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How to write a technical paper

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ABSTRACT

Writing a technical paper can be an hard task and, often, writers are not certain what should be included and how the information should be presented. [2]
Usefully, there is a standard outline to which the most important scientific and engineering journals are compliant. Here instructions for authors for publications in *railwaysignalling.eu* e-journal, are given.
Even if this document doesn't give tips about the *railwaysignalling.eu* formatting rules, you can use it as both an instruction set and a template into which you can type your own text. However, for further details about any formatting costraints for publications, refer to the the document "technical_paper_formatting_rules".
A standard technical paper contains an introduction, which includes a statement of the problem, a literature review and a general outline of the paper, a methods section showing the work done, results and analysis, discussion and applications, and a conclusions section.
Following this tips, you'll be able to write a clear and flowing paper, to be published on the e-journal.

KEYWORDS: technical paper, journal article, scientific writing, how to, outline

1. INTRODUCTION

The essence of engineering is the application of theory to produce tangible results. If a technical paper contains both theory and measured results, and clearly shows how the theory and results can be broadly applied, generally it can be submitted for a publication. [9]
railwaysignalling.eu is a technical e-journal. It grows with the purpose to publish high-tech articles about the most advanced and widespread signalling and train control European solutions.
So, what's the best way to share your professionality, increase your knowledge and your visibility?
The most engineering and science articles, have an accepted general format, witch consists in a structure of paragrhaphs, through which the author should completely and clearly describe his work.
Note that *railwaysignalling.eu* doesn't impose you to submit only a strictly innovative publication. Indeed, if one of our purposes is pushing the railway signalling technologies to innovative solution, on the other hand we want to share all kind of knowledge about these topics, even if already known by someone.
Thus, even if your contribute isn't oriented to find new results, we aim to transfer and extend the area of your knowledge.
The layout of a formal technical paper typically consists of the following key elements: *Abstract, Introduction, Methods, Results, Analysis, Discussion* and *Conclusion*. The Abstract and Introduction are standard with their titles and content. The core of the paper is contained in the main body section, (*Methods, Results, Analysis* and *Discussion*) and the labeling or titles for these sections vary depending on the topic. The *Conclusion* section is relatively standard with its titling and content. Optionally, an Acknowledgements section is inserted between the conclusions and references paragraphes.
This paper explains in details how to write a technical article following these rules, to be published on *railwaysignalling.eu*. Anyway, what you're going to read is applicable to every branches of engineering.

2. STRUCTURE OF THE PAPER

2.1 Abstract

The abstract is a brief, accurate, and comprehensive summary of the article contents, without added interpretation or criticism. [10]
It should be a single paragraph, no longer than 200 words, written with the purpose to reduce the whole paper in a fiew rows. Thus, it should contains:

- A general introduction to the topic (summary of the *introduction* paragraph)
- A brief description of the analysis and the operative methods (summary of the *methods* paragraph)
- An outline of the major results (summary of the *introduction* paragraph)
- A summary of the *conclusion* paragraph

The challenge you've to deal with, is just raising the main contents of the whole paper and building a stand-alone mini-summary of the paper.
Readers normally have their first contact with an article by seeing just the abstract and deciding on the basis of the abstract whether to read the entire article. Thus, an abstract must be informative and readable, well organized, concise, and self-contained. [10]
Furthermore, note that, in the most cases:

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1. Only the words in the abstract can be searched using library database
2. With the right words in the abstract, you can get a high search engine ranking for your keywords.

Write the abstract after all the other sections of the document are completed. Below, an example of a well done abstract:

"Fishes swim by flapping their tail and other fins. Other sea creatures, such as squid and salps, eject fluid intermittently as a jet. We discuss the fluid mechanics behind these propulsion mechanisms and show that these animals produce optimal vortex rings, which give the maximum thrust for a given energy input. We show that fishes optimize both their steady swimming efficiency and their ability to accelerate and turn by producing an individual optimal ring with each flap of the tail or fin. Salps produce vortex rings directly by ejecting a volume of fluid through a rear orifice, and these are also optimal. An important implication of this paper is that the repetition of vortex production is not necessary for an individual vortex to have the 'optimal characteristics." [2].

2.2 Introduction

Since the abstract is "only" a summary of the paper, the introduction is the true start of the paper. Its purpose is to interest the reader in the paper. To accomplish this task, it's useful to follow the outline of Figure 1.

