Felice Frankel on micro and subatomic imaging

Mathematician Benoit Mandelbrot, the father of fractal geometry, has called your book Envisioning Science "priceless." That's high praise.
I am so grateful for his support. Benoit has spoken to me often about how the mathematics of his fractals came after he first saw their images. This is one of my soapboxes: seeing a thing first often leads to an expansion of ideas after.

We are visual creatures after all, are we not?
Absolutely. We have to be very careful because there's so much visual noise out there. Digital manipulation can change the information in images, so we need to become intelligent about how images are made. Envisioning Science is an attempt to encourage future scientists, and also non-scientists, to look at science through a camera's lens – to go deeply into the ideas that one can capture in a photograph, or any sort of illustration. It's about visually communicating ideas in science. That's what I'm totally committed to.

You did a wonderful job with the yeast colony, for example.
Thank you. Yes, the hardcover version of Envisioning Science has a detail of what some people see as a stunning picture of a yeast colony, which looks just like a flower. The patterns within this flower are even more exciting. I took this photograph in [yeast genetics pioneer] Gerald Fink's lab at MIT for a science journal. I made the picture with the Petri dish and later digitally removed it because I thought it would bring more attention to what was going on in the most important part of the image – these wonderful patterns. We did, by the way, get the cover of Science, which I was delighted about, but the researchers were concerned that by digitally altering the image, I was also deleting information about scale. It's those conversations that are so important to have in

the science community.

In the seventeenth century, natural philosopher Robert Hooke said, "A sincere hand and a faithful eye to examine and to record the things themselves as they appear." Where do you draw the line with the aesthetics of the scientific image?

The problem is, that line keeps moving around! It really depends upon the purpose of the image. If I make the picture for a submission to a science journal, obviously we want to be as straightforward as possible. I don't think I'm bringing in an aesthetic. I believe I'm revealing an aesthetic that makes the image more accessible.

Tell me about a time when a scientist was absolutely thrilled with the colorful portrayal of his or her research.

Moungi Bawendi, a chemist at MIT who works with nanocrystals, is making material that fluoresces when you look at it under UV light – you get different colours depending upon the size of the crystals. He and his colleagues had photographed the nanocrystals in a solution with various kinds of containers, so the different shapes got in the way and distracted your eye away from the colors of the nanocrystals, which was the important point of the science. Very simply, all I decided to do was to make a picture of these beautiful colors lined up in similar vials with the view to communicate the science succinctly: as you change the size of the nanocrystals, you change the color. That's all we wanted to say. Moungi agreed.

You focus on science in the laboratory. Are you equally amazed by the images satellites are capturing these days?

How can you not be? These images are stunningly beautiful. But you must remember

that the colors are produced digitally. The information is captured through various filtration methods and by knowing what filter has captured what cloud, for example, the person working on the image will color it accordingly. This is not deceptive. NASA is doing a fabulous job of bringing attention to the glorious world out there. Chemists and physicists now need to do the same for the micro and subatomic world. It is just as beautiful and just as exciting as the cosmos.

How did you begin working with Harvard chemist George Whitesides?

Pure luck! I was on a midcareer (Loeb) Fellowship at Harvard and ended up auditing one of his molecular biology classes. I enjoyed his visual sensibility and invited myself to his lab after class one day. He introduced me to one of his postdocs, Nick Abbott, who was working on a submission to Science magazine. I looked at the photographs of the work and knew I could do better. These were 4-mm-wide square drops of water, which stayed within a grid pattern when you plopped them on the surface. So, to make a long story short, I asked them for all kinds of different material and went to work. Not only did I get the picture in focus, but we also made the cover of Science, which was quite remarkable. That was the beginning.

When you work at the atomic level, do you make images using electrons and atomic forces?

I've worked at the nano level, a bit larger than the atomic level. And I always work with people who know much more about the equipment than I do. These instruments require extensive training, so I sit with either the technician or the researcher and ask them to do this or that to the image, to represent it the way I would like to. This whole realm is very difficult to communicate, even for students in the field. One of the researchers was telling me that he was with an undergraduate who was holding a test tube of nanotubes up to

the light and proclaimed, “I don’t see them.” Well, of course you can’t see them with the naked eye, because you need electrons to see them!

Is two-dimensional photography limited in an era of moving images and multidimensional computer modelling?

I firmly believe that there is a strong place for the still image. I work with animators and people working with dynamic imaging, but I wonder if we get more information from a moving animation. Take, for example, the series of still pictures I made over time of a Belousov-Zhabotinsky reaction. The reaction is continuous, but if you look at stills taken every eleven seconds and display them within a grid of twelve images, you can actually see how one moment changes to the next.

If I were to animate the process, would you get more information by seeing it in motion? We can be blown away by knock-your-socks-off animation, but sometimes it happens too quickly to sufficiently communicate deep ideas.

What images in science would you say have over time changed the way we see ourselves?

The earthrise. The double helix. The X-ray. And then of course there are pervasive images in science that are dead wrong, like the dumb illustration of evolution, where an ape-like figure slowly stands upright. This is not what evolution is about. It’s a terrible simplification of something much more complicated.

In the introduction to Envisioning Science, the late author and educator Phylis Morrison traces the history of the scientific image back to Neolithic cave paintings in France and early sketches by Copernicus and Darwin. How broadly do you define the scientific image?

Yes, what is a science image? It's a very good question. People painted images in the Chauvet cave 30,000 years ago. Although they didn't know they were making a science image, they documented bison and whatever else they were seeing. I document what I see too. I feel the world is science and if one takes a picture of part of the world, then that picture is a representation of that world, and so it is a science picture.

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