The Importance of Technical Paper Writing

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Writing a technical paper for submission to a Symposium can be a daunting task, especially if you are not accustomed to doing this sort of writing. Furthermore, after writing the paper, you naturally want to have it accepted! There are two important things to understand when submitting a paper for acceptance at a conference, (1) technical content, and (2) how well the author expresses his/her ideas in a clear manner.

Bonnie Brench has written an excellent article that gives some do's and don'ts when writing a technical paper for submission to a conference. As the EMC Society Technical Advisory Committee Chair, and after performing many peer reviews for conferences, I can tell you how important it is to follow her guidelines! Every year, many papers are not accepted, even when the technical content was probably quite good. I use the word 'probably' because the authors were not clear enough about what they did, and why it was an important technical contribution. As we head towards the time to begin paper submissions for EMC 2011 in Long Beach, please take the time to read her article and follow her advice to give yourself the best possible chance to have your paper accepted!

Writing a Technical Paper

By Bronwyn Brench, N.C.E.

Introduction

Whether experienced at writing papers or just beginning, it is always useful to have your memory refreshed on what constitutes a successful technical paper. Clearly, a successful paper is one that is accepted into a technical publication and then is read and referenced by others. To achieve this end, it must first be determined that a particular body of work is unique and valuable to others. Second, the paper must be well written and follow the style guide of the chosen publication. This article covers the basics of paper acceptance, and reviews many of the writing pitfalls made by both veteran and beginner authors alike.

I. Paper Acceptance

It is vital to know the criteria for the type of publication, and to understand the audience for which the paper is intended. Two typical venues for technical papers in the EMC field are the IEEE EMC Transactions and the IEEE EMC Symposium. A third option is the Practical Papers section in the IEEE EMC Society Newsletter. Here, papers are generally shorter and cover topics of wider interest to readers. The focus of this article is on papers submitted to the *IEEE Transactions on EMC* and the IEEE International Symposium on EMC Proceedings publications.

IEEE EMC Transactions

The *IEEE Transactions on EMC* has very clear instructions, located on the inside back cover of the journal, on the requirements for a paper submitted for publication. Basically, work of archival (long lasting) value is sought, including advances in the state of the art, both theoretical and experimental. There are two paper length options; a full length, eight page Paper, and a Short Paper. Full length papers are peer reviewed in detail and edited, and multiple review periods are possible. Short Papers are generally four pages in length and typically narrower in scope. These are either accepted as submitted without any substantial changes, or rejected.

IEEE EMC Symposium

Paper submittals to the annual IEEE International Symposium on EMC may be directed toward the Regular or Special Sessions, and all papers have the same requirements: they must be significant to EMC, have technical depth, be readable in clear English, and contain new, unpublished work. These papers are peer reviewed, although not as heavily as for the *IEEE Transactions on EMC* papers. Manuscripts will be either: accepted, accepted with required changes (requiring a second peer review), accepted with suggested changes, or rejected.

If the paper is directed toward one of the Special Sessions at the Symposium, do not make the mistake of thinking it will be automatically accepted because it was "invited". These sessions are typically organized by an individual or EMC Society Technical Committee (TC) on a topic that is of particular interest. Therefore, think of it as an invitation to submit a paper on a special topic; a topic that will not necessarily be repeated the following year. All Special Sessions papers are peer reviewed, and are held to the same required high standards as Regular Session papers.

Regular Session papers may be presented orally or in a Poster Session (Open Forum). Both types receive equal peer reviews; it is merely the presentation that differs. One common misconception is that papers in the Poster Session are of lesser value or have more relaxed standards. This is far from the truth as it is always a goal of the Symposium review committee to ensure that a good variety of topics are presented in the Poster Sessions. The major benefit of a Poster Session to the author is the ability to directly interact with interested attendees, which can be a great source of information to those doing similar work.

II. Key Parts of a Technical Paper

The Writing Overview

Once the requirements for the paper have been reviewed and the work has been completed and researched for technical value, the writing may begin. Writing a technical paper, especially for an international audience, can be a daunting task. Not only can the English language be a problem, but many scientists and engineers never learned how to write a formal technical paper. There are a few good instruction guides on line, [1] and [2], if a tutorial is needed; however, the highlights of technical paper writing and a few notes on many of the common errors are given in this article.

