The Singularity Is Coming—Now What?

IBM's Blue Gene brain simulation has made gains in one of the most sophisticated tasks man has ever taken on—creating artificial intelligence (AI). With the true AI milestone comes the dawn of the singularity, when computers overtake humans. Contributing editor Glenn Reynolds looks into the future and wonders; what happens after the singularity?

By Glenn Harlan Reynolds

Illustration by Nathan Huang

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For some time now, futurists have been talking about a concept called the Singularity, a technological jump so big that society will be transformed. If they're right, the Industrial Revolution—or even the development of agriculture or harnessing of fire—might seem like minor historical hiccups by comparison. The possibility is now seeming realistic enough that scientists and engineers are grappling with the implications—for good and ill.

When I spoke to technology pioneer and futurist Ray Kurzweil (who popularized the idea in his book The Singularity Is Near), he put it this way: "Within a quarter-century, nonbiological intelligence will match the range and subtlety of human intelligence. It will then soar past it."

Even before we reach that point, Kurzweil and his peers foresee breathtaking advances. Scientists in Israel have developed tiny robots to crawl through blood vessels attacking cancers, and labs in the United States are working on similar technology. These robots will grow smaller and more capable. One day, intelligent nanorobots may be integrated into our bodies to clear arteries and rebuild failing organs, communicating with each other and the outside world via a "cloud" network. Tiny bots might attach themselves to neurons in the brain and add their processing power—and that of other computers in the cloud—to ours, giving us mental resources that would dwarf anything available now. By stimulating the optic, auditory or tactile nerves, such nanobots might be able to simulate vision, hearing or touch, providing "augmented reality" overlays identifying street names, helping with face recognition or telling us how to repair things we've never seen before.

Scientists in Japan are already producing rudimentary nanobot "brains." Could it take decades for these technologies to come to fruition? Yes—but only decades, not centuries. The result may be what Kurzweil calls "an intimate merger between the technology-creating species and the technological evolutionary process it spawned."

If scientists can integrate tiny robots into the human body, then they can build tiny robots into, well, everything, ushering in an era of "smart matter." Nanobots may be able to build products molecule-by-molecule, making the material world look a lot like the computer world—with just about everything becoming smart, cheap and networked to pretty much everything else, including your brain.

It's almost impossibly futuristic-sounding stuff. But even that scenario is just the precursor to the Singularity itself, the moment when, in Kurzweil's words, "nonbiological intelligence will have access to its own design and will be able to improve itself in an increasingly rapid redesign cycle." Imagine computers so advanced that they can design and build new, even better computers, with subsequent generations emerging so quickly they soon leave human engineers the equivalent of centuries behind. That's the Singularity—and given the exponential acceleration of technological change, it could come by midcentury.

But Is It for Real?

It seems like a tall order, but lots of people think that such predictions are likely to come true. I asked science-fiction writer John Scalzi about Singularity issues and he pointed out that the Skype video we were using to chat would have seemed like witchcraft a few centuries earlier. Profound technological changes once took millennia, then centuries, and then decades. Now they occur every few years. The iPhone and pocket-size 12-megapixel digital cameras would have seemed amazing a decade ago. Web browsers are only about 15 years old. People (including my wife) have computers implanted in their bodies already, in the form of defibrillators,

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pacemakers and other devices.

Still, I'm describing a world in which nanotechnology makes us (nearly) immortal, in which robots can make almost any object from cheap raw materials (basically, dirt) and in which ordinary people are smarter than Einstein thanks to brain implants—but still nowhere near as smart as fully artificial intelligences. That's a world that's hard to imagine. And what we do imagine can sound either good or bad. On the upside, what's not to like about being super-smart and healthy, with access to most products essentially for free? On the downside, could always-on links from our brains to the computing cloud lead to Star Trek's über-totalitarian Borg collective or something equally scary? And, what happens to those computer-brain interfaces and nanobots when they're taken over by the descendants of the Conficker worm? Now there's an argument for strong antivirus software.

