

“Publish or Perish”:

A Guide for Writing Scientific Papers - with Some Subjective Recommendations

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These famous scientists did scientific writing and progressed science...

Kristian Birkeland



Isaac Newton



Marie Curie



Abstract

- Scientific writing is an important cornerstone of all sciences used to document research results.
- A suitable format for scientific writing in natural sciences is given as a template with guidelines for the structure and look.
- “The Gold Standard” (or IMRAD)- The contents of the different typical chapters of a scientific paper in natural sciences are outlined with guidelines.
- Some subjective recommendations for scientific writing are given - use them or not.
- As an addition, MIT-professor emeritus Stephen Senturia’s practical advices for writing successful papers are outlined and commented.

Proposed Format for Writing for Papers in Natural Science

- A good and often used format template: IEEE Paper Format for scientific papers and laboratory reports:
 - Download the template from:
www.ieee.org/documents/trans_jour.docx
Backup link: tid.uio.no/kurs/fys4260/trans_jour.docx
 - If you use Linux or Mac, go via:
www.ieee.org/documents/IEEEtran.zip
 - Comment: Web pages like these may change or disappear to “Bit Heaven” – if so do a web search (OK by August 2016)
- The template gives guidelines for the structure and look, **not** the scientific content of the paper
- The best way to learn about this format is simply to start using it
- This template is now widely used for conferences and journal papers worldwide, also outside the IEEE organisation.
- Journals and conferences where you intend to publish your work may have different templates – look them up!

Preparation of Papers for IEEE TRANSACTIONS and JOURNALS (May 2007)

First A. Author, Second B. Author, Jr., and Third C. Author, Member, IEEE

Abstract—These instructions give you guidelines for preparing papers for IEEE TRANSACTIONS and JOURNALS. Use this document as a template if you are using Microsoft *Word* 6.0 or later. Otherwise, use this document as an instruction set. The electronic file of your paper will be formatted further at IEEE. Define all symbols used in the abstract. Do not cite references in the abstract. Do not delete the blank line immediately above the abstract; it sets the footnote at the bottom of this column.

Index Terms—About four key words or phrases in alphabetical order, separated by commas. For a list of suggested keywords, send a blank e-mail to keywords@ieee.org or visit http://www.ieee.org/organizations/pubs/ani_prod/keywrd98.txt

1. INTRODUCTION

THIS document is a template for Microsoft *Word* versions 6.0 or later. If you are reading a paper or PDF version of this document, please download the electronic file, TRANS-JOUR.DOC, from the IEEE Web site at <http://www.ieee.org/web/publications/authors/transjnl/index.html> so you can use it to prepare your manuscript. If you would prefer to use LATEX, download IEEE's LATEX style and sample files from the same Web page. Use these LATEX files for formatting, but please follow the instructions in TRANS-JOUR.DOC or TRANS-JOUR.PDF.

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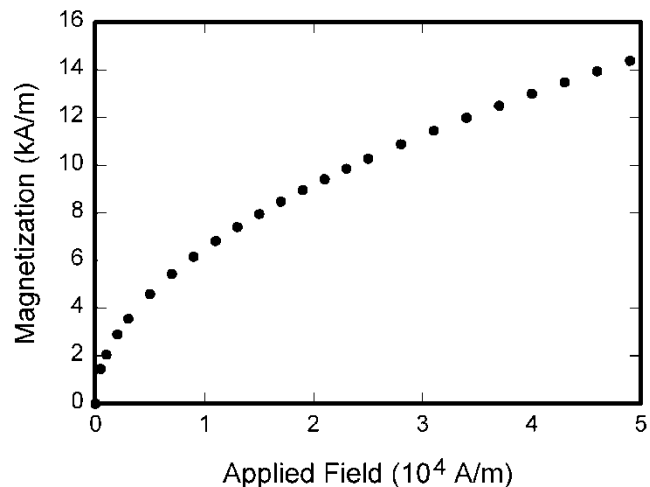