A technical paper is not an English paper. It is also not a science lab report. The layout of a formal technical paper typically consists of the following key elements: Abstract, Introduction, Work Done, Results & Discussion, Conclusion, and References. The Abstract and Introduction are standard with their titles and content. The meat of the paper is contained in the middle sections, Work Done, Results, and Discussion, and the labeling or titles for these sections vary depending on the topic. The final two sections, Conclusion and References, are also relatively standard with their titling and content. Sometimes an Acknowledgements section is inserted between the Conclusions and References.

Working drafts often begin with the Work Done, Results, and Discussion sections. The Introduction and Conclusion sections can be started a bit later, to aid in binding the flow of the paper together. Make certain that any goals and objectives stated in the Introduction are addressed in the Conclusions. Oddly enough, the Abstract should be written last. It is only after the introduction and conclusions have been written that there will be clarity in how to phrase this special, brief summary of the paper.

Abstract

The Abstract is the most important part of a technical paper, and perhaps one of the most misunderstood parts. Everyone reads them, and they are essentially the "selling point" for the paper. Even experienced authors lose sight of the purpose of an abstract and how it should be written. The key thing to remember about an abstract is that it should be a stand-alone mini-summary of the paper. Abstracts are typically extracted from each paper and published separately in an abstract listing, for readers to browse when deciding which papers they want to read in full or attend for the actual presentation of the paper. For this reason, it is especially important to spend detailed writing time on the abstract to get it precise.

The Abstract should be clear and concise, a single paragraph, typically 200 words maximum. It should include the purpose, a brief description of the work, and the pertinent results or conclusions. The English should be impeccable, especially if an international audience is expected. A special effort had to be made at the 2007 IEEE International Symposium on EMC, for example, where the EMC Society celebrated its 50 year anniversary, to grammatically edit a large majority of the extracted abstracts so that they could be clearly understood by the wide set of international attendees.

The most common mistake made is to treat the abstract as a brief introduction to the paper. The author mistakenly believes that this is where the reader's attention must be caught with eye grabbing phrases, and then leaves them with a cliff hanger to hope they will read on. The reality is that the abstract loses its conciseness and the crucial results/conclusions synopsis is left out. Other points to note include:

- Using too many words can cause readers to skim and possibly miss important points.
- Leaving out the summary results or conclusions can cause readers to lose interest.
- Using acronyms should only be done if used again within the abstract.
- Making a reference with a footnote is never allowed.
- Making a reference with a citation at the end of the paper is never allowed.
- Make certain the English is perfect.
- Avoid background information; that is for the Introduction.

If these guidelines are followed, then your abstract will become a perfect selling point for your paper.

Introduction

The Introduction is the true start of the paper. Do not make the mistake of thinking that the Abstract is a sort of first paragraph; it is totally separate. The Introduction does just that – it introduces the reader to the work.

A typical Introduction includes four paragraphs. The first paragraph is the place for those wordy, eye catching phrases giving the reasons for and importance of the work, and why someone would want to read the paper. The second and third paragraphs contain a brief description of the background to the problem and the connection of the present work to the background. The final paragraph includes a clear statement of the purpose or goal of the work; it is an expansion from the Abstract. This will lead the readers smoothly into the start of the actual work of paper.

One error that is frequently found in paper submittals is that little, if any, research was done by the authors to determine that the work is indeed new and original. No matter how well written the paper is, it will be rejected if it is not original. Researching the subject matter is a good fundamental engineering practice. Why would you want to spend time doing the work and writing it up if the answer is already known? This vital step can save a great deal of wasted effort.

The Main Body

This is the main part, or "meat" of the paper, and includes the work done, results, analysis, and discussion sections. The exact layout and section titles will vary depending on the topic.

A description of the work and methods used, i.e. how the work was performed, should be given in the first section. A mistake sometimes made is to list the equipment used, as if it were a lab report. If a description of any of the equipment used is necessary in understanding the work, then it is acceptable to describe that key equipment.

Next, the results should be given and analyzed. The results section is sometimes separated from the discussion section, but usually they are combined. Tables, graphs, and diagrams should be used to help visualize and explain the results and analysis. Each table and figure needs a written explanation; do not assume the reader can understand it on their own. What may be obvious to the authors may not always be obvious to others.

Frequent problems are found with tables and figures when they are shrunk down to fit in a two column format. Please, use the sizes and formatting as defined in [3] or [4]. Using anything different makes the paper harder to read and follow, and causes it to look unprofessional. If the details of the figure cannot be seen when shrunk down, then consider breaking it into multiple figures. Pay attention to any labels or wording in figures that get reduced; these must be 8 to 12 point type after reduction. Also, it is important to make sure the curves in multiple curve plots are distinguishable. Even though the use of color is now acceptable, solid fill colors are preferred as they contrast well both on screen and on a black-and-white hardcopy.

