

MEE004

Abstract Art: The Neglected Art of Writing Abstracts

John Morris

Faculty of Engineering, Maharakham University, Maharakham 44150, Thailand
Corresponding Author: j.morris@auckland.ac.nz, +66 86 224 9239

Abstract

Abstracts may be the most important section of any paper, but abstracts in many published papers were found to be poorly written. The most prevalent fault was the omission of numeric results which prevents readers from using and citing results without needing access the full text of a paper. In two important journals, 100% of abstracts sampled lacked numeric results! Other common faults included unneeded detail (obvious statements and verbose statements) which lengthened abstracts (typically at least by 10%) and, possibly, prevented authors from increasing the overall signal-to-noise ratio by inclusion of additional key data from the authors' experiments. Many authors are missing the opportunity to increase the visibility and gaining citations of their research by omitting details of results - particularly numeric results.

Keywords: Technical Papers, Writing Style, Abstracts.

1. Introduction

Abstracts are generally the last part of a paper that is written: scanning published abstracts suggests that little attention is paid to them - perhaps because they are written hurriedly in the rush to get the rest of the paper published. However, I will argue that they are possibly the most important part of a paper and deserve more attention.

The journal *Chemical Abstracts* was first published by the US Bureau of Standards in 1907 [1], moved to University of Illinois in 1909 and taken over by the American Chemical Society in 1956 [2]. It included abstracts and citations of almost every chemistry paper - starting with 12,000 papers in 1907, to over 40 million entries now. Every university and many industrial organizations devoted many library shelves to very large paper copies until searchable electronic versions appeared in the 1980s[3].

For many chemistry researchers, since the chemical abstracts invariably provided key data, *e.g.* physical properties of compounds, and a full reference, it was often unnecessary to refer to the paper itself and many of us simply cited the paper from its abstract. This was valuable for libraries on constrained budgets - as long as you had *Chemical Abstracts*, much of the information you needed to support your research was readily available and searches for, often difficult to obtain papers, could be avoided. Recently, this custom seems to have been forgotten, forcing us, sometimes unnecessarily to search for full papers. Although web search engine now make it possible to find relevant papers (and well organized specific target search engines, such as the modern successor to *Chemical Abstracts* [3], make it easy), abstracts have become valuable again for a different reason. Publication of scientific journals is expensive, so few publishers provide full texts free on line. If your institution does not subscribe to a journal electronically, you must pay a considerable charge - typically at least \$US30 for an article that may contain only 8 pages - a

very high charge per page - or search only papers available in a finite set of affordable subscriptions.

This paper was prompted by advice on abstract writing which appears to be regularly read (based on its prominence in Google searches) but which does not mention any requirement for numeric results [4].

1.1 Importance of abstracts

The abstract of your paper will be read *many more times* than the full text. Thus you should prepare it carefully. It should describe your methods and results with some detail as it may be read by someone who cannot easily access the full text. If you write a good abstract, then others can cite your work without needing access to the full text: this represents a small contribution to the rapid dissemination of your work and to the whole community.

2. Requirements

2.1 Background

Provide a *very brief* background to justify your research. This should usually be quite short (no more than two sentences) and avoid 'motherhood' statements that everybody accepts. Often you can effectively combine a description of your system or technique or ... with a statement of its aim or application.

2.2 Verbosity

Nobody wants to read 20 words when 10 will suffice! Abstracts are, by definition, concise and should be written simply and directly. Apart from strict constraints on word counts applied by some editors, a verbose abstract may be skipped by a reader, because the sought details are missing or obscured.

Direct active style

A common failing in technical papers is not writing in a *direct active* style, in which the key word is a *verb*.

MEE004

For example, why write:

An experiment was carried out to measure the composite's tensile strength. (1)

instead of

We measured the tensile strength. ? (2)

The first is bad in the paper's text, but unforgivable in an abstract - ten words used when five suffice. Here, the useless words are "experiment" (of course you made one: the whole paper is about it), "was carried out" (just not needed) and "composite" (the whole paper is about composites, starting with the title - you don't need to repeat it). However, you must be clear that you measured something and didn't derive values from simulation or calculation, make 'measure' the verb. Examples of failure to use a direct active style taken from recent published papers are in Table 1.

Table 1: Examples of direct active forms

Original	Direct active form
We address the problem of estimating ..	We estimate ..
We performed an experiment to test ..	We tested ..
.. shown to successful in solving this task	.. solve this task successfully
We carried out an extensive analysis ..	We analyzed carefully ..

