GUIDELINES ON WRITING A GOOD PAPER FOR THE *PROCEEDINGS OF THE WINTER SIMULATION CONFERENCE*

James R. Wilson
Former *Proceedings* Editor, Program Chair, and Board Member

(December 27, 2008)

The *Proceedings of the Winter Simulation Conference* is the permanent record of the papers presented at the conference. As an aid to authors who seek to improve the readability of their *Proceedings* papers, this note summarizes some useful guidelines on technical writing, including key references on each topic that is discussed. For questions about these guidelines, please send e-mail to <jwilson@ncsu.edu> or contact the *Proceedings* Editors.

I. Organizing the paper (what to do before beginning to write)

A. Analyze the situation—that is, the problem, the solution, and the target audience.

1. Formulate the objectives of the paper.

2. Specify the scope of the paper's coverage of the subject and the results to be discussed. Orient the paper toward the theme of your session as indicated either by the title of your session or by the instructions of your session chair. Also take into account the type of track—tutorial, methodology, or application.

3. Identify the target audience and determine the background knowledge that you can assume for this particular group of people. Introductory tutorials are generally attended by newcomers who are interested in the basics of simulation. Advanced tutorials are designed to provide more experienced professionals with a thorough discussion of special topics of much current interest; and some special-focus sessions in this track are designed to provide experts with an overview of recent fundamental advances in simulation theory. Methodology sessions are attended by professionals who have at least an undergraduate-level background in computer simulation techniques. In the application tracks, session attendees are generally familiar with the application area covered by their session.

4. Formulate the most logical sequence for presenting the information specified in item 2 to the readers identified in item 3. For a discussion of effective aids in organizing your paper (specifically, brainstorming, clustering, concept maps, issue trees, and outlining), see pages 21–26 of Matthews and Matthews (2008). In structuring your presentation, keep the following points in mind.

a. Introductory and advanced tutorials should have an educational perspective. Within the advanced tutorials track, special-focus sessions should synthesize the latest research results in a unified treatment of a given topic.

b. Methodology contributions should provide up-to-date information on proven techniques for building and analyzing simulation models.

c. Application papers should relate directly to the practice of simulation, and they should emphasize lessons of transferable value.

B. Make outlines to organize your thoughts and then to organize both the written and oral presentations of your work. See chapter 1 of Menzel, Jones, and Boyd (1961) and pages 24–26 of Matthews and Matthews (2008) for an excellent discussion of the construction and use of various types of outlines.

1. The introductory paragraph(s)
    a. State the precise subject of the paper immediately.
    b. State the problem to be solved.
    c. Summarize briefly the main results and conclusions.
    d. Tell the reader how the paper is organized.
2. The main body of the paper
    a. Include enough detail in the main body of the paper so that the reader can understand what you did and how you did it; however, you should avoid lengthy discussions of technical details that are not of general interest to your audience.
    b. Include a brief section covering notation, background information, and key assumptions if it is awkward to incorporate these items into the introductory paragraph(s).
    c. Include sections on theoretical and experimental methods as required. For an application paper, you should discuss the development of the simulation model—including input data acquisition as well as design, verification, validation, and actual use of the final simulation model. For a methodological or theoretical paper that requires substantial mathematical development, see Halmos (1970), Higham (1998), pages 1–8 of Knuth, Larrabee, and Roberts (1989), Krantz (1998), or Swanson (1999).
    d. Plan the results section to achieve the most effective mix of text, figures, and tables in the presentation of the findings. The definitive reference on the design of tables and figures is Tufte (2001).
3. The concluding paragraph(s)
    a. Explain how the theoretical and experimental results relate to the original problem. State why these results are important.
    b. State the final conclusions explicitly in plain language.

II. Writing the paper

A. Prepare an abstract that is concise, complete in itself, and intelligible to a general reader in the field of simulation. The abstract may not exceed 150 words, and it should not contain any references or mathematical symbols.

1. Summarize the objectives of the paper.
2. Summarize the results and conclusions.
3. State the basic principles underlying any new theoretical or experimental methods that are developed in the paper.
4. For complete instructions on the preparation of scientific abstracts, see *Guidelines for Abstracts* (1997), pages 91–93 of Carter (1987), page 5 of the *AIP Style Manual* (1990), or chapter 9 of Day and Gastel (2006).