Discussing the results is also important, but leave the conclusions for the Conclusion section. The objective here is to provide an interpretation of your results and a description of any significant findings. This will logically lead readers into the Conclusion section.

Conclusion

This is a place many authors get stuck. They have written up their work and described, analyzed, and discussed their results. What more can be said without repeating everything in the summing up? This is the time for the author to sit back and think about how their work relates to the big picture.

The author should review their original stated purpose, the results, and discussions. Perhaps there is more that can be done to further the work. With these thoughts fresh on the mind, the conclusion can then be written such that it is not simply a "we did this, this, and that", but rather a concise summing up, or review, followed by a brief discussion on how your findings relate to the big picture. A discussion of any recommendations for further work is also a fine addition, if relevant.

Acknowledgements & References

Sometimes an Acknowledgement section is inserted just before the Reference section. This is especially important if funding has been received from a special source for the work and research that was performed. Co-workers who assisted in the work but were not involved in the final writing may also be listed here.

There are many categories of references or works cited, so use the style guide in [3] or [4] for details on how to list each type. It is essential to supply a comprehensive and relevant set of references. This is necessary because it gives credit to those who have done similar work and it indicates to the reviewers that you have done your homework. Papers that only reference the author's previous work or a few recent papers attract the reviewer's attention as being incomplete.

A word about authors and co-authors: the IEEE has a policy [5] concerning who should be included as co-authors on a paper; an extraction of this policy is quoted below:

"The IEEE affirms that authorship credit must be reserved for individuals who have met each of the following conditions:

1. Made a significant intellectual contribution to the theoretical development, system or experimental design, prototype development, and/or the analysis and interpretation of data associated with the work contained in the manuscript,
2. Contributed to drafting the article or reviewing and/or revising it for intellectual content, and
3. Approved the final version of the manuscript, including references."

Anyone not meeting each of the three conditions should therefore be included in the Acknowledgement section.

III. And Finally …

Proofread! Once the final draft of the paper is finished, do not forget to leave time for the review, both technical and grammatical. Incomplete sentences, redundant phrases, misspellings, and grammatical errors are unprofessional. Waiting a day or two before reviewing helps to provide a fresh approach, and more mistakes can be found. Another good way to catch errors is to give the paper to somebody else to read. The more people who review it, the more comments will be received, creating opportunities to improve the paper. If English is not your native language, it would help if one of the reviewers is a native English speaker, or have a trained technical editor proofread your paper. It may be that your heavily accented English is passable to a native English speaker, but can other non-native English speakers also understand? I heard a story about how one native English speaker had to act as an interpreter between two others speaking their own accented versions of

the English language! It will increase your chances for success if the grammar is correct.

Writing an effective paper is time consuming, but is worth the effort when it is finally published and others can read and reference your work in their own research. Know and follow the criteria for the particular publication to which you are submitting, and make sure that all the components of a good technical paper are included in the next one you write.

IV. Acknowledgement

I would like to thank Colin Brench, who has reviewed technical papers for many years for the IEEE International Symposium on EMC, for his input on what reviewers look for in Symposium and Transactions papers.

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Biography

Bronwyn Brench has been active in the IEEE EMC Society Symposium committees for a number of years. She was the Registration Chair in Boston 2003, and again in Austin 2009, and will be at the upcoming Long Beach 2011 Symposium. For the 2007 Hawaii 50th Anniversary Symposium, she was the Publications Editor and reviewed all of the paper abstracts and Advance and Final Programs.

Bronwyn was the technical editor of the IEEE Std. 1597.1 – 2008, Validation of Computational Electromagnetics Computer Modeling and Simulation, and also the first (1998) and second (2001) editions of the book, EMI/EMC Computational Modeling Handbook (Kluwer Academic) by Archambeault, Brench, & Ramahi. She has reviewed and edited numerous technical papers and articles for publication, as well as authored and co-authored over a dozen papers published in various technical reports and at IEEE Symposia. Prior to her EMC involvement, she was a member of the IEEE Standards Subcommittee on Photovoltaic Storage Systems for seven years (1980–87), and Chairman of that Subcommittee for the final four of those years. The result of this work was ANSI/IEEE Std. 937–1987.

Bronwyn received her B.Sc. in Electrical and Electronic Engineering in 1977 from The City University, London, has been a NARTE certified EMC Engineer since 1990, and is a past Senior Member of the IEEE.

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