FUTURE BOY

Forget What You Know About Nanotech

It's not just about making things small. It's about making them different.

By Erick Schonfeld, November 07, 2003

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Nanotechnology is supposed to turn every industry on its head, from plastics to microchips to health care. We are told that it will make things lighter, stronger, cheaper, and smaller. It will extend Moore's Law and zap cancer cells. It will improve our current capabilities a millionfold.

All of this may or may not be true, but it almost certainly is the wrong way to think about the real potential of this budding science. Just ask Charles Lieber, a chemistry professor at Harvard who is one of the nation's leading nanotechnologists. "There has been way too much hype from the investing business community in this area that demonstrates a lack of understanding of what may or may not be important from a business perspective," he tells me.

"The promise of nanotechnology is still thought of in the guise of existing technology," he continues. "Yet the point is to make something different that is not possible today." Take microelectronics as an example. Semiconductor transistors can already be measured in nanometers (billionths of a meter). As transistors become smaller and smaller in accordance with Moore's Law, there is always the fear that conventional semiconductor manufacturing techniques will reach their physical limits. Here's where advances in nanoelectronics could help by approaching the problem from the bottom up -- that is, by building circuits out of individual molecules.

Nanoelectronics happens to be one of Lieber's specialties. Yet he is not convinced that it will ever be able to compete economically with more conventional forms of chip manufacturing. After all, as long as the chip industry continues to spend billions of dollars on R&D, Moore's Law will hold out. Rather than try to make a Pentium out of nanomaterials, it might be better to use some of the novel properties of these materials to find a completely different way of computing.

For instance, using a nanotech approach, it would be theoretically possible to build an optical router on an electronic chip. It turns out that nanomaterials can act as building blocks for both electronic circuits and optical detectors and emitters. That means that both optical communications and computation can be built onto the same chip, as both Lieber's lab and IBM (IBM) have demonstrated.

Today these two worlds -- the optical and the electronic -- are completely separate. "It is set in stone that you can't mix these industries," Lieber notes. "Throw that whole idea away," he suggests, "in

this vision of how we should take advantage of the uniqueness of nanoscience. You can bring together any of the unique material properties at any time."

But why stop at just melding existing industries? These nanomaterials will be so small, he maintains, that it will be much easier to create an interface between them and biological structures. For instance, you could do away with the silicon on top of which all the circuitry lies in a conventional chip. Instead, you could "put it on plastic and couple it to an optical output for a computer on your eye." Perhaps such a device could one day help blind people see again.

Another possibility would be to build a nanolab with millions of nanosensors that could screen a single drop of blood for numerous disease markers, or that drug companies could use to test millions of small molecules for their disease-fighting potential. Nanotechnology research may also uncover new ways to produce and store hydrogen for tomorrow's energy needs. It is hard not to delve into the realm of the fantastic when discussing nanotechnology. But whatever the application, using the novel properties of nanomaterials to open up new possibilities is certainly more interesting than using nanomaterials simply to improve existing technology.

Even the very act of nanomanufacturing will be completely different. Lieber foresees a day when parts such as carbon nanotubes, nanowires, and nanoparticles will be mixed and matched to form a wide assortment of nanodevices. "From some small, minimalist parts box of nanostructures," he says, "you can think of having a universal manufacturing line, whether to assemble a computer, a biological sensor, or an optical system." In other words, once we get the building blocks right, we'll be able to start figuring out how to make them self-assemble into a virtually limitless array of nanodevices that will exhibit any of several wonderful electronic, magnetic, optical, or physical properties.

Shouldn't we be careful about unleashing a technology that could result in new forms of nanopollution to wreak environmental and biological havoc? Self-assembly sounds like something that could escape our control -- the famous gray-goo scenario. Lieber, for one, doesn't think such scenarios are very realistic. Caution is important, as with any scientific endeavor. But most schemes for self-assembly of nanomachines envision a fixed manufacturing platform. "If you want to worry about anything, worry about a virus," Lieber says. "That is a self-replicating machine that uses your own cells to attack you." Yes, but somehow that seems better than being attacked by a nanobot.

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