Nanotechnology, storytelling, sensing, and materiality

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Introduction

The process of taking quantum theory and transforming it into a quotidian experience via nanotechnology seems inevitable. In the international marketplace, there are currently hundreds of nanotechnology-based products ranging from sunscreens and beauty products to fitness clothing and equipment to medical products, and more are being added every day. (Project on Emerging Nanotechnologies, 2008) Meanwhile, government funding for nanotechnology research, over the last five years, is estimated at $40B (2004-2008) and, in 2009, it's expected that an additional $9.75 billion will be invested. (cientifica, [sic] April 2009: 2)

Still no one really knows how to explain or describe nanotechnology simply. Scientists and others trying to educate and communicate to the public about nanotechnology focus on descriptions of size and scale. (Berger, October 17, 2008) The comparison to a human hair (one nanometre is 1/60,000 of a single human hair) is usually made in a futile attempt to describe and discuss it. Even amongst scientists, the standard for explaining nanotechnology is to invoke a measurement; nano means one billionth. (So, a nanometer = one billionth of a metre.) Alternatively, explaining that nanotechnology allows us to manipulate matter at the atomic and molecular levels will generally reward you with a blank stare. These explanations simply don't fire the imagination or aid understanding.

'"You don't see something until you have the right metaphor to let you perceive it", [Robert Stetson] Shaw said, echoing Thomas Kuhn.' (Gleick 1987: 262) An important figure in the development of chaos theory, Shaw highlighted the importance of the metaphor (vital to storytelling and exciting to the imagination) while using the metaphor of 'sight' to describe the ability to understand a new concept. In reality we are dependent on all of our senses for information although sight tends to be privileged where scientific information is conveyed.

Sensing and understanding nanotechnology

At the molecular and atomic levels (i.e. the nanotechnology level), the equipment used for sensing matter is not based on optics (sight) but haptics (touch). 'In going from a light or electron microscope to a scanning probe microscope we have moved away from looking to touching.' (Jones 2007: 18) Most people do not realize that any visual images of nanoscale structures that they see are products of art just as much as they are products of science:

> At the nano-scale [sic], seeing is actually feeling (atomic force microscopy depends on a tiny tip moving up and down as it traverses a surface). Turning what is 'felt' into images to be seen and read for what they might tell us, is a complicated challenge. Among themselves, nanoscientists talk of 'blobbology' [sic], the craft skill of interpreting computer-generated images of surfaces. The importance of such craft skills is not exclusive to nanoscience, but nanoscience highlights the interpretative challenges involved. (Rip 2009).[1]

Data gathered by the sense of touch is mediated by computer software which then produces a visual image for interpretation. This image can be further manipulated to create some of the ‘nano art’ seen on the web. (There are two main categories of ‘nano art’, images which have been created with data gathered in a laboratory and then further manipulated to create an ‘artistic’ image or purely artistic renderings that are not based on any data gathered in a laboratory.)

These newish, haptic microscopes stand in strong contrast to the better known and still used optical microscopes with which most of us are familiar. In a sense (pun intended), the new microscopes open up storytelling possibilities. In fact, these sensing devices represent a biphasal shift in that, first, we have no direct contact via any of our senses; everything is mediated through both hardware and software. (Arguably, one could say that optical microscopes also mediate between observer and observed but the inclusion of a database and sophisticated imaging software needed to produce an image - required for nanoscale observation, are a different order of mediation altogether.) Second, we have tended to rely on the visual sense over our other senses when discussing science, and as noted earlier, most

[1] For the purposes of this paper the terms nanotechnology and nanoscience are being used interchangeably as the distinction is one only scientists and engineers are likely to make.

nonscientists have experience of optical microscopes only: even though with nanotechnology, we now rely on haptic contact.

There is work which focuses on yet another sense, on hearing. ‘Vibrational exchanges’ are used to sense or detect matter at the nanoscale. These are, in effect, an attempt to ‘listen’ to the molecules in a technique called ‘nanomechanical resonance spectroscopy’ (NRS). (Berger Aug. 27.2008) Additionally there is much work being done on nano radio:

> Peter Burke and Chris Rutherglen [University of California at Berkeley] developed a carbon nanotube 'demodulator' that is capable of translating AM radio waves into sound. In a laboratory demonstration, the researchers incorporated the detector into a complete radio system and used it to successfully transmit classical music wirelessly from an iPod to a speaker several feet away from the music player.
>
> Although other researchers have developed nano-sized radio wave detectors in the past, the current study marks the first time that a nano-sized detector has been demonstrated in an actual working radio system, the scientists say. (Azonano, October 18, 2007)

Materiality

All of this ‘sensing’ activity is in the service of better understanding the material world. But the material we are now talking about lies in the realm of the invisible, the nano scale, while our senses operate at the macro scale. Everything we know to be true at the macro scale is different at the nano scale.