B. Write the rest of the paper as though you were talking to a group of interested colleagues about your work.

1. Strive for accuracy and clarity above all else.
2. In writing the introduction, you should bear in mind the following maxim of Knuth, Larrabee, and Roberts (1989):

   > The opening paragraph should be your best paragraph, and its opening sentence should be your best sentence.

   You cannot achieve such an ambitious goal on the first try; instead as you add new sections to the paper, you should review and revise all sections written so far. For more on the spiral plan of writing, see pages 131–133 of Halmos (1970).

   a. Like the abstract, the introduction should be accessible to general readers in the field of simulation.
   b. For methodology papers and advanced tutorials, substantially more advanced background may be assumed in the sections following the introduction.
3. In constructing each sentence, place old and new information in the respective positions where readers generally expect to find these types of information. For an excellent discussion of the principles of scientific writing based on reader expectations, see Gopen and Swan (1990) and Williams (2007, 2008).

   a. Place in the topic position (that is, at the beginning of the sentence) the old information linking backward to the previous discussion.
   b. Place in the stress position (that is, at the end of the sentence) the new information you want to emphasize.
   c. Place the subject of the sentence in the topic position, and follow the subject with the verb as soon as possible.
   d. Express the action of each sentence in its verb.
4. Make the paragraph the unit of composition.

   a. Begin each paragraph with a sentence that summarizes the topic to be discussed or with a sentence that helps the transition from the previous paragraph.
   b. Provide a context for the discussion before asking the reader to consider new information.
   c. Avoid paragraphs of extreme length—that is, one-sentence paragraphs and those exceeding 200 words.
   d. Place the important conclusions in the stress position at the end of the paragraph.
5. Allocate space to a topic in proportion to its relative importance.
6. For methodology papers, emphasize the concepts of general applicability that underlie the solution procedure rather than the technical details that are specific to the problem. Supply only the technical details and data that are essential to the development.
7. For application papers, emphasize the new insights into the problem that you gained from building and using the simulation model.

8. Use standard technical terms correctly.

    a. For standard usage of mathematical terms, see James and James (1992) and Borowski and Borwein (2002). For example, a nonsquare matrix cannot be called "orthogonal" even if any two distinct columns of that matrix are orthogonal vectors.

    b. For standard usage of statistical terms, see Dodge (2003), Porkess (2005), and Upton and Cook (2006). For example, the probability density function of a continuous random variable may be called a "density" but not a "probability distribution function" or a "probability function."

    c. For standard usage of computer terms, see *The Free On-Line Dictionary of Computing* (Howe 1993) and *Dictionary of Algorithms and Data Structures* (Black 1998).

    d. For standard usage of industrial engineering terms, see *Industrial Engineering Terminology* (Engineering and Management Press 2000). For example, the time that a workpiece spends in a manufacturing cell may be called "cycle time" or "flow time" but not "throughput time."

9. Avoid illogical or potentially offensive sexist language. See Miller and Swift (2001) for a commonsense approach to this issue.

10. Strictly avoid the following—

    a. religious, ethnic, or political references;

    b. personal attacks;

    c. excessive claims about the value or general applicability of your work; and

    d. pointed criticism of the work of other people.

    Such language has no place in scientific discourse under any circumstances, and it will not be tolerated by the *Proceedings* Editors. With respect to software tutorials, items c and d immediately above require authors to avoid invidious comparisons of their products with competing products.

11. In writing the final section of the paper containing conclusions and recommendations for future work, you should bear in mind the following maxim of van Leunen (1992):

    > The mark of a good summary is revelation: "Remember this, reader? And that? Well, here's how they fit together."

C. For each table, compose a caption that briefly summarizes the content of the table. Comment explicitly in the text on the significance of the numbers in the table; do not force the reader to guess at your conclusions. See chapter 13 of *The Chicago Manual of Style* (2003) or chapter 16 of Day and Gastel (2006) for a comprehensive discussion of how to handle tables.

D. For each figure, compose a caption (or legend) that explains every detail in the figure—every curve, point, and symbol. See the *AIP Style Manual* (1990) or chapters 17 and 18 of Day and Gastel (2006) for excellent examples.

E. Revise and rewrite until the truth and clarity of every sentence are unquestionable.

1. For questions about the rules of English grammar and usage, see Bernstein (1965), Fowler (1965, 1996), Hale (1999), Fowler and Aaron (2006), O'Conner (2003), Strunk and White (2000), and *Webster's Third New International Dictionary of the English Language, Unabridged* (1976).

