The power of the 'pretty picture'

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Images used in science communication do not always show the subject matter in the best or most informative way. Felice Frankel describes the role of the beautiful image as a successful and compelling way to communicate complex ideas.

My work as a science photographer has taken two directions at once — in creating arresting images of science research in order to convey its importance and its beauty both to a broader public and to the scientists themselves, while always maintaining the integrity of the science I photograph. Recently, I have also devoted a great deal of time to the equally important enterprise of encouraging scientists to the scientific benefit of visually representing their results with more communicative and accessible images and other forms of visual scientific representations[1]. So it is always something of a shock for me to hear that often-repeated statement: "Now here's another pretty picture", the not-so-subtle, disdainful comment offered by many researchers during presentations of otherwise interesting and elegant results. For me, the fact that many materials researchers are moved to make excuses for showing beautiful images of their work, as though they were not an integral part of the presentation and the science, but more tangential, is disturbing. Among other things, their discomfort fascinates me. "Pretty picture" is their label for an extraordinarily appealing image, but one that cannot possibly have any value in real science. The speaker will rapidly move on to the next grey-scale graph or formula — a wink to the audience acknowledging everyone's agreement that no attractive representation of their science should be taken seriously.

I wonder what causes this insecurity. The advent of remarkable new imaging tools has given us an exciting opportunity to see the materials world in ways we've never dreamed of. And surely, one of the reasons why so many scientists delve into the field in the first place has to do with its inherent beauty. But why is communicating that attribute discouraged? It's true that researchers should be absorbed in documenting the 'material' to communicate to their colleagues, but unfortunately, that's where it seems to stop — that the 'good enough' image is good enough.

THE RESPONSIBILITY OF JOURNALS

The overriding problem is that researchers are not encouraged by journals to create anything other than purely 'documentary' images. Journals do not use high-resolution and well-composed images in the way they deserve to be used. They don't reproduce images at a size permitting the reader to become absorbed along with seeing the relevant information — often the grey-scale images in particular are reproduced small. The problem, the editors tell us, is 'space'. I sympathize entirely with journal art departments understanding well what they go through and knowing from my own work with them how committed they are. They wish more resources were available to them to reproduce the rare stunning image with better reproduction. Unfortunately, art departments do not have final authority on how much space will be devoted to images and are therefore limited to what they can do. Their only opportunity to demonstrate their creativity is designing journal covers, when they can properly reproduce a well composed and executed image. For that reason, researchers unfortunately think of the special image only after the fact, when their article is being considered for publication and are requested to submit cover material.

Some of my own book projects provide good examples of the problems I am focusing on here. In a discussion on how science at the micro and nanoscale might borrow from nature's design[2], I chose a photograph I had previously taken of a macroscopic image of a *Morpho* butterfly wing[3] (Fig. 1a). I needed to make some SEMs (Fig. 1b,c) — the richness of the samples was inspiring and I made many more than are shown here. The material was begging to be imaged at