> ... while your reality tells you that you are sitting in your chair right now as you are reading this, reality at the subatomic level means that you are not really sitting in your chair - thanks to the repulsion of your and the chair’s electrons you are actually floating on it at a height of a fraction of a nanometer [sic]. (Berger, January 30, 2008)

We now have two forms of materiality - that which exists at the macro scale and is perceptible by our senses - and that which exists at the nanoscale and is not perceptible by our senses. The great difference between now and the 19th century (when we started seriously studying atoms and molecules) lies in the subtle levels of control that we are now learning to exert over them. We have understood the basics about atoms and molecules for quite some time now and when we want to affect any change in molecular or atomic structures we have fairly crude means of doing so. For example, we apply heat and/or pressure to create metals. (It's called heating and beating.) However, these days scientists are examining ways of manipulating the bonding that takes place between the atoms and molecules to create flexible electronics. Metals will be made to do things we never imagined possible and 'heating and beating' will not be necessary; most of the action will take place at a scale that we cannot sense. (Nanotechnology Now, June 26, 2008)

> For Husserl the crisis of science was a consequence of the gap between the visible and invisible realms of nature. … How will nanotechnology affect this gulf? Nanotechnology represents a new type of invisibility - not mathematical, or electronic, but rather material in nature, the material invisibility of objects beneath the possibility of lived or phenomenal experience. Up to the present, it has been possible to hide cameras; but cameras were in principle visible, existing on the meso [macro] scale of human perception. With nanotechnology we will never know when we are under surveillance - or whether we have a GPS chip embedded in our skin or lungs. The possibilities for paranoia are endless. (Frodeman 2006: 385)

Our sense of the world's material and of the material of our own bodies is being affected profoundly. More and more we seem to be inhabiting existences that are as much imagination as reality.

Storytelling

'Any sufficiently advanced technology is indistinguishable from magic' - according to Arthur C. Clarke, an important 20th Century science fiction novelist and English physicist. When trying to explain or describe 'magical' nanotechnology we have yet to find compelling descriptions. There is the dull, and for most, meaningless mathematical description (one billionth of a metre) or the attempts to describe the scale by using various images of progressively smaller items.

The nanotechnology stories we get from nonscientists (storytellers) are more imaginative but rely on the audience's sense of sight. Books (e.g. *The Diamond Age* or, *A Young Lady's Illustrated Primer* by Neal Stephenson) are read; video games (e.g. *Metal Gear Solid*) are viewed; (video games could be thought of as integrating a more haptic approach while retaining a visual orientation, which remains dominant.); science fiction television programs (e.g. *Star Trek: The Next Generation* - where the alien species The Borg use nanoprobes); are watched (Wikipedia, n.d.) and nanotechnology art works (e.g. Cris Orfescu's *Premiere Art Portfolio*) are looked at on the web.

The biphasal shift mentioned earlier (perception mediated by hardware and software and the shift from using sight to also using touch and sound) challenges traditional means of getting the story across. Scientists (with artists and others) are trying new means:

> [Joël] Chevrier, a professor at the Université Joseph Fourier in Grenoble, France, together with his collaborators hopes to open up a completely new field for our perception. This new 'playground' - using haptic, vision and sound interfaces - is the world we are living in; but explored at scales entirely foreign to everything we experience around us. …
> Chevrier and his team built a virtual atomic force microscope (AFM) and coupled it to an advanced haptic interface as well as a sonification and visualization system. … About 10,000 people have used this demonstrator during three exhibitions in Grenoble, Paris and Geneva. (Berger, January 30, 2008)

Chevrier's project offers some intriguing possibilities but there are problems for most writers, artists, academics, and, for that matter, scientists as well - with regard to equipment and budgets for installations. The fundamental question centres on how we will convey the reality of a world (as per our current understanding) that we can imagine only dimly. It is the metaphors that will allow us to see/understand.

There are many metaphors floating around: Spiderman is invoked to suggest the possibilities of adhesion technologies: scientists are working to exploit the adhesive forces at the nanoscale that allow a gecko to suspend itself along a vertical surface (Berger, December 3, 2008); alchemy is invoked to suggest possible new metallic forms for example, scientists can make the electrons of certain atoms [e.g. iron] behave as if they are part of a different element's atom (Nanowerk, June 15, 2009); Lilliput is invoked to give a sense of size; and there are many, many more.

For a time the most dominant and successful nanotechnology metaphor was 'grey goo'. Coined by K. Eric Drexler in his attempt to describe potential catastrophic consequences of nanotechnology, it hasn't been used much lately. The idea is that a device Drexler called a nanoassembler would start replicating itself to disastrous effect. In short, all of the atoms on the earth would be consumed and only 'grey goo' would remain. (Drexler 1987) The scientific reasons that Drexler suggested might result in the potential 'grey goo' catastrophe proved not to be entirely valid.

Sometimes the stories, the images, the artistic efforts which define a particular endeavour or concern take us by surprise emerging from the unlikeliest sources. Mary Shelley, in 1818 and at the age of 21, had published a horror story which has been interpreted in many ways but for most, stands as an iconic story about science gone wrong. Shelley's Frankenstein has proved to be a very flexible metaphor and the monster's story has been used to warn against the dangers of biochemistry, electricity (Hitchcock 2007: 132), and, more recently, genetically modified foods.

Still, the Frankenstein story has its roots in the 19th Century, in a world dominated by Newtonian physics and optical microscopes. Nanotechnology and associated sensing apparatuses (also used with other emerging technologies) function at scale where quantum principles of physics apply. We need new metaphors and new stories as our sense of who and what we are, and what the world is made of, is being re-examined and redefined while we touch, hear, and see in new ways.

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