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CUTTING NANOTECH DOWN TO SIZE

WHAT'S REAL, WHAT'S HYPE, AND WHAT WE'RE JUST STARTING TO COMPREHEND ABOUT NANOSCIENCE

by *Tom Keenan*

Get down to a billionth of a metre and you enter a world that's qualitatively different from the one we know. Nanoscale particles of gold would appear red, if you could see them, because they interact with light differently. "Super bearings", almost free of friction, become theoretically possible, because at the atomic scale the bumps and hollows of surfaces are "incommensurate" and don't rub each other the wrong way.

A similar kind of transformation seems to happen in the brains of some serious scientists when they try to think on the nanoscale. In language usually reserved for Internet pop-up ads, respected cryptographer Ralph Merkle [www.merkle.com] writes of nanotech's possible ability to "reverse the aging process". Well, maybe it will, but we're a long way from understanding enough about the biological clock to construct a device, no matter how itty bitty, that will make it run backwards.

Of course, there *are* wonders that nanotechnology will accomplish, and most experts agree that we'll see the first fruits in the medical area (synthetic bones and other tissues are close), and in improved everyday materials (such as stronger, lighter car bumpers). It will almost undoubtedly help us detect cancer, largely because of a recent discovery by Dr. Vadim Backman

[www.bme.northwestern.edu/faculty/fac_core_backman.shtml] of Northwestern University that cancer cells do things that are visible on the nanoscale before they actually become cancerous. Backman is searching for "biomarkers of early carcinogenesis", and of course everyone wishes him the best of luck.

These are laudable - even Nobel-laudable - achievements, but surely not a justification for the total nanohype coming from people who should know better. Some of this is driven by the world of commerce, where for a time "nano" was a codeword for "buy this stock, NOW, stupid!" James Surowiecki, in a recent *New Yorker* article entitled *Bring On the Nanobubble*

[www.newyorker.com/talk/content/?040315ta_talk_surowiecki], points out that a similar hysteria surrounded the words "tron" and "tronics" in the early 1960s, culminating in the Crash of 1962, when investors dumped

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their tronic darlings. The pattern has been repeated for words ranging from "silicon" to "dot com", and there's some evidence that "nano" has come - and is now going. Investors have recently punished NASDAQ nanohopefuls, from Nanogen (NGEN) to Nanometrics (NANO).

One of the few guaranteed winners in the business side of nanotech will be good old IBM. Big Blue has a patent lock on tons of relevant intellectual property, and the deep pockets to keep it on the shelf until it's useful. Their people helped invent basic nanotools like the Scanning Tunneling Microscope (STM) and the Atomic Force Microscope (AFM). In 1989, IBMers also accomplished the world's smallest feat of graffiti tagging, by spelling out the company's initials with thirty five xenon atoms. IBM now has an AFM-based disk drive with no moving parts called the *Millipede*

[www.research.ibm.com/resources/news/20020611_millipede.shtml]. It will, according to a breathless IBM press release, store a "trillion bits per square inch - 20 times higher than the densest magnetic storage available today." That's 25,000,000 printed textbook pages on a surface the size of a postage stamp, if your mind works better with things you can actually visualize.

Now who exactly is going to read that pile of textbooks is an interesting question. It certainly won't be us mere mortals. Bill Joy, Chief Scientist at Sun Microsystems, put the cat among the pigeons in April, 2000 with a controversial *Wired Magazine* essay called *Why the Future Doesn't Need Us* [www.wired.com/wired/archive/8.04/joy.html]. Mr. Joy may make fine computers, but he has to haul out everyone from the Unabomber to the Borg of *Star Trek* to try to convince us that genetic engineering and nanotechnology will put us on the evolutionary junk heap. One point made by Joy certainly does ring true, however: "If our own extinction is a likely, or even possible, outcome of our technological development, shouldn't we proceed with great caution?"