2. For those who use English as a second language, particularly helpful references are Booth (1993), Fowler and Aaron (2006), and Huckin and Olsen (1991).

3. For guidelines on how to edit your own writing effectively, see Cook (1985).

F. Prepare a complete and accurate set of references that gives adequate credit to the prior work upon which your paper is based.

1. The author-date system of documentation is required for all papers appearing in the *Proceedings of the Winter Simulation Conference*. Chapters 16 and 17 of *The Chicago Manual of Style* (2003) provide comprehensive, up-to-date information on this citation system.

2. In preparing your list of references, you should strive for completeness, accuracy, and consistency. Using the information provided in your list of references, the interested reader should be able to locate each source of information cited in your paper.

3. For complete instructions on citing electronic sources, see sections 17.4–17.15 of *The Chicago Manual of Style* (2003). For example, section 17.9 contains basic information on uniform resource locators (URLs); and section 17.11 provides useful rules for breaking a URL across two or more lines either in the text or in the list of references. Many specific examples of citations for various types of electronic sources can be found throughout chapter 17 of *The Chicago Manual of Style* (2003).

4. The final electronic version of your paper—that is, the Portable Document Format (PDF) file ultimately produced from the Word or LaTeX source file of your paper—may include external hyperlinks referring to some of the electronic sources cited in the paper that are accessible online.

   a. If an external hyperlink is live, then it is colored red; and when viewing the PDF file of your paper on a computer, the reader may select (click) that hyperlink for immediate online access to the cited material. More specifically, selecting (clicking) a live external hyperlink will activate the reader's Web browser and load the relevant URL into the browser's address bar so that the reader can view the cited source of information. (A live external hyperlink may also be used to activate the reader's e-mail software for sending a message to a specific e-mail address; for example, see the hyperlink given in the first paragraph of this document.)

   b. If an external hyperlink is not live, then it is colored black; and such a hyperlink merely displays the URL of the cited material without providing a mechanism for immediate online access to that material.

   c. If you use external hyperlinks in your paper, then you must ensure that the text displayed for each external hyperlink is correct and complete so that a reader who has only a hard copy of the paper can still access the cited material by (carefully) typing the relevant displayed text of the hyperlink into the address bar of a Web browser or e-mail program. Remember that your responsibility for the accuracy and completeness of each hyperlink in your paper parallels your responsibility for the accuracy and completeness of each conventional citation of a nonelectronic source—neither the Editors nor the publisher of the *Proceedings* can verify any of this information for you.

G. See Wilson (2002) for further discussion of the ethical considerations in writing a scientific paper, including:

1. achieving a consensus among collaborators on who should be a coauthor of the paper;
2. achieving a consensus among coauthors on the order of authorship in the paper's byline; and
3. writing the paper so as to anticipate and answer key questions that will be asked by the paper's referees and readers.

III. Achieving a natural and effective style

A. Alfred North Whitehead (1929) memorably expressed the gist of the matter of writing style:

> Finally, there should grow the most austere of all mental qualities; I mean the sense for style. It is an aesthetic sense, based on admiration for the direct attainment of a foreseen end, simply and without waste. Style in art, style in literature, style in science, style in logic, style in practical execution have fundamentally the same aesthetic qualities, namely attainment and restraint. The love of a subject in itself and for itself, where it is not the sleepy pleasure of pacing a mental quarter-deck, is the love of style as manifested in that study.
>
> Here we are brought back to the position from which we started, the utility of education. Style, in its finest sense, is the last acquirement of the educated mind; it is also the most useful. It pervades the whole being. The administrator with a sense for style hates waste; the engineer with a sense for style economises his material; the artisan with a sense for style prefers good work. Style is the ultimate morality of mind.

Kurt Vonnegut (1985) made the following equally trenchant observation on writing style.

> Find a subject you care about and which you in your heart feel others should care about. It is this genuine caring, and not your games with language, which will be the most compelling and seductive element in your style.

Strunk and White (2000), Williams (2007, 2008), and Zinsser (1998) are excellent references on achieving a natural and effective writing style.