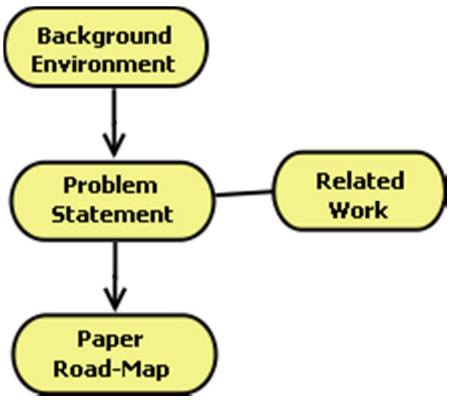

Figure 1: Introduction outline

Thus, the introduction starts with a broad statement and it becomes more detailed until finally identifying the specific problem that the paper addresses. [2]
Inside this framework, it can be useful to cite the work of someone else, regarding similar topics. The literature review identifies the seminal historical contributions, outlines the state of knowledge and specify why and how your contribute is new and\or original.
Later, the introduction can either give a general outline of the paper, with more details then the ones briefly shown in the abstract.
Below, an example of a well done introduction, with emphasis on each of the sub-section just presented:

"Observations of swimming fishes and other organisms such as salps reveal a series of vortex rings forming behind the animals, which play an important part in their mechanisms of propulsion. (BACKGROUND ENVIRONMENT)
Fishes produce these vortices by an undulatory motion of the body and tail, controlling the periodic shedding of vorticity into the wake, and salps form them more directly, by ejecting fluid backwards through an orifice.
In both cases the vortices roll up into three-dimensional (3D) ring-like structures. For fishes, the important question is what frequency and amplitude of the undulatorymotion provide the most efficient propulsion? A similar question faces the oarsman of a gondola. For efficient motion, should the oar be moved slowly at large amplitude or quickly with a smaller amplitude? (PROBLEM STATEMENT)
Here, we discuss this question, not in terms of a periodic motion, but by considering each flap of the tail or fin as a single event. This may be repeated periodically during steady swimming, but may be aperiodic during a turn or other manoeuvre. For other organisms using a jet for propulsion, the hard question is how long a jet provides the optimal efficiency." (PAPER ROAD-MAP) [2]

In conclusion, the introduction acts as a bridge that transports your readers from their own lives into the "place" of your analysis.
So, it should do the following:

- alert a reader's interest
- provide a context for the main issue
- indicate the scope and direction of the paper
- indicate the focus of the paper
- show the reader how you are interpreting and approaching the question
- indicate your conclusion and point of view

2.3 Main Body

This is the main part, or "core" of the paper and includes the methods through which the work's been done, results, analysis, and discussion sections. The exact layout and labeling or section titles will vary depending on the topic.

2.3.1 Methods

A description of your work and methods used, i.e. how the work was performed, should be given in this section.

2.3.2 Results

Next, if your work comprises a set of quantitative results, they should be given and analyzed.
Tables, graphs, and diagrams should be used to help visualize and explain the results. Each table and figure needs a written explanation. Do not assume the reader can understand it on their own because what may be obvious to the authors may not always be obvious to others. [13]

2.3.3 Discussion

The objective here is to discussing and analyzing results, providing an interpretation and a description of any significant findings.

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2.4 Conclusion

This final paragraph doesn't introduce any new information to the paper. It merely summarizes and concludes.

The summary part of this section is different than that at the end of the introduction section. Indeed, here the summary draws on the fact that the reader knows all of the new results presented in the article. It then summarizes what the important results where.

Furthermore, this parapraph generally includes more specific conclusions. It is often more quantitative than the abstract, but listing equations, computer software code or something similar, should not be necessary.

2.5 Biography

A technical biography for each author must be included. It should not be longer than 20 lines. The name should be linked to the author's website (if applicable) or LinkedIn profile.

2.6 Appendix

A technical paper can present one or more appendixes. This section is optional and contains information no strictly necessary to understanding of the paper, but may further clarifies a point without burdening the body of the paper.

Moving text to the appendix is a good way to reduce the pages of the main portion of your paper, and to preserve the pace of reading. Appendices usually contain long program codes, rigorous and tedious proofs, mathematical background of a key concept which is not well documented, and detailed instructions of reproducing an experiment.

3. GENERAL TIPS

Before starting to write, it's useful to take a look to some guidelines, which can help during the work.

For further details about technical writing, you should refer to a wide and complete guide, like [6] or [7].

3.1 The importance of a previous document structure

At the beginning of your work, you may not be ready to write full paragraphs, but you can decide which sections your paper will have and give them descriptive titles. So, it's very simple and useful to following these step:

1. Decide the section structure
2. Write a little outline of each section, which indicates the subsection titles
3. Expand titles into a topic sentence for each paragraph.
4. At this point, since you know the exact topic of each paragraph, you will find the paragraph easy to write.

3.2 Use figures and diagrams

Figures and diagrams can help to illustrate concepts, draw a skimming reader into the text (or at least communicate a key idea to the reader), and make the paper more visually appealing. Furthermore, different people learn in different ways, so you should complement a textual or mathematical presentation with a graphical one. Even for people whose primary learning modality is textual, another presentation of the ideas can clarify, fill gaps, or enable the reader to verify his or her understanding.

It's important to follow a single style for all the figures present in the document, so choose a drawing software to design any kind of diagrams and always use it.