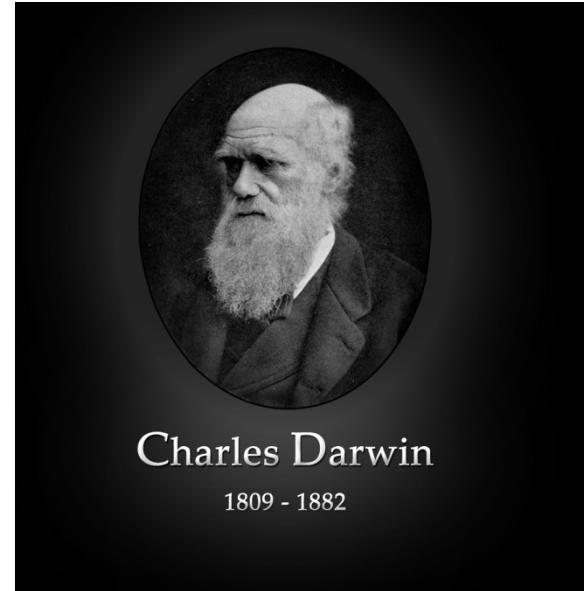
Fig. 1. Magnetization as a function of applied field. Note that “Fig.” is abbreviated. There is a period after the figure number, followed by two spaces. It is good practice to explain the significance of the figure in the caption.

Motivations for Scientific Paper Writing

- "A research project has not contributed to science until its results have been reported in a paper, the observations in which are accompanied by complete recipes" From [1]
 - [1] M.J. Katz, "From Research to Manuscripts – A Guide to Scientific Writing" ISBN- 13 978-1 4020-4045-0. The Netherlands: Springer, 2006, p.ix-x.
- Other motivations for writing scientific papers:
 - Personal: "For the CV", for Ph.D. studies, etc.
 - Company/Institution, etc.: "Reputation/money/marketing" For University College of Southeast Norway this has high priority.
 - Placing the research results in the public domain to block off patenting by others
 - Moral, societal obligations as a public funded institution
 - Etc., etc.

The “Gold Standard” for the Content for a Paper in Natural Sciences (IMRaD)

- Abstract
- Introduction
- Material and Methods
- Results
- Discussions
- Conclusions
- Acknowledgements
- References
 - Acknowledgements sometimes obsolete and skipped.
 - Except “Abstract” and References”, the heading titles can be modified to more specific titles, for instance using “Process Technology” instead of “Materials and Methods”, but the principal content of each chapter should be kept
- Nicknamed “IMRaD”: Introduction, Methods, Results and Discussions



The Gold Standard for Content of Papers in Natural Sciences

- "Write with precision, clarity and economy. Every sentence should convey the exact truth as simply as possible."
Instructions to Authors. *Ecology* 1964
- Many practical guides to writing scientific papers including experimental reports can be found on the web, for instance on the following links:
www.ncbi.nlm.nih.gov/pmc/articles/PMC3474301/
and
www.ieee.org/publications_standards/publications/authors/author_guide_interactive.pdf
- An extensive, general formal guide can be found on:
owl.english.purdue.edu/owl/resource/560/13
- An informative and friendly guideline by S. Senturia can be found on:
www.stephendsenturia.com/uploads/5/4/5/1/54515009/senturia_-_five_tips_for_making_tenure.pdf

Comments on “Abstract”:

- Also an “Executive Summary” or critical “marketing information”
 - From [1]:
 - ◆ A. One or two sentences on BACKGROUND
 - ◆ B. Two or three sentences on METHODS
 - ◆ C. Less than two sentences on RESULTS
 - ◆ D. One sentence on CONCLUSIONS
 - Comment: **BACKGROUND** should include motivation for the work
 - If possible, **RESULTS** should be quantified in performance: “N²: Numbers and Nouns, not A²: Adjectives and Adverbs” (For instance: Instead of saying a developed pressure sensor was “very sensitive”, write the actual number, for instance a sensitivity of 60 mV/V/Bar)

Comments on “Introduction”

- Motivation(s) and background for the work are important issues
 - For applied research, societal needs and benefits are very important motivations, e.g. MEMS crash sensors reducing car fatalities and giving billion dollars market opportunities for manufacturers
- Background should describe state-of-the-art – meaning what has already been done by others
- Innovative work needed: “Knowledge gap to be filled”
- Or in academic terminology: Your hypothesis to be tested
- Work to be done – “Plan of attack”

Comments on “Material and Methods”

