- Accuracy
- Contents
- Completion

- From revise to review
 - Peer review
 - Request for review
 - Procedure and rules
 - Formal Technical Review
 - Editorial Review
 - Managerial Review

Collaborative Writing

- Work Breakdown Structure
- Responsibility and Task Assignment
- Common Convention
- Final electronic form convention
- Who's doing what in revising and reviewing?

Consistency in:

- Capitalization
- Italics
- Abbreviations
- Acronyms
- Numbers
- Enumeration
- Symbols
- Equations
- Spelling

Mechanics: Capitalization

Capitalization :

First words , first sentence in quotations.

Proper name : person, object, place, project, institution, river, vessel , genus, culture, ethnic group, formal job title .

Titles of : books, periodicals, published & unpublished reports, articles, document sections.

References to : figures, tables, chapters, sections, equations

Rules for capitalizing multiple-word titles and proper names.

General guidelines for capitalizing scientific terms.

Mechanics: Italics

Titles of : journals, books, newsletters, manuals
Letters, words, term, equation symbols that are
being highlighted for discussion
Foreign words
Emphasis
Names of specific vessels

Mechanics: Abbreviations

Terms & words in graphics &
bibliographies

Certain words & phrases

Standard units of measure (dictionaries &
textbooks)

Mechanics: Acronyms

Capitalize acronyms (not periods),
but not common nouns

First time -> spell out the phrase +
(ACR)

Too many -> list of ACR in front
matter

Plurals -> ACR + s

Mechanics: Numbers

Arabic num for cardinal & ordinal num
words for num 1 – 10 & two-word fractions (int)
Begin sentences with word num or reword
Two num together -> spell out the fewer or reword
Pronoun “one” : always spell out
Dates, time of day, pages, figures, notes
Num + percent sign (%)
British & American vs. EU & Inter Standards
Non-technical prose

Mechanics: Enumeration

Chapter-section Enumeration:

Numerical system

Alphanumerical system

Pagination:

Front matter : lowercase roman numerals

Body -> end matter: Arabic numerals (1 -> n)

Tables & Figures: sequentially

Equations: sequentially

Footnotes, endnotes, reference numbers:

cf. Reference standards.

Mechanics: Symbols

- Symbols : check with a relevant style guide, textbook, or handbook

First time use -> (full spelling)

Too many -> list at the front matter

e.g. : Al (aluminum), Cu (copper), Fe (iron)

Mechanics: Equations

- Justified in the longest line with equation numbers
 - Align run-over lines on the equal sign (=)
 - Break an equation longer than one line.

Mechanics: Spelling

Proofread your document for misspellings

Be consistent in the spelling of words (same dictionary)

Carefully use American & British English

In the end ...

- Research is vocational!
- Use your brain and logics as often as possible.
- Rigor is needed in all steps.

« The difference between a trivial project and a significant project is not the amount of work required to carry it out, but the amount of thought that you apply in the selection and definition of your problem. »

David P. Beach & Torsten K.E. Alvager

Handbook for Scientific and Technical Research, Prentice-Hall, 1992, p. 29

GOOD LUCK!