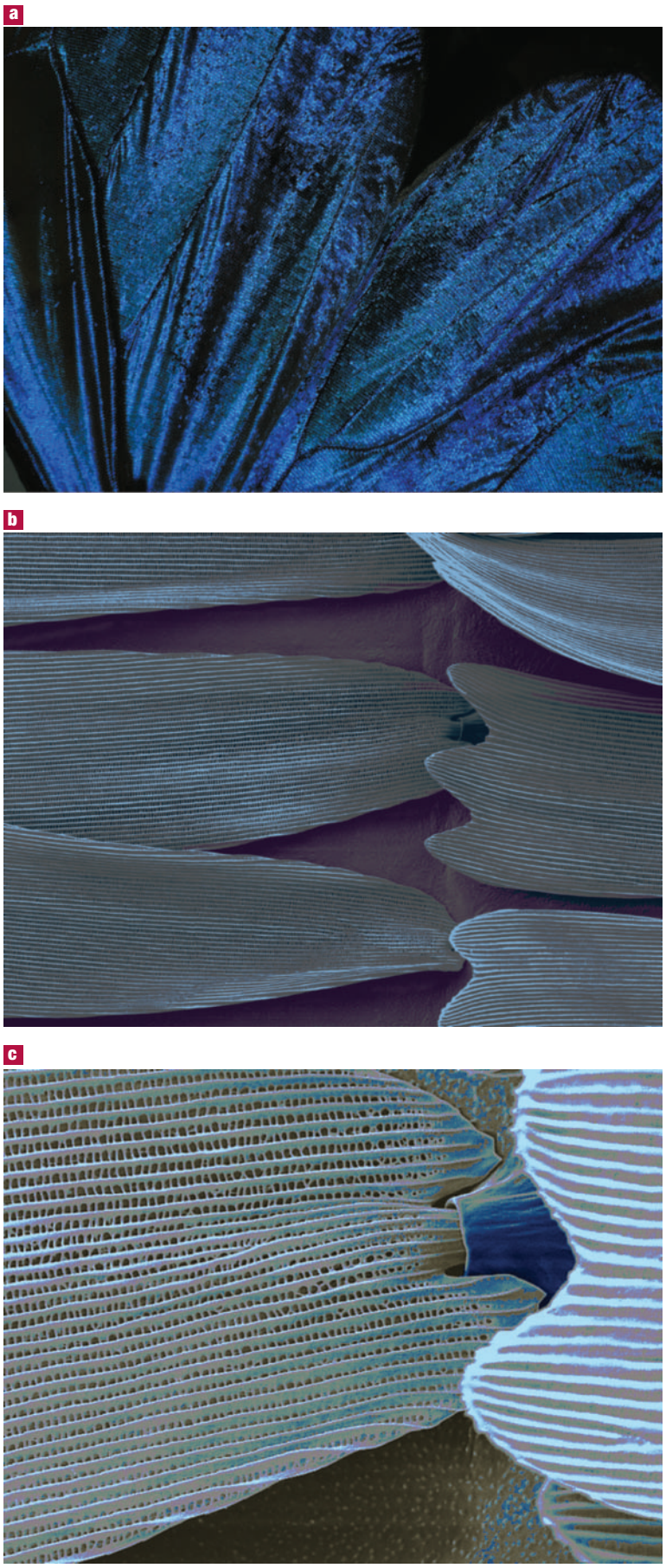

Figure 1 **Increasing detail of a *Morpho* butterfly wing tells a more interesting and informative story than just one image. a, A 4-cm detail, captured on film with a 35-mm camera and a 105-mm macro lens. b and c, Digitally coloured SEMs of the same *Morpho* butterfly wing at different scales : image widths are approximately 200 μm (b) and approximately 60 μm (c). (Images by F. Frankel.)**

various scales and to be shown large, in order to see its periodic structure. I assumed there would already be an abundance of similar images in the literature and that I wasn't doing anything unusual.

Surprisingly, when later researching various relevant articles, I was amazed at how few images in the literature communicated how stunning the material was[4]. What could have been a beautiful visual expression of fascinating science, turned out, for most of these journals, to be text-full articles with the images used as tangential, almost unreadable decoration.

The message from the journals to scientists is loud and clear: "Science images are second class. Don't waste your time. We will give your images very little attention (space). And for that matter, if you must show your pictures in colour, then you will have to pay for it yourself." As a result, scientists don't bother making the very best image and give little thought to important communicative elements like composition and clarity. The 'good enough' image is simply good enough.

THE NEXT GENERATION OF SCIENTISTS

We are missing a unique opportunity. The inter-disciplinary nature of materials research is fertile ground for using pictures to translate important science to each other, and to help define the work to those unfamiliar with what exactly the field is about. Using accessible and communicative images and displaying them properly could be a valuable tool to engage future researchers. And, not unimportantly, given the substantial financial investment of research money to support nanoscale science initiatives, materials scientists have a perfect opportunity to stake out part of that territory. Certainly, producing wonderful and accessible images of materials science research is one way to communicate its relevance. It is possible for an image or illustration or diagram to be both highly informational and breathtaking to look at.