- This section gives a detailed description of your materials used, the tools you have used, and complete instructions for your experimental procedures
- The “**Acid test**” of the quality of the content here is that your experiment can be verified by being repeated as completely as possible by any competent person by following your descriptions
 - Cheaters are from time to time discovered by peer evaluations or other ways – for example a recent (2006) case with a dentist in Norway: He invented results to fit his hypothesis on mouth cancer protection when using pain killers in several papers. Other examples? The “Schön scandal” from Bell Labs on fraud properties of organic transistors? A Scottish scientist Steve Eaton was given a prison sentence in 2013 for faking research data on experimental anti-cancer drugs, etc., etc.**Such cheatings disturb and slow down the progress of science!**
- This rigorous requirement for a paper is a **major cornerstone** of scientific work in natural sciences to control and build on the earlier acquired knowledge in future work!

Material and Methods - continued

- Paper reviewers will for good reasons kill your paper if you are sloppy here!
- Careful planning of the work is needed to fulfil this requirement.
- Painstaking documentation is also needed as you go along.
 - For example clearly identifying all materials and equipment used, and experiment parameters like temperature, etc. – also those you do not think have any significance.
 - Equipment should be identified by complete brand name and specific version.
 - **Never, ever trust your memory!** Write it down as you go along, preferably in a file stored in safe document archive system with version control. Not being able to repeat a successful experiment because you have forgotten something is frustrating, unnecessary and might lead to expensive and time consuming corrective actions – and in rare cases all in vain.
- Lengthy or cryptic documentation like statistical calculations can be put elsewhere if possible, for instance in “Attachments”, to increase the readability of the paper.

Comments on “Results”

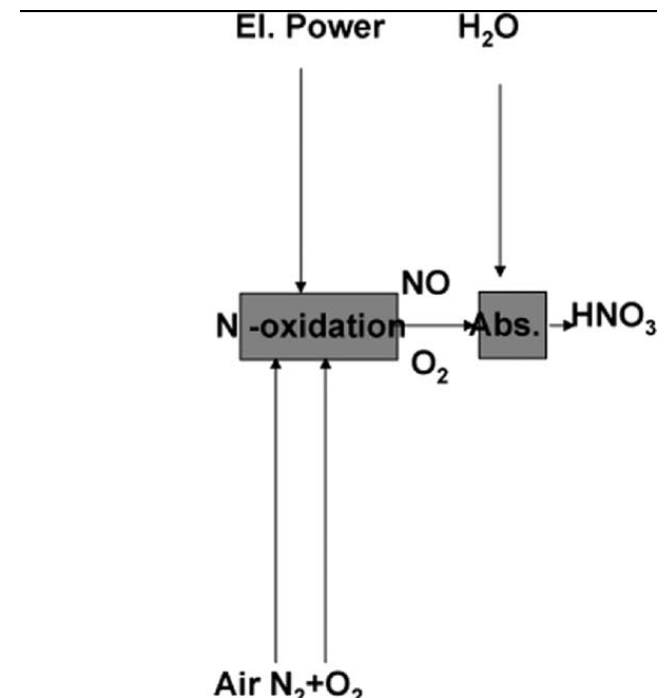
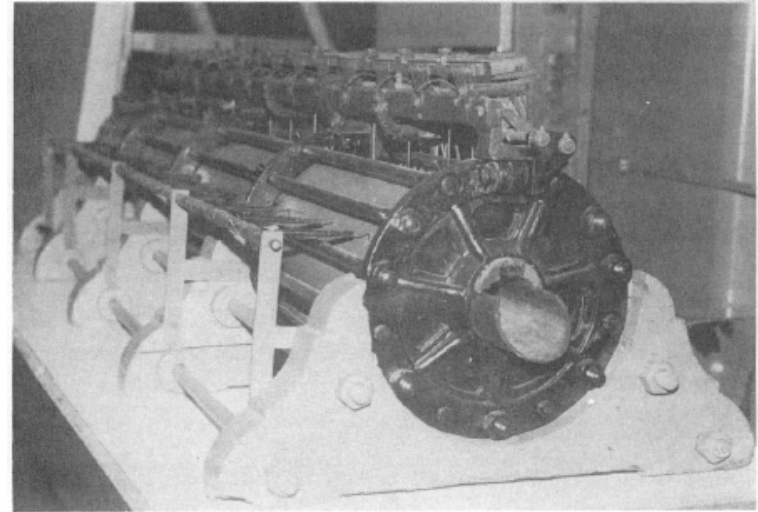
- This section should ideally give an objective and neutral report of the findings of the work:
 - The function of this section is to summarize general trends in the data without comments, biases, or interpretations:
 - ◆ General observations
 - ◆ Specific observations
 - ◆ Case studies: Best cases and/or representative cases
- Many reviewers (I am among them) are strongly against mixing Discussions and Results in the same section:
 - The reader should follow your **objective observations** before evaluation with your **subjective views** in the Discussions section, which contains your subjective assessments, parts of which can and often will be questioned.
- However, the readability and shortness can often be improved by mixing Discussions and Results in the same section and therefore widely used, but then it is recommended that no controversial assessments are put forward.