B. Contrast the following descriptions of an experiment in optics:

1. I procured a triangular glass prism, to try therewith the celebrated phenomena of colors. And for that purpose, having darkened my laboratory, and made a small hole in my window shade, to let in a convenient quantity of the sun's light, I placed my prism at the entrance, that the light might be thereby refracted to the opposite wall. It was at first a very pleasing diversion to view the vivid and intense colors produced thereby.
2. For the purpose of investigating the celebrated phenomena of chromatic refrangibility, a triangular glass prism was procured. After darkening the laboratory and making a small aperture in an otherwise opaque window covering in order to ensure that the optimum quantity of visible electromagnetic radiation (VER) would be admitted from solar sources, the prism was placed in front of the aperture for the purpose of reflecting the VER to the wall on the opposite side of the room. It was found initially that due to the vivid and intense colors which were produced by this experimental apparatus, the overall effect was aesthetically satisfactory when viewed by the eye.

The most striking difference between these two accounts of the experiment is the impersonal tone of the second version. According to version 2, literally nobody performed the experiment. Attempting to avoid the first person, the author of version 2 adopted the third person; this in turn forced the author to use passive verbs. As Menzel, Jones, and Boyd (1961) point out, "Passive verbs increase the probability of mistakes in grammar; they start long trains of prepositional phrases; they foster circumlocution; and they encourage vagueness." Notice the dangling constructions in the second sentence of version 2. Isaac Newton (1672) wrote version 1. Even though it was written over 330 years ago, Newton's prose is remarkable for its clarity and readability.

C. To achieve a natural and effective writing style, you should adhere to the following principles that are elaborated in chapter 5 of Menzel, Jones, and Boyd (1961):

1. Write simply.
2. Use the active voice.
3. Use plain English words rather than nonstandard technical jargon or foreign phrases.
4. Use standard technical terms correctly.
5. Avoid long sentences and extremely long (or short) paragraphs.
6. Avoid slavish adherence to any set of rules for technical writing, including the rules enumerated here.
7. Remember that the main objective is to communicate your ideas clearly to your audience.

Acknowledgments

These guidelines are based on a similar document prepared by James O. Henriksen, Stephen D. Roberts, and James R. Wilson for the *Proceedings of the 1986 Winter Simulation Conference*.

References

AIP style manual. 1990. 4th ed. New York: American Institute of Physics. Available online via <www.aip.org/pubservs/style/4thed/toc.html> [accessed December 27, 2008].

Bernstein, T. M. 1965. *The careful writer: A modern guide to English usage*. New York: Atheneum.

Black, P. E., ed. 1998. *Dictionary of algorithms and data structures*. Washington, DC: U.S. National Institute of Standards and Technology. Available online via <www.nist.gov/dads> [accessed December 27, 2008].

Booth, V. 1993. *Communicating in science: Writing a scientific paper and speaking at scientific meetings*. 2nd ed. Cambridge: Cambridge University Press.

Borowski, E. J., and J. M. Borwein. 2002. *Collins web-linked dictionary of mathematics*. 2nd ed. Glasgow: Collins.

Carter, S. P. 1987. *Writing for your peers: The primary journal paper*. New York: Praeger.

Cook, C. K. 1985. *Line by line: How to improve your own writing*. Boston: Houghton Mifflin Co.

Day, R. A., and B. Gastel. 2006. *How to write and publish a scientific paper*. 6th ed. Westport, Connecticut: Greenwood Press.

Dodge, Y., ed. 2003. *The Oxford dictionary of statistical terms*. 6th ed. New York: Oxford University Press.

Engineering and Management Press. 2000. *Industrial engineering terminology*. Rev. ed. Norcross, Georgia: Institute of Industrial Engineers. Available online via <www.iienet2.org/Details.aspx?id=645> [accessed January 13, 2008].

Fowler, H. R., and J. E. Aaron. 2006. *The Little, Brown handbook*. 10th ed. New York: Pearson Longman.

Fowler, H. W. 1965. *A dictionary of modern English usage*. 2nd ed. rev. Sir Ernest Gowers. New York: Oxford University Press.

———. 1996. *The new Fowler's modern English usage*. 3rd ed. rev. R. W. Burchfield. Oxford: Clarendon Press.

Gopen, G. D., and J. A. Swan. 1990. The science of scientific writing. *American Scientist* 78 (November-December): 550–558.

Guidelines for abstracts. 1997. Bethesda, Maryland: NISO Press. Available online via <www.niso.org/standards/resources/Z39-14.pdf> [accessed December 27, 2008].

