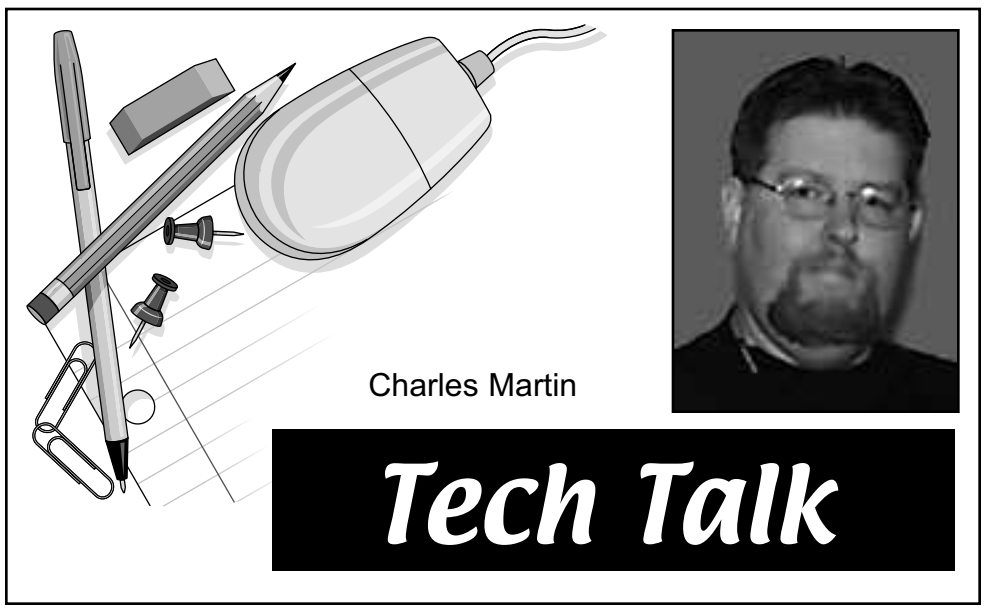
Nanotechnology holds great promise in many areas

The 'tiny revolution' continues with advances in medicine, computers ... even clothes!



Not too long ago, I wrote a Tech Talk about coming advances in science, including a term called *"nanotechnology"* that may be new to many of you, but has actually been percolating away in the labs for quite some time – and is now starting to bubble to the surface.

Scientist Eric Drexler invented the term in 1986 based, as many things still are, upon the writings of Richard Feynman three decades earlier. He coined the term to describe the ongoing effort to build machines so small that the very components are actually sincle molecules (or, in some cases, even smaller particles like atoms), but the term has expanded in usage to include almost anything that is man-made on a molecular level. While some of what's expected from nanotechnology sounds like science fiction (and a lot of it is still in the theory or experimental stage), some examples of "nanotech" have already emerged into practical applications – and these products point out where future examples of this technology is headed. Like most new technologies, it holds great promise – and also has a few drawbacks that nobody likes to talk about.

Nanoo, Nano

Might as well start by explaining where the term actually came from. "Nano" didn't, as some might suspect, get taken from Robin Williams' familiar greeting in Mork & Mindy – it's origins come from *nanite* or *nanomachine*, a construct of electrical or mechanical type whose dimension are measured in nanometers, which is a millionth of a millimeter, or about 1/80,000th of the diameter of a human hair.

Why, you might ask, do we need to make machines that small? The answer is simple even if the technology isn't: *resistance*. As any electrician will tell you, different materials have different rates of resistance when you pass information (in the form of electricity or light) through them. The materials we using in wiring, like copper, have low rates of resistance, but they still generate some heat and inefficiency. For years, the race has been on to find materials that will "superconduct" electricity (generate no appreciable heat or inefficiency). If you can make transisters out of atoms or molecules instead of materials hundreds of thousands of times thicker (like, say, wire), you reduce the inefficiency down to as near zero as makes no difference. This dramatically increases the power and efficiency of a machine while dramatically decreasing the amount of power required.

To put it mildly, our world would be very different if a commercially-viable, mass-producable superconducting material could be found. Such materials already exist, but at present require ultra-cold temperatures to work (to minimize the vibration of molecules, which interferes with the efficiency). Just this past week, however, a team from MIT has (perhaps) made major strides in this race by inventing a new form of matter, a gas which is "superfluid" (the molcules are perfectly round, thus allowing energy to pass through them efficiently).

As I mentioned, the term *nanotechnology* has been expanded (some might say "abused") to include items that don't actually operate on quite that small a level, but are incredibly tiny. This can be used for exciting purposes like the superconductive materials of the future, or more mundane (but economically important) areas like toxic waste cleanup (molecular-level "machines" can be "programmed" to attach themselves to particular elements, making them easier to detect or be absorbed/cleaned up).

Atomic … pants?!

An example you might not have immediately thought of provides a good illustration of how commercial businesses will be approaching – and marketing – nanotechnolgy. Two clothing companies – Eddie Bauer and Dockers – have recently starting making pants and shirts with a micro-fine Teflon-like coating on them. This was never before possible, since in order for the material to bond with the fabric and yet leave it pliable and soft, the Teflon coating had to be smaller than the molecules of the pants. The effect of this new coating is that liquid just rolls right off the clothes like rain off a freshly-waxed car – the Teflon-like material provides enough of a barrier that the (larger) molecules of the liquid or food/ink/etc can't penetrate. Ingenious, but there's a downside: these clothes have to be washed according to directions, because if they are exposed to high heat the coating might separate from the fabric and be absorbed by your skin, which is not healthy. The companies say that the conditions under which this would happen are exceedingly unlikely to be duplicatable by consumer dryers or dry cleaning, but the jury's still out on whether this technology is really ready for "prime time," but even if the technique isn't yet fully mature, it's an intriguing promise that is likely to be perfected soon. Sounds like the sort of thing you'd have seen in an episode of Star Trek.