Results - continued

- This section is together with the Material and Methods section the most enduring parts of a scientific paper.
 - These 2 parts contains the objective contribution to science, while the other parts are ephemeral (significance eroding with time) as science move forward.
- The results are also the part that is most useful for future work by others and yourself, most often being the section containing reference contents in future papers, sometimes also used to question and counter your assessments in Discussions and Conclusions.
 - Citations in scientific papers by other authors most often refer to parts in the Result section – positive and negative.

Results - continued

- Take care not to **manipulate** your reader by selecting or twisting the results that best fit your Discussions and Conclusions.
- Be aware that unexpected results instead of a disappointment might be a "**New Gold Mine**" of new science, large or small.
 - The famous Norwegian scientist Kristian Birkeland invented electric arch fixing of air nitrogen to nitric oxide by accident when he failed to demonstrate an electromagnetic cannon in 1903! The modern synthetic fertilizer industry got started in the first decade of the 20th century by the foul smell of nitric acid from the short-circuited cannon!



Results - continued

- To improve readability and pave the way for constructive Discussions, do your utmost to present your results in a clear and concise way.
 - This often means processing your raw data into statistical presentations, graphs and tables.
 - Photos, microscope images, drawings, etc., are all important ways to visualize your results.
 - However, be careful to **maintain objective reporting of results** (For instance, statistical processing tools may twist or disguise significant findings if used wrong: As Mark Twain put it: "Lies, damned lies, and statistics")

Comments on “Discussions”

- In this section we interpret how the results have brought new knowledge contributing to science. This should be done as objectively as possible, but will always contain elements of subjective interpretations of the results.
 - **Objectivity** to show that parts of the results lead to conclusions that most readers will agree upon and support.
 - **Subjectivity** to point out indicative, but not conclusive results that need to be further evaluated by future work by you or others.
 - Obviously, there is a “Grey zone” in between that can be difficult to balance.

Discussions , continued

- Organisation of the discussion of results should guide the reader through your argumentation:
 - A suggested way:
 - ◆ Recapitulate your scope of work and the results achieved by the work (New Innovation or hypothesis proven)
 - ◆ Compare your findings with work of others, cited in the References
 - ◆ State your conclusions you can make based on your results and relevant results by others. This includes stating what can be considered proven results, and what are subjective, questionable interpretations.

Discussions , continued

- If your work was well planned and executed and earlier sections are written well, the Discussions section can most often be made short and mainly refer to the findings in the Results section.
- However, if your Results are hard to interpret or unexpected, you may need to:
 - Use mathematical tools like statistics to look for trends and patterns.
 - Suggest further work to achieve results that give more knowledge towards the scope of work.
 - Suggest further work to address possible new findings.

Comments on “Conclusion(s) (and Further Work)”

- The conclusion(s): One paragraph statement of the highlight point(s) of the paper
 - The main message(s) you want to highlight.
 - Most often, it is your main result, for instance:
 - ◆ Hypothesis proven
 - ◆ New technology or device invented and demonstrated
 - Proposal(s) for Further Work can also be included, if the results are inconclusive or opens up for new knowledge that might be acquired.
 - ◆ For instance, a proposal for a gyroscope design with a potential improved performance.