Make sure the curves in multiple curve plots are distinguishable. Solid fill colors are preferred as they contrast well both on screen and on a black-and-white hardcopy.

Figure 2 shows an example of good diagram to be added in a technical paper, drawn using the freeware "GnuPlot" software, currently available online at the URL "http://www.gnuplot.info/"

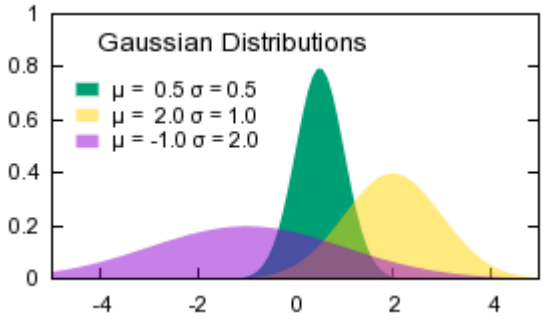

Figure 2: Example of diagram

3.3 Write for readers, not for yourself

Write for the readers, rather than writing for yourself.

In particular, think about what matters to the intended audience, and focus on that. It is not necessarily what you personally find most intriguing.

Another way of stating this is that the purpose of the paper is not to describe what you have done, but to inform readers of the successful outcome or significant results, and to convince readers of the validity of those conclusions.

A common mistake is to focus on what you spent the most time on. Do not write your paper as a chronological narrative of all the things that you tried, and do not devote space in the paper proportionately to the amount of time you spent on each task. [8]

3.4 Principles and pratices of successful writers

In conclusion, the following tables list a set of principle and pratices you should always to keep in mind if you want to be a good copywriter:

Principles
Correctness Write correct English, be clear and try to write short and flowing sentences.
Consistent names Refer to each significant character (algorithm, concept, language) using the same word everywhere. Give a significant new character a proper name.
Singular To distinguish one-to-one relationships from n-to-m relationships, refer to each item in the singular, not the plural.

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Subjects and verbs Put your important characters in subjects, and join each subject to a verb that expresses a significant action.
Information flow In each sentence, move your reader from familiar nformation to new information.
Emphasis For material you want to carry weight or be remembered, use the end of a sentence.
Coherence In a coherent passage, choose subjects that refer to a consistent set of related concepts.

Table 1: Principles of successful writers

Practices
Write in brief daily sessions. Ignore the common myth that successful writing requires large, uninterrupted blocks of time. Instead, practice writing in brief, daily sessions.
Focus on the process, not the product. Don't worry about the size or quality of your output. Instead, reward yourself for the consistency and regularity of your input.
Prewrite. Don't be afraid to think before you write, or even jot down notes, diagrams, and so on.
Don't worry about page limits. Write the paper you want, then cut it down to size.
Cut. Plan a revision session in which your only goal is to cut.

Table 2: Pratices of successful writers

For more details about this issue, refer to **Errore. L'origine riferimento non è stata trovata.**.

4. CONCLUSION

A technical paper should be clear and it should flow smoothly. Following these formatting instruction, your document'll be well structured and will be a pleasure to read it.

With good, clear and innovative contents, your paper can also an opportunity to make a good final impression and to end on a positive note. Before starting to write, if you have not already done it, also read the *railwaysignalling.eu* formatting constraints, addressed by the document **"**technical_paper_formatting_rules".

5. NOMENCLATURE

IEEE	Institute of Electrical and Electronics Engineers
GPRS	General Packet Radio Service
QoS	Quality of Service
STM	Specific Transmission Module
TSR	Temporary Speed Restriction

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7. BIOGRAPHY

Maurizio Palumbo was born in Naples, Italy, on 26 September 1986. He got , at the end of 2010, his degree in Computer Engineering from the University *Federico II* of Naples.

He's a curious, smiling and enthusiastic engineer.

Since the beginning of 2011 he has worked at Alstom Transport SPA in Bologna headquarter, as technical consultant for Alten, one of the European leaders in consulting and engineering. He has been involved in two ERTMS/ETCS L2 projects. In particular, he has specialized in the trackside subsystems, working both on Italian (Bologna-Florence High Speed Line) and Danish (Fjernbane East railway) projects. He's the founder and of railwaysignalling.eu, where he's also known as *Vesuvius*.

APPENDIX A: Copyright and author responsibilities

Copyright is a legal term describing rights given to creators for their literary and artistic works.

The copyright law of the European Union has arisen in an attempt to harmonise the differing copyright laws of European Union member states. It consists of a number of directives, which the member states are obliged to enact into their national laws, and by the judgments of the Court of Justice of the European Union [12].

One of the biggest mistakes that people commonly do is thinking if an online work has no copyright notice (the symbol is "©"), it is not copyrighted. Instead, in general terms, all works such as publications or documents pubblished online are subject to copyright, whether or not this is explicitly stated.

For this reason, riproduction, use or disclosure of third parts of any contents you can find online or by third parts, is forbidden without the owner autorithy or express references.

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