Where No Book Has Gone Before

Another area where nanotechnology is already making a mark is in the concept of "digital paper." I can feel your eyes rolling upwards already – we were all promised back in the 80s that computers would make paper redundant and that long before now we'd all be working exclusively on electronic documents. Okay, so that didn't quite work out … but take a look at the photo below, an example of nanotech-thin LED displays whose pixels are so tiny they number in the hundreds of millions rather than today's thousands. The practical upshot of this prototype clock and e-book reader (see pictures below) is that you can view the content from any viewable angle without backlighting … exactly the same way paper works … and the information is clear and crisp. Once the costs for manufacturing such materials drop, you can expect to see a lot of small electronic devices – digital watches, clocks, LCD computer displays and even televisions – quickly adopt this paper-thin technology.

And you thought your two-inch-thick digital plasma-screen HDTV was something.

While it would be wonderful to buy a device in, let's say, a decade from now that could store thousands of books in a single small sub-laptop-sized device (to say nothing of what that would do to the weight of those backpacks our kids carry around) that really performs the way we've all been hoping for, the really exciting possibilities of this remains to be explored. Imagine new "eyes" for people who are blind, or televisions that can be mounted in any room as easily as picture frames.

You can learn more about this fascinating new approach to LEDs by visiting www.extremetech.com/article2/0,1558,1764919,00.asp.

Micro-Medicine

By far the most important application to which nanotechnology will be employed, however, is in the field of medicine. Micro-miniaturization of chemicals allows more efficient delivery and many other benefits.

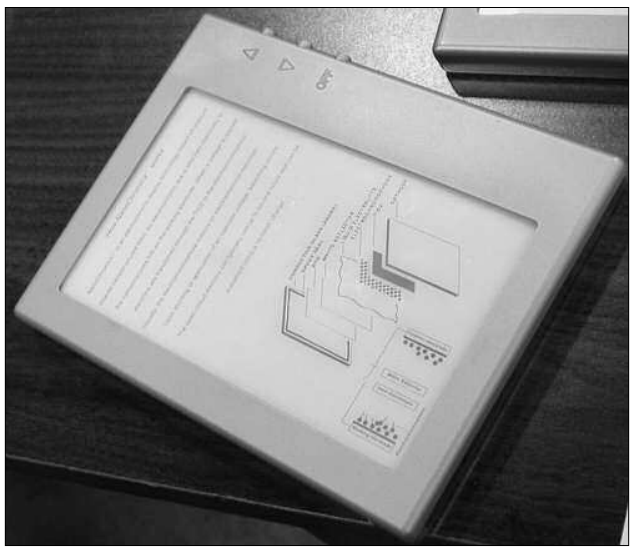
Scientists at the University of Michigan are, as we speak, testing a "cannonball" to fight cancer using nanotechnology. The basic (very simplified) idea is this: cancer-killing molecules are placed inside a "ball" of material cancer cells like to absorb (like folic acid). The cancer cell absorbs the folic "shell" but now the "medicine" is literally inside the cell rather than attacking the more-difficult outer walls, greatly increasing the efficacy (you can see what they're up to at www.med.umich.edu/opm/newspage/2005/nanoparticles.htm).

Likewise, the ability to deliver medicine in micro-fine form can be a boon all sorts of patients, and a benefit to doctors and drug companies as well. Take, for example, the East Orlando-based company Nutrition by Nanotech (www.nutritionbynanotech.com), who have used nanotechnology to develop micro-fine vitamin B12, herbal and other remedies in spray form that gets absorbed directly into the body via capillaries rather than having to be digested (and largely wasted) through the digestive system or shot (with a needle) into your bloodstream.

By absorbing the vitamin or herbal weight-loss solutions directly, the potency is preserved and the amount you need to take is greatly reduced. This not only makes it much more cost efficient to manufacture, but less expensive for consumers – Nutrition by Nanotech founder J. Michael Valo compares his $15 B12 spray effecctiveness to a monthly regimen of vitamin shots from a doctor (and you can imagine what that would cost!).

When one thinks about the implications of easily absorbed under-the-tongue sprays like Nutrion by Nanotech's product – children who are afraid of shots, patients who are too frail to receive the medication in conventional ways, people whose digestive systems can't handle strong doses – it offers exciting possibilities that go well beyond things like vitamins and weight-balancing herbal solutions. Low-cost, high-efficiency solutions like this (and applied to other areas, from electricity delivery to improvements in seed and fertilizer efficiency) could improve the lives not just of Americans but people in need all over the world.

Sure, as the popularlity of nanotechology grows we'll see it used as much as a "marketing buzzword" as a legitimate label ("microscopic manufacturing" or "molecular medicine" just don't roll off the tongue quite as well, even though in most cases they're more accurate labels), but the promise of nanotech isn't one of revolution, but of evolution: new ways of delivering the things we already know and use today, better and more efficiently – resulting in lower costs, greater benefits, less waste and more availability. If nanotechnology can help us solve the riddle of superconductivity or aid in the curing of diseases, it will make our future – and our children's – a lot brighter.



This prototype clock's display (top) is as white and bright as paper, but requires no backlighting, can be seen at any viewble angle, and uses 1/100 the power that today's digital alarm clocks require.

The e-book reader seen above (bottom) is able to show fine print and illustrations in detail that's not even possible for our newspaper's cameras to accurately capture.