Comments on “References”

- This is a list of all sources cited in the paper using the appropriate bibliographic format
 - The section names the “links” through which your paper is tied into the “Web of science”
 - ◆ The cited sources should be of approved scientific quality, just like your own paper
 - Be careful with sources not being peer evaluated, like newspapers, popular (“vanity”) press articles and “predatory” scientific journals: Information here range widely from true to wrong, and are very often twisted/manipulative to serve non-scientific motivations!
 - ◆ The cited sources should be available for anyone wanting to look them up, maybe preferably Open Access.
 - Be careful with short-lived sources like web pages or unpublished material that already have become or could be unavailable!
 - Personal communications are generally not good as cited sources.

Ethical Standards of “Scientific Writing”

- We all have morale obligation to contribute to the progress of science! (Commented earlier)
- What are good and bad ethics may differ a lot – make up your own opinion! Examples:
 - R&D where the results can be used in defence applications?
 - R&D where the results can be used in applications that could increase global warming?
 - Nations, cultures, institutions, companies, persons, and so on often have their specific ethical guidelines for good or bad – can be difficult to balance! The classical example: The tobacco industry and their research to increase nicotine addiction.



Ethical standards, continued

- Some bad ethics are obvious:
 - Cheating (commented earlier) is unethical and slows down the progress of science, and sometimes is a criminal act, and is always disturbing the progress of science.
 - Using war prisoners in medical research.
 - Making experiments where Health, Safety and Environment (HSE) issues are not properly addressed, for instance exposing people to carcinogenic materials.
- Sponsors should be properly honoured in chapter “Acknowledgment” but seldom more than that.
 - Example:

Ethical standards, continued...

- Authorship: The “[Vancouver Protocol](#)” from ICMJE is widely used as good guidelines on authorship.



- ICMJE developed these recommendations to review best practice and ethical standards in the conduct and reporting of research and other material published in medical journals, and to help authors, editors, and others involved in peer review and biomedical publishing create and distribute accurate, clear, reproducible, unbiased medical journal articles. The recommendations may also provide useful insights into the medical editing and publishing process for the media, patients and their families, and general readers.

Ethical standards, continued...

- These guidelines were given for medical journal articles, but is now widely adapted in most fields of science.
- From an ethical point of view, it is easy to agree that these guidelines are common sense.
- Comment: Order of authors is not included in these guidelines and can be a difficult issue since there is no international consensus here:
 - Main contributor is often listed “First author”, and assisting authors are then often listed by importance of contributions or alphabetically. Typically, a supervisor like a professor will be listed last in a paper with the student doing most of the work as “First author”
 - Minor contributors should be properly acknowledged in the paragraph “Acknowledgements”
 - Maybe a good advice: Consult a “Gray hair peer colleague” in your network in your field on authorship issues.

