CARBON 46 (2008) 1113–1114

available at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/carbon

Editorial

Writing a scientific paper: III. Experimental

I am writing this Editorial on a Sunday morning at an ambient temperature of around 22 °C while listening to the radio (Bang & Olufsen, Model Beolit 1000) tuned to Classic FM at a frequency of 101.5 MHz. My computer (Apple Macintosh iMac with Intel 2 GHz Core Duo processor, OSX 5.2) has had the "mouse" replaced by a trackball (Kensington Expert Mouse, Model K64325) and uses a word processing program (Word® 2004 from the Microsoft Office for Macintosh 2004 suite). I am sure you are immediately interested! Curious perhaps as to why I am giving you these facts.

If you were interested in radios you would perhaps know that Bang & Olufsen (B & O) is a very expensive and innovative brand of electronic equipment, based in Denmark, and that this model is a portable radio that is over 40 years old. It is not digital but it still produces clear reproduction of all analogue radio broadcasts on MW, LW and SW. Indeed I bought it a few years before moving to the USA in 1969 so that I could listen to the BBC wherever I was in the world. The radio still works perfectly and, believe it or not, it gives me the same programs as any other analogue radio purchased today, regardless of manufacturer, with perhaps even better clarity of reproduction.

As a scientist you will know that the Apple Macintosh range of computers has been innovative in the field of computer design and user interface. You will also know that the word processing program Word® is the most used program of its type in the scientific community. The great majority of electronic submissions to CARBON are produced using this program.

Why do I tell you this? Simply because it is part of the accepted format for writing a scientific paper. But is it important? NO!

The document is the same regardless of computer and operating system used. You cannot tell from reading this Editorial anything about the system I am using, and that is how it should be. The equipment manufacturer and model is irrelevant.

I recently received a manuscript which spent two pages telling me about the makes and models of all equipments used. Two different SEMs, two different TEMs, one of which was equipped with EDS and EELS instrumentation, a Raman spectrometer and a TPD apparatus, etc. The length was even longer because each instrument was given a separate subsection, wasting a lot of space. Was all this information necessary? If the reader wishes to check the authors' results does he need to assemble the same suite of apparatus? Surely not! While I well recognise that different instruments can have different resolutions etc., the make and model are usually irrelevant. If TEM A gives different pictures from TEM B, how do I know which to believe? And if this is the case, surely all results are suspect. In giving such information we are perhaps simply often showing off how rich our laboratories are, or are we simply providing free advertising for the instrument manufacturers?

Some authors will have noticed that in the last year or so I have sometimes deleted such information from manuscripts when I consider it to be irrelevant, and I thought it appropriate that I explain why, and at the same time point out that we should keep our papers short and to the point (concise and precise). Give essential information, and don't pad!

You may have noticed that in the second paragraph I referred to "Bang and Olufsen (B & O)". Why did I include the information in parentheses? Was it necessary? Of course the answer is "no". I never used it again in the Editorial (until now that is). The purpose of placing abbreviations in parentheses is to define them for future use. If you are not going to use them, there is no need to define them! On the contrary, is there really any need nowadays to define TEM and SEM? How many of you did not know what I was talking about when I used these abbreviations earlier? Almost certainly, none of you. But still almost every author who uses results from these instruments insists on making the definitions, sometimes several times.

The point I am trying to make is that we often include irrelevant information in our manuscripts and in so doing we lengthen them unnecessarily. Writing a scientific paper is a serious matter and needs to be approached carefully. Bear in mind that the care taken to write your paper may be seen as an indication of the care taken to do your experiments. Eliminate everything that is unnecessary, and at the same time make sure you include all that is necessary.

This morning's mail included a review of a manuscript in which the authors described a pyrolysis process for carbon fibers. The make and model of the furnace was given but there was no mention of the size. From the time in the furnace and the speed at which the fiber passed through it the reviewer was able to calculate the furnace length as 2.5 Km! Obviously some vital information was missing!

What then is the purpose of the Experimental section? It is certainly important, and a member of our Editorial Advisory

Board wrote a recent letter to ask why the section was in smaller print because he thought it an important component of the manuscript and found it difficult to read. (Such is no longer the case with the new manuscript format.)

The Experimental section has two purposes:

a. To allow readers to repeat the experiments if they wish. This might involve (i) checking dubious results, and/or (ii) preparing identical materials for further investigation, and
b. To convince readers that the work has been done systematically and thoroughly using appropriate equipment.

Because of this the section should contain ALL information needed for another person to repeat the experiment. This means details of sample preparation, sources of materials, purity, particle size, times and temperatures and synthesis of intermediates. It should also include details of important experimental parameters used in analytical and measurement techniques, such as voltages, wavelengths and strain rates.

In some respects the Experimental section is analogous to a recipe in a cookery book. It lists ingredients and procedures but does not specify the use of particular equipment.

What then should we do with instrumental details? The answer surely lies in the technology that is now available to us. Looking back over the last 25 years as Editor-in-Chief of CARBON Journal one sees two major changes. One is the electronic submission process and the other is the availability of Supplementary Material on the website. The first of these began as an option but is now a requirement. The second is an option that, in my opinion, should be made a requirement. One of its components should be a list of the equipment used. This would free space in the journal and would in no way devalue the manuscript.

A final point concerns the way people describe instruments, especially electron microscopes, both scanning and transmission. Many of you will know that I started research on graphite nearly 50 years ago by studying neutron radiation damage in natural single crystals of Ticonderoga graphite using a transmission electron microscope. In those days the "workhorse" of electron microscopes was the Siemens Elmiskop I. The best resolution was around 10 Å (1 nm). To us it was a "high resolution" instrument, certainly much higher that some of the early instruments where 5 nm was as good as one could get. Nowadays I am often told that both a TEM and a HRTEM (high resolution) were used, (or an SEM and a FESEM) and this morning I came across a paper in press for another journal that promises "super resolution". Is "super" better than "high"? The resolution is what is seen on the micrograph, and that depends on many factors, especially the magnification at which the micrograph was taken. A picture taken at 5000× on a HRTEM cannot show high resolution. Surely it is enough to say that "the samples were examined by transmission and scanning electron microscopy" and to give instrument details in the Supplementary Material? I have often asked the question "at what point does an instrument become high resolution?" and have never received a clear answer. One person said that it was high resolution when it was capable of lattice resolution, but that only raises the question: "which lattice?" I wonder whether anybody makes a low resolution transmission electron microscope, and why is there no high resolution scanning electron microscope? Scientists can be very inconsistent!

I am convinced that the Experimental section of almost all papers could be significantly shortened. It should concentrate on providing the information that the reader really needs to have in order to be satisfied on the above two points, and provide a list of equipment used in the Supplementary Material section. Surely that is enough!

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0008-6223/$ - see front matter

doi:10.1016/j.carbon.2008.04.001

Available online 6 April 2008