Noun phrases

English allows you to string together several nouns to make a compound term. Instead of writing

excited by a source of wavelength of 850nm(3)
write

850nm excitation source (4)

This removes a number of unnecessary words - the prepositions and articles. This is particularly helpful if your first language is not English. It is difficult to understand which article ('the', 'a' or none) is appropriate. There is a correct preposition to associate with verbs and nouns but many to choose, so an easy mistake to make. Unfortunately, the wrong choice is readily seen by a native speaker, even though you thought it was a sensible one to use. In a noun phrase, you leave out the articles and the prepositions, shortening your sentence *and* reducing errors.

Personal pronoun

Use them! Ignore ill-advised 'experts' or just bad examples found in the literature. This advice is an illogical extension of an important rule for good scientific writing: your work should be objective. Your design, analysis and conclusions must be objective, but it is *your* design and *your* analysis, so save space - write 'we' or 'I' - and especially eschew pompous statements like 'the present author'.

Common practice uses the passive voice - creating an illusion of objectivity - but sometimes the English passive leads to an unnecessarily complex structure:

simplify it with 'we' or 'I' and save a few valuable words.

Numeric results

Almost every scientific paper contains some numeric results. Often these are key results: new material properties, performance improvements, better efficiency, lower cost *etc.* These must be included in a good abstract. They enable readers to use *your* results without access to the full paper. If you have large tables of numeric results, then put a digest of them in the abstract, *eg* means and standard deviations or values at common parameters.

Do not claim more accuracy than is realistic, *ie* do not write 8.374, when your data is only accurate to 5%, write 8.3 ± 0.4 . Implying more accuracy than justified is particularly misleading in the abstract, which may be read without access to experimental details which would reveal the likely real accuracy.

2.4 Units

One set of abbreviations permitted - and strongly recommended - in abstracts are the SI units. They save space and are clearly defined: any reader can look them up.

2.5 Forbidden

Numbered references

An abstract must stand alone: many readers will not have access the reference list, so do not write

We extended previous results[23]

If you must refer to previous work, then use the authors' names (plus *et al.* if more than two):

We extended Smith and Jones' work on

If this work is well known, then your readers understand this reference well, but [23] will be meaningless. In contrast, the abstracts in *Nature* break this rule regularly! References immediately follow the abstract in the on-line version, so *Nature* editors may argue that this is appropriate. Other publishers sometimes include references with the on-line abstract. However, abstracts are routinely copied into personal bibliographies (leaving the references behind) and cost-saving publishers may change their policies to save space and time, so, unless you are writing for *Nature*, I recommend avoiding them in abstracts.

Acronyms

A few acronyms are well known, *eg* readers of an electronic design paper will understand 'ASIC' and 'VHDL', and they may be used *without expansion*, but not all acronyms are universally known, so write them out in full in the abstract - even if you define and use them in the body of the paper.

Generalizations

Generalizations should be saved for the introductory sentences of the main text. Although generalizations should be avoided there too in the interests of brevity! General statements, *eg* about 'global warming', waste space there also. A good paper will start with some

MEE004

hard facts, *eg* estimates of actual costs or effects on sea levels or similar.

Stating the obvious

A paper on global warming does not need to start
Global warming is a major problem for the environment. (5)

Everybody (except a few American politicians and oil company CEOs) knows this! Start the abstract with a specific statement of the aim of your work to alleviate the problem, *eg*

We estimated the global warming reduction through combustion engine emissions using ..(6)

This combines your research topic and its aim or importance in a single sentence. Similarly, omit redundant phrases like 'in this paper' and replace 'This paper shows that ...' with 'We show that ..'. When you must fit all your results into 100 or 200 words, every word saved is valuable. You can probably also remove any occurrence of 'this paper' from the whole paper.

Plagiarism checkers

Plagiarism checkers are available to editors and reviewers [5]. Obvious statements (*eg* Quote(5) above) may be innocently written, but flagged by a plagiarism checker because it is *similar* to ones appearing in dozens of variants elsewhere. Editors are busy and may automatically reject after reading the total plagiarism score that you attracted from several other equally innocent statements. You want your abstract be found by researchers using search engines to build bibliographies: a more detailed statement combining a specific aim linked to the global problem is 'safe': a plagiarism checker will not match the whole sentence, see Quote (6).

Non-standard units

Non-standard units are time-wasting and annoying for readers who might be unfamiliar with them, *eg* imperial units (inches, pounds *etc*) and 'rai' for area in Thailand. Imperial units are now not understood outside the US and rarely used in their country of origin. Your work will not be useful internationally, unless you use units that are internationally recognized standards.