Hale, C. 1999. *Sin and syntax: How to craft wickedly effective prose*. New York: Broadway Books.

Halmos, P. R. 1970. How to write mathematics. *L'Enseignement Mathématique* 16 (2): 123–152. Available online via <www.ise.ncsu.edu/jwilson/files/halmos70em.pdf> [accessed December 27, 2008].

Higham N. J. 1998. *Handbook of writing for the mathematical sciences*. 2nd ed. Philadelphia: Society for Industrial and Applied Mathematics.

Howe, D., ed. 1993. *The free on-line dictionary of computing*. London: Imperial College Department of Computing. Available online via <foldoc.org> [accessed January 13, 2008].

Huckin, T. N., and L. A. Olsen. 1991. *Technical writing and professional communication for nonnative speakers of English*. 2nd ed. New York: McGraw-Hill.

James, R. C., and G. James. 1992. *Mathematics dictionary*. 5th ed. New York: Chapman & Hall.

Knuth, D. E., T. Larrabee, and P. M. Roberts. 1989. *Mathematical writing*. Washington, D.C.: Mathematical Association of America. Available online via <tex.loria.fr/typographie/mathwriting.pdf> [accessed December 27, 2008].

Krantz, S. G. 1997. *A primer of mathematical writing: Being a disquisition on having your ideas recorded, typeset, published, read, and appreciated*. Providence, Rhode Island: American Mathematical Society.

Matthews, J. R., and R. W. Matthews. 2008. *Successful scientific writing: A step-by-step guide for the biological and medical sciences*. 3rd ed. Cambridge: Cambridge University Press.

Menzel, D. H., H. M. Jones, and L. G. Boyd. 1961. *Writing a technical paper*. New York: McGraw-Hill Book Company.

Miller, C., and K. Swift. 2001. *The handbook of nonsexist writing*. 2nd ed. San Jose, California: iUniverse.com.

Newton, I. 1672. New theory of light and colors. *Philosophical Transactions* 6 (80): 3075–3087.

O'Conner, P. T. 2003. *Woe is I: The grammarphobe's guide to better English in plain English*. Rev. ed. New York: Riverhead Books.

Porkess, R., ed. 2005. *Collins web-linked dictionary of statistics*. 2nd ed. Glasgow: Collins.

Strunk, W., and E. B. White. 2000. *The elements of style*. 4th ed. Boston: Allyn and Bacon.

Swanson, E. 1999. *Mathematics into type*. Updated ed. rev. by A. O'Sean and A. Schleyer. Providence: American Mathematical Society.

The Chicago manual of style. 15th ed. Chicago: The University of Chicago Press. Available online via <www.chicagomanualofstyle.org> [accessed December 27, 2008].

Tufte, E. R. 2001. *The visual display of quantitative information*. 2nd ed. Cheshire, Connecticut: Graphics Press.

Upton, G., and I. Cook. 2006. *A dictionary of statistics*. 2nd ed. Oxford: Oxford University Press.

van Leunen, M.-C. 1992. *A handbook for scholars*. Rev. ed. New York: Oxford University Press.

Vonnegut, K. 1985. How to write with style. In *How to use the power of the printed word: Thirteen articles packed*

with facts and practical information, designed to help you read better, write better, communicate better, ed. B. S. Fuess, 33–38. Garden City, New York: Anchor Press. Available online via <literature.sdsu.edu/onWRITING/vonnegutSTYLE.html> [accessed December 27, 2008].

Webster's third new international dictionary of the English language, unabridged. 1976. Springfield, Massachusetts: G. & C. Merriam Company. Available online via <unabridged.merriam-webster.com> [accessed December 27, 2008].

Whitehead, A. N. 1929. The aims of education. In *The aims of education and other essays*, 12. New York: Macmillan.

Williams, J. M. 2008. *Style: The basics of clarity and grace*. 3rd ed. New York: Pearson Longman.

———. 2007. *Style: Ten lessons in clarity and grace*. 9th ed. New York: Pearson Longman.

Wilson, J. R. 2002. Responsible authorship and peer review. *Science and Engineering Ethics* 8 (2): 155–174. Available online as <www.ise.ncsu.edu/jwilson/files/wilson02see.pdf> [accessed December 27, 2008].

Zinsser, W. 1998. *On writing well: An informal guide to writing nonfiction*. 6th ed. New York: HarperCollins Publishers.