Yes, indeedy, Mr. Joy. Even if we *could* pop a nanobot to detect a future cancer, would we really want to? There are already macro-scale genetic and radiological tests that can do a decent job of predicting how you will depart this mortal coil. Do we see people lining up to find out? Maybe that's because once that information exists, it might get into the hands of the government, your insurance company, or prospective employers. We haven't begun to think deeply enough about the legal and ethical aspects of nanodiagnostics and nanomedicine. There are laws regulating breast implants and even the storage of DNA data, but who's watching nanotech?

One Canadian organization that at least has their eyes open to nanotechnology is Winnipeg's ETC Group [www.etcgroup.org]. These freelance social critics, who have also taken on genetically modified foods, point out that "unique nanotechnology products and processes are entering large-scale use in the environment without regulatory oversight". The mind does indeed boggle at the things that *could* go wrong with nanotech:

What if somebody creates steel-eating nanobugs and turns them loose on bridges?

What if nasty nanomachines escape from the lab and make gazillions of copies of themselves?

If a machine becomes smarter than a human, is it legal or ethical for us to turn it off?

David Forrest makes these points quite nicely in a report for the *Foresight Institute* [www.foresight.org], which attempts to be a kind of "neutral ground" for the discussion of nanotechnology. Foresight is one of the few think tanks that is actually worrying about the profound implications of nanotechnology. It is chaired by the grand old man (though, appropriately, he's under fifty) of this discipline, K. Eric Drexler, who received the very first Ph.D. from MIT in Molecular Nanotechnology, and in 1986 wrote *Engines of Creation: The Coming Era of Nanotechnology*, a book which is now available free on the Internet. [www.foresight.org/EOC/index.html]

Of course, legal regulation of nanotech may ultimately be futile. Some experts believe that nanotechnology will be so powerful, and so very profitable, that attempts to control it will drive it underground, or to offshore "nanotech havens". On that future junket to a small tropical island, you might acquire a nice tan *and* your own clandestine cellular repair nanobot.

But who is sending instructions to that bot inside your body? Just as hackers followed soon after computers came along, can nanohackers be far away? Could a nanotechnology enhanced William H. Gates III suddenly keel over while demonstrating Windows 2050, because somebody in the audience hijacked his nanopacemaker? Oh, and by the way, experts believe that anything smaller than 100 nanometers will escape the notice of the body's immune system, so don't count on your T-cells to deal with nanobots gone bad. If you're feeling just a bit paranoid, then rest assured, the US Department of Defense is only the *second* largest funder of US nanotech research (after the National Science Foundation). Of course, that's before you add in the unspecified amounts for nanotech projects from the "Intelligence Community". Start worrying.

Or not. Because nanotech just might bring you the ultimate *desideratum*: Eternal Life. Scientist Ralph Merkle not only believes in nanotech, he believes that a lot of dead folks are really just terminally ill with today's technology. His Web site [www.merkle.com] notes that "a second opinion from a future physician - one with access to a fundamentally better medical technology based on a mature nanotechnology - lets us avoid the unpleasant risk that we might bury someone alive." So his cryonics plan is to freeze people for a century in the hope that future docs may be able to fix 'em up just fine. Merkle is a director of the Alcor Life Extension Foundation [www.alcor.org], the Arizona-based operation that currently has fifty-nine souls suspended

in liquid nitrogen at -196 degrees Centigrade. According to their Web site, "most people pay for cryonics with life insurance", and they recommend you secure a policy of \$120,000 if you want your whole body preserved, or \$50,000 if you're happy to come back as just a head.

So nanotechnology has become a pseudoreligion, with priests like Drexler and Merkle, holy books like *Engines of Creation*, and temples like the imposing Alcor facility in Arizona. It offers life eternal to true believers, and just enough abuse from skeptics to forge a tightly bonded community. And, hey, if they can carve atoms at will, perhaps they can just make a church full of congregants. Maybe, but don't hold your breath.

What we do know is that nanotech will fundamentally change manufacturing, medicine, and mindsets. We're starting to understand the "what" (smart materials, molecular level disease fighting) and the "how" (atomic force microscopes and specialized atomic construction tools), and even the "when" (sooner rather than later) of nanotech. The bigger questions about nanotechnology, which we're only starting to comprehend, are going to be: Why? Why not? And, for Whom?

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