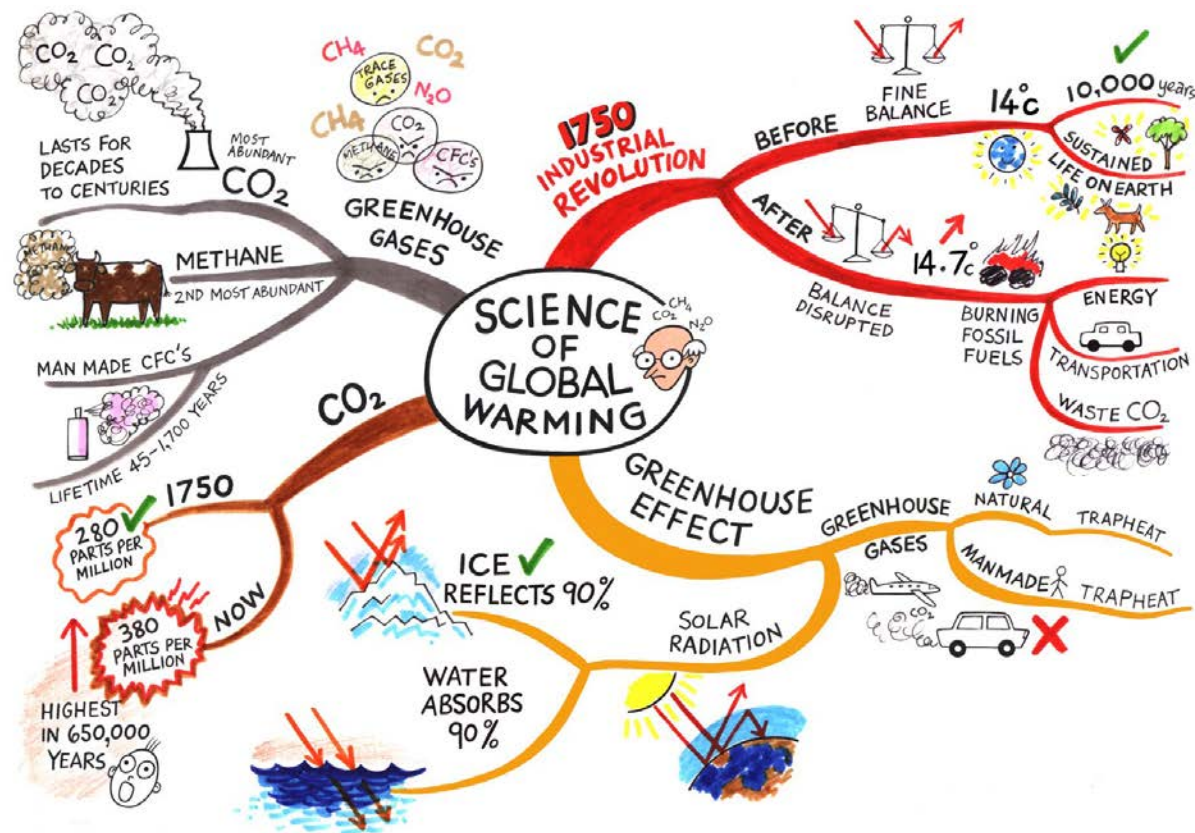
Additional comments on “Scientific Writing”

- Addendum: For some studies like bachelor studies: Project reporting might have its own “non-academic” guidelines. These guidelines are often modelled based upon internal reports typically used in technology companies, and are often less stringent on academic validity.
- Also, there are many guidelines for scientific and technical writing available that may be useful depending on your needs. However, **be critical, in my opinion a lot of bad advices are given that are not appropriate for scientific writing in natural sciences!**

Additional Comments, continued...

- The society at large needs natural sciences and scientific writing for future challenges!
- So “Publish or Perish” can also be a tool for “Real-life” missions. However, be careful: Scientist or politician?

From: www.mindmapart.com :



Summing up:

- **About Scientific Paper Writing:**
 - Writing papers is the most important way we contribute to the advancement of science
 - It is based on formal requirements established to communicate research results to bring science forwards
 - It is based on the peer evaluation procedure as quality assurance
 - It can be done in many ways as long as some basic rules are followed
 - Learning to be a good scientific writer is hard work
 - High ethical standards should be followed
 - All of you will read scientific papers, and most of you will write scientific papers, so understanding how a scientific paper is created is important
- This presentation can be downloaded from the MME2016 web pages and from:
www.fys.uio.no/studier/kurs/fys4260/Scientific_writing-Ohlckers.ppt

Material used for this presentation

- M.J. Katz, "From Research to Manuscripts – A Guide to Scientific Writing" ISBN- 13 978-1 4020-4045-0. The Netherlands: Springer, 2006, p.ix-x.
- S. Steingraber & al: "Guidelines for writing scientific papers", 1985, in Honors Organismal Biology Lab, Mich.State Univ.
- IOP guidelines for reviewers
- Robert Puers: "How to improve the acceptance of scientific papers" MME2014, Istanbul
- S. Senturia, "How to Avoid The Reviewer's Axe: One Editor's View ", JMEMS Editorial 2003

Addendum:

Stephen Senturia's advices on scientific writing:

- Professor Emeritus at MIT, USA, has written a "paper":
JOURNAL OF MICROELECTROMECHANICAL SYSTEMS, VOL. 12, NO. 3, JUNE 2003: Guest Editorial: How to Avoid the Reviewer's Axe: One Editor's View. Link:
www.me.umn.edu/labs/miml/reviewer-axe.pdf
- This "paper" gives some friendly and straightforward recommendations for potential paper authors based upon his lifelong experiences from all sides: As scientific paper author, as reviewer and reader, and as journal editor. Highly recommended!

