# How to Write a Good Scientific Paper

Library of Congress Preassigned Control Number: 2017964213

for

How to write a good scientific paper (ISBN 9781510619135).

Published by
SPIE
P.O. Box 10
Bellingham, Washington 98227-0010 USA
Phone: +1 360.676.3290
Fax: +1 360.647.1445
Email: books@spie.org
Web: http://spie.org



Printed in the United States of America.
First printing

# How to Write a Good Scientific Paper

Chris A. Mack

**SPIE PRESS**
Bellingham, Washington USA

# Contents

# Preface

Writing for peer-reviewed publication is an important part of the careers of many scientists and engineers. It is also an essential part of the scientific enterprise. Something this important should be done well. However, many scientists and engineers do not consider themselves good writers, so how can the average scientist write a good scientific paper?

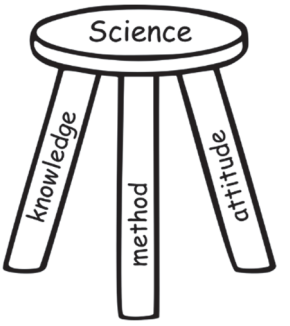
The good news is you do not have to be a good writer to write a good science paper, but you do have to be a careful writer. And while the creativity that often marks good science will sometimes spill over into the writing about that science, in general, good science writing does not require creative writing. In particular, writing for a peer-reviewed science or engineering journal requires learning and executing a specific formula for presenting scientific work.

This book is all about teaching the style and conventions of writing for a peer-reviewed science journal. (For the sake of brevity, I will use the word "science" to mean both science and engineering.) Anyone who absorbs the lessons of this book can become a better writer. At the least, you can become a good enough writer that your readers will judge your work by the quality of the science rather than the quality of the writing.

What I know about science writing has come from three separate experiences. First, I have written over 200 papers in my 30+-year career in the semiconductor industry. Like most authors, I have become a better writer through practice. I have also spent the last six years as Editor-in-Chief of the *Journal of Micro/Nanolithography, MEMS, and MOEMS* ($JM^3$), published by SPIE. That experience has forced me to judge the writing of others and to see the good, the bad, and the ugly of science publishing. Because of this experience, I embarked on a project of studying what makes for good science writing, and I have read many papers and books by other writers, editors, and historians of science on that topic. Taking advantage of my post as Editor-in-Chief, I started writing a series of editorials in $JM^3$ on good science writing (2012–2018). This book is mostly a compilation of those editorials.

## The Three Pillars of Science

Science can be thought of as the combination of three essential things: (1) a communal collection of knowledge (both facts/data and theories); (2) a method of evaluating the efficacy of scientific theories by comparing the predictions of those theories to observation/experiment; and (3) an attitude of skeptical inquiry and the belief that all scientific knowledge is provisional and subject to revision when confronted with new evidence. (A popular alternative breakdown of the "norms" of science, emphasizing its sociological nature, is Merton's "cudos", first introduced in 1942: communalism, universality, disinterestedness, originality, and skepticism.[1]) This breakdown of science into a body of knowledge, a method, and an attitude is useful in assessing the "scientific" content of any given behavior. If any one of these three pillars of science is missing from an activity, one cannot claim that the activity is scientific.




The growth of scientific knowledge is predominately incremental—we build on past knowledge more often than we displace it. Thus, the first pillar of science—a communal collection of knowledge—requires mechanisms for disseminating and preserving knowledge within the scientific community. By far the most important mechanism in use today is the scientific publication. Although there are many forms of scientific publication, the most important is the peer-reviewed journal paper. The goal of this book is to help authors produce good scientific papers and thus support the goals of science.

## Using This Book

This book can be read straight through, which I recommend for early-career scientists who are relatively new to writing and publishing papers. It can also be used as a reference for specific topics (e.g., how to produce a good figure or write an abstract). Each chapter is purposely short and can be read in isolation for easy reference. The appendix—a checklist for editors, reviewers, and authors—is a summary of the lessons of this book.

Throughout this book I will use the words "science" and "scientist" in the most expansive way possible to include people and activities generally called "engineering." Publishing in highly practical engineering fields or highly theoretical science fields (and every part of the continuum in between) has mostly the same requirements. Some fields, such as medicine, include additional important requirements, especially related to the use of and reporting on human or animal subjects. I will not be covering those important topics in this book, but the general lessons here apply even to those more specialized fields.

Because of my experience as Editor-in-Chief of $JM^3$, I have intimate knowledge and insider information about this specific journal. Where useful, I have included specific information from $JM^3$ to use as examples of the points I

make in the book. JM$^3$ is probably representative of journals positioned halfway between pure science and pure engineering, and I hope that examples from this journal will make the lessons of this book more real.

## Acknowledgments

My learning about science writing leaves me with many debts of gratitude. The experience of writing, for me, had been a mostly joyful and satisfying one. I am indebted to the many good authors who I have read and to the many coauthors I have been privileged to write with. Less pleasant have been the rejection letters and difficult reviews that I have received over the years, but I am even more indebted to these editors and reviewers for their careful and constructive criticisms that forced me to improve even when I did not want to. I am also grateful for the readers of my books and articles who have given me feedback and asked me questions. They have taught me that when a reader does not understand what I have written, it is almost always my fault, not theirs.

I would also like to thank the volunteer scientists that make up the editorial board of JM$^3$. Together, we have gone through the sometimes exciting but often routine process of publishing a peer-reviewed science journal issue after issue. Finally, I would like to thank the wonderful staff of SPIE, who not only publish JM$^3$ but are also publishing this book and making it freely available in electronic format. I have learned a tremendous amount from Eric Pepper and Karolyn Labes, who have coached and mentored me in my role as Editor-in-Chief and have reviewed and improved all of the material in this book. Thanks to John Mays and Scott McNeill as well for reviewing the text of this book.

I conclude with these oft-repeated words: much of what is good in this book is a consequence of the many people who have helped me over the years, and all of what is bad is due to my own shortcomings.

Chris A. Mack
*Austin, Texas*
*January 2018*

## References

[1] R. K. Merton, *The Sociology of Science: Theoretical and Empirical Investigations*, University of Chicago Press, Chicago, IL (1973).