Some in the next generation of researchers are perpetuating the message that images are tangential to the communication of the research. A while ago, I was surprised to see how few graduate students have 'bothered' to set the SEM resolution to its maximum. "Why should we?" they had probably asked themselves, "if the image is only going to be reproduced as a 2.5 × 5 cm unreadable rectangle?" No matter that one might actually see more at a higher resolution, and that there might, in fact, be more information. We are changing that attitude at MIT's Center for Materials Science and Engineering and the results are sometimes breathtaking.

VISUAL TRANSLATIONS, DIAGRAMS AND ILLUSTRATIONS

I am convinced that giving careful thought to how we visually express science in order to communicate the work, whether in images, diagrams or illustrations[5],

clarifies the science for both the viewer and the communicator. An image for your own notebook is different from one used to tell a story to someone else (Fig. 2). And similarly, the thinking that is involved when creating one's own visual translation of research is different from simply borrowing from someone else's representation. The process of producing a simple drawing or a sketch to communicate a particular concept is a powerful teaching tool. Isn't that how we already informally talk to each other?

THE WEB AND TAKING RESPONSIBILITY

With the advancing use of the web, we now have a new area that brings important opportunities for interactive and linked information, and for other visual means of expressing science. But with that opportunity comes new responsibility. We must begin to exercise the same rigorous standards for our visual expressions of science as we do for our scientific investigations. First, we must not to be seduced by what might turn out to be superficial tools, albeit 'cool', made attractive by its mere interactive component. We must ask the question, does the interactive component really communicate more and does it give us more information than a less complicated series of still images?

Second, most of us who make images are aware of the potential to 'enhance' and manipulate an image. We must continue to remind ourselves of what we already know, that when one changes a histogram or colours an SEM, for example, (as I did in Fig.1b,c) one is changing the data. Therefore, we must always question the appropriateness of such changes[1]. See Fig. 3 as an example.

Because of the ease in manipulating images, journals and researchers must become more responsible and inform their readers of whatever manipulation was performed. Scientists must be asked to maintain accurate step-by-step records of how they first captured the image and what was done to that image for the final submission. The same is true for graphs or other visual expressions of data. Journals should and must provide a web-based 'image/figure methodology sidebar' or section and post the information.

THE FUTURE

The visual expression of research is a powerful means of communicating important science and must gain the respect it deserves. A 'pretty' picture of science is not mere decoration but one that reveals the beauty and substance that is already there. Teaching the next generation of researchers to include insightful thinking of how to visually represent science will have a profound effect in advancing the communication and understanding of science.

Figure 2 **Improving an image by redesigning. a, Patterned hydrophobic lines, 3–4 mm long, on a self-assembled monolayer (SAM) stop water from further wetting the surface. This image was made by the researchers for their notebook and used in the published article. (Image reprinted with permission from ref. 6. Copyright (1992) AAAS). b, At my suggestion, the sample was redesigned to further communicate the significance of the lines. In addition, by colouring the water before dropping it on the SAM, the purpose of the investigation is reinforced — that the lines are preventing the water from blending together. Note, as well, the not-so-trivial issue, that the image in b is in focus while the other is not. Image b was used on the cover of the journal. (Image by F. Frankel.)**

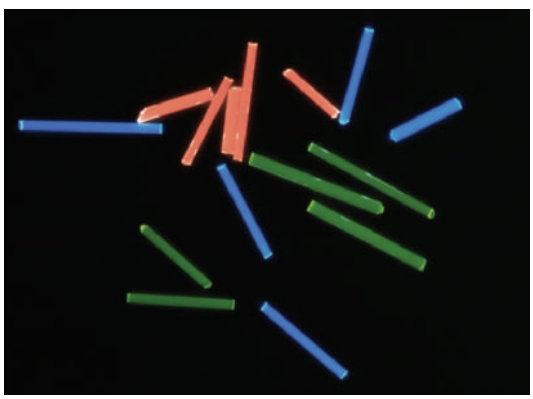

Figure 3 **A digitally 'corrected' image of fluorescently labelled 3-cm rods. The original image was captured on the wrong choice of film giving a green colour to those rods that should have been orange. I digitally changed the colour of those specific rods matching them to how they appeared in the camera. I stress that any digital alterations must always be recorded and reported. (Image by F. Frankel.)**

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