3. Citations

Modern search tools make the generation of citation counts for individual papers readily available. Even many years ago, when papers were written on mechanical typewriters and sent by postal mail to journal editors, a hard-working professor in my department had published more than 150 papers (all neatly titled "XX I:..." to "XX CL: ..", "XX CLI: .."). Now, such a count might be considered small! Prolific authors claim more than 100 published papers: so search committees sometimes look more closely at citation counts to assess a candidate's real contributions. Thus it is important to try to ensure that other researchers are citing your papers.

As the long history of *Chemical Abstracts* shows, some workers will cite your work - quite reasonably - on the basis of numeric data found in the abstract: they only want a key piece of data (*eg* property of some material). Taking the data from the abstract is the same as taking it from a handbook!

A reviewer of this paper suggested that citing a paper based on the abstract alone can be *dangerous*. Whilst this is generally true and it is clearly desirable that the full paper be checked, there are also other situations where the abstract is actually sufficient: *eg* if you want to claim that your result exceeds the best published result, if the abstract is written concisely, with sufficient background detail, then you only need the numeric result to make your claim valid.

Clearly stated and useable results in your abstract increase the chance that your work will be cited! This will increase your citation counts and have a positive influence on your CV.

4. Experiments

A selection of abstracts from major journals (*IEEE PAMI*, IF=4.8 [6]; *Nature*, IF=30.98 [7]; Springer *JRTIP*, IF=1.11 [8]) were read and assessed. The most common failure was the omission of useful numeric results from the abstract: 100% of abstracts checked in one issue of *IEEE PAMI* [6] and over 50 % for *JRTIP*[8]. This is a major problem: readers are forced to access the full paper to obtain data which they might want to use for their own experiments or as a basis for improvements that they want to make. For an author, it may mean a lost citation, because the reader may find the needed data in other papers. For the *IEEE* journal, it was hypothesized that the editors were removing numeric data, but no direction to this effect could be located in the directions for authors [9]. Acronyms and verbiages were the next most prevalent problem: *Nature* appears to have strict editors and is a good model, but in most of the rest, the abstract could be shrunk by 10 % or more.

5. Conclusions

An abstract, based on the number of times it is read, is the most important part of your paper. However, regrettably, it appears that the majority of researchers fail to follow some simple rules to generate good abstracts. The most significant failure was omission of complete summaries of results, in particular numeric results. It appears that most writers attempt to describe what the reader can find in the text, rather than the key results that would enable a reader to use those results immediately. Abstracts are far more readily available - invariably free - so many researchers miss an opportunity to more widely distribute their own work.

Verbosity is the next most prevalent problem. Given that a significant proportion of non-English speakers in the scientific community, this is surprising. Good technical English is concise and simple and

MEE004

therefore easier to write - especially if your first language is not English! Unfortunately, it appears that the native speakers, who can add the redundant and complex expressions with ease, are not setting a good example for the rest of the community. Since an abstract space is limited, a good abstract has a very high signal-noise ratio, adds the maximum amount of scientific detail and omits anything that is redundant or clearly understood from context. It is obviously unnecessary to start the abstract of a research paper with "The aim of this paper is to show X is ..". Editors, publishers and readers would all prefer you to start with the actual *result*: "We show that X is .."!

6. References

- [1] US Bureau of Standards (1907), *Chemical Abstracts*. US Bureau of Standards, 1956-2010.
- [2] American Chemical Society (1956), *Chemical Abstracts*. American Chemical Society.
- [3] Fachinformationszentrum Karlsruhe (1983), STN.
- [4] C. Andrade (2011), How to write a good abstract for a scientific paper or conference presentation," *Indian Journal of Psychiatry*, no. 2, pp. 172-175.
- [5] Plagiarism checkers (2015), Commercial companies: <http://www.grammarly.com/plagiarism-checker/>, www.turnit.com, <http://www.plagscan.com/seesources/...>.
- [6] IEEE (2014). Table of contents, *IEEE Transactions Pattern Analysis and Machine Intelligence*, vol. 36, no. 12.
- [7] Royal Society (2014), Table of contents, *Nature*, vol. 36, no. 12.
- [8] S. Saponara, A. Plaza, M. Diani, M. Carlsohn, and G. Corsini (2014). Special issue on algorithms and architectures for real-time multi-dimensional image processing, *Journal of Real-Time Image Processing*, vol. 9, no. 3, pp. 393-396, 2014
- [9] IEEE (2014), Template and instructions on how to create your paper, IEEE, URL: http://www.ieee.org/documents/trans_jour.docx