Stephen Senturia's advices:

- First, the titles of the Guidelines:
 - (Almost) Nothing is New.
 - Rely on the Believability Index.
 - Watch for Gambling Words.
 - Don't Be a Longfellow.
 - Don't Pull Rabbits Out of Hats.
 - Mine All the Gold.
 - Remember: Reviewers are Inarticulate and Authors are (somewhat) Paranoid.

Stephen Senturia's advices:

- **Almost) Nothing is New**
 - Everyone knows that there is nothing new under the sun. Everyone, that is, except an ambitious author who believes that his or her work is unique. While there are a few truly unique and amazing results published once in a while, most of our work is built on the work of others.....
 - So if you have some new findings, even if you think they are minor, publish the work and contribute to the progress of science!

Stephen Senturia's advices:

- Rely on the Believability Index.
 - The essence of scientific advance is that results are believable because they have been repeated and checked by independent investigators. By definition then, a truly new result is not scientifically confirmed until it has been repeated by others. This leads me to the concept of a Believability Index.....
 - ◆ At the lowest level of believability is an author's speculation as to the reason for any new result. (Said another way, "Talk is cheap.")
 - ◆ But if a new experimental result is sufficiently documented in a manuscript, reviewers may accept it, even if they don't agree with the speculative explanation for the new behaviour.

Stephen Senturia's advices:

- Watch for Gambling Words.
 - Caution against using “gambling words” like “obviously,” “probably,” “certainly,” and “undoubtedly.” If you have to persuade using probabilistic words, it means you can't prove your point and you are speculating.....
 - So don't get too much carried away by your enthusiasm.....

Stephen Senturia's advices:

- Don't Be a Longfellow.
 - In *Tales of a Wayside Inn*, the poet Longfellow presents a set of stories told by various guests at the inn, sitting around the fire. While Longfellow was a wonderful story-teller, he should NOT be adopted as the role model for scientific writing....
 - So keep the writing short and concise....

Stephen Senturia's advices:

- Don't Pull Rabbits Out of Hats
 - We all recall the thrill when, as children, seated on the floor of a crowded school auditorium, we would see the visiting magician pull a rabbit out of his hat. Some of that thrill seems to stick, because many scientific writers seem to want to imitate the magician, for instance by adding results of an extra experiment not included in Materials and Methods.
 - *Reviewers get tenacious searching for the flaws when confronted with rabbits out of hats. The rule is simple: **Don't do it.***

Stephen Senturia's advices:

- Mine All the Gold.
 - Imaging you are out on a mission looking for silver, and then stumbles upon a gold find. Since you are looking for silver, you ignore it as the idiot you are.
 - The science history is full of such unexpected "gold discoveries", so the guideline is that if you get some unexpected results, take care to check whether it is a potential gold mine you should investigate further.
 - Many examples here in the history of technology – for instance Birkeland's Electric Cannon failure inspired him to invent his ammonium manufacturing process.

Stephen Senturia's advices:

- Remember: Reviewers are Inarticulate and Authors are (somewhat) Paranoid
 - *When a reviewer complains about something in a paper, the chances are very good that there is a problem with the paper.* Not every comment by every reviewer is a correct or proper criticism, but I would say that more than 90% of the criticisms that I have seen have some degree of merit.
 - *But, reviewers are inarticulate and giving little feedback. Reviewers often state their objections badly, and that makes their reviews look arbitrary, even whimsical. The authors' anger and paranoia are then provoked. Now what...*
 - ◆ The best fix here is to consult a "grey hair" senior you might know who does reviewing regularly and ask for help.

About This Presentation:

- Contains subjective guidelines given by the author
- You may use or reject them based on your own needs
- Should be used as one input among many others
- **Further Work:**
 - A presentation “How to plan for a scientific paper” is in the works
- **Additional comment**
 - **Open Access** publishing is coming now with a very strong impact on how we publish....We need to learn more about how to deal with it! A new presentation is in the works, so stay tuned!

Postscript

- The presentation can be downloaded from:
www.mme2011.org/Scientific_writing.ppt
- Feedbacks and inputs to improve the presentation are most welcome!
 - Contact: Per.Ohlckers(at)hive.no

Thank you for your attention!