Dramatically enhancing human capabilities for good, alas, also means enhancing human capabilities for evil. That's something famed computer science professor and writer Vernor Vinge warns about: technology that could, as he wrote in his novel Rainbows End, "put world-killer weapons into the hands of anyone having a bad-hair day." Then there's the mind-control problem. Nanorobots floating around in your bloodstream could keep your coronary arteries from clogging, but they also could release drugs on command, making you, say, literally love Big Brother. Knowing what we know about human history, do such abuses seem terribly unlikely?

Of course, the problem may never come up. Vinge, who originated the Singularity idea, has written about why it may never arrive —though he's betting the other way. So what can we do now to affect how things turn out? Some people are trying. The Foresight Institute has published guidelines for developing nanotechnology, such as a ban on self-replicating nanobots that function independently (potentially turning the whole world into more nanobots, something known in the trade as the gray-goo problem) and sharp limitations on weapons-related nanotech research. Researchers in artificial intelligence are working on guidelines for producing "friendly AI" that would be well-disposed toward humans as part of their programming, thus foreclosing any pesky robotic world-domination ambitions. NASA, Google and others have even started something called the Singularity University to study ways to avoid problems while still reaping the benefits. Some have suggested that we ought to go slow on the so-called GRAIN technologies (Genetics, Robotics, Artificial Intelligence and Nanotechnology). Sun Microsystems' Bill Joy has even called for "relinquishing" some technologies he sees as dangerous.

But I wonder if that's such a good idea. Destructive technologies generally seem to come along sooner than constructive ones—we got war rockets before missile interceptors, and biological warfare before antibiotics. This suggests that there will be a window of vulnerability between the time when we develop technologies that can do dangerous things, and the time when we can protect against those dangers. The slower we move, the longer that window may remain open, leaving more time for the evil, the unscrupulous or the careless to wreak havoc. My conclusion? Faster, please.

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32. The singularity will be wireless and nano-botless
There is no need to use nano-bots to create a singular mind or to merge a human mind with remote artificial intelligence. Human nerve cells (neurons) have already the capability to transmit information across a synapse (with no "wiring") using naturally occurring electron emissions. There are probably newer and more complex terms to describe the process but the terms "neuron", "synapse" and "electron" have existed for at least about 100 years and are probably most widely understood. All that needs to happen is for someone to work out a way to intercept and magnify cell transmissions as they pass over a synapse, and then reroute the transmissions to either another synapse or to a server that can process and further route and transmit the signals to other synapses. There is no need to build a receiver, as human minds are ready-built receivers and are the perfect devices for receiving information that has been rerouted from other minds. This is all perfectly plausible with technology at hand now, and probably was possible in a rudimentary form near the end of the 19th century or beginning of the 20th. The major obstacles in deploying a rerouted human neuron network are ethics committees and human outrage. Meanwhile, robots are being developed as remote intermediaries to carry information from human bio-networks. The whole concept has frightening implications. But so long as the networks are hidden the potential is even more horrific, because so long as the potential of the networks remains unknown to the larger populace the networks can be used to control and destroy lives leaving no known trace (as indeed they are today by people who have the money to fund development). That is it in a nutshell. A person could think of chemical communications between cells as a form of "nano" interaction, but chemical transmissions are slower than electron signals and are probably driven by electron signals anyway.

31. RE: The Singularity Is Coming—Now What?
Placing limits or prognosticating on technological advances does not have a good track record. Flat earth, heliocentricity, going faster than 20mph, flying, television, atomic energy, computers, telephones, the list is long. In retrospect, it is easy to point out the missing common factor, the predictions that something is impossible or not going to happen fails. The key is a smart computer, given access to knowledge and material processing, to design it's descendant. If rabbits had access to unlimited food with no preditors, we'd be ass-deep in bunnies. I remember no television, and black & white television. My father remembers horse-drawn milk delivery. My grandmother remembered no electricity.

30. RE: The Singularity Is Coming—Now What?
This stands out as one of the most trivial articles ever published in PM. Why not get an informed article about nanotechnology, an article by someone who actually knows something relevant? For example, chemists often work with enzymes, one class of real world nanomachines.

29. RE: The Singularity Is Coming—Now What?
With the exception of 1 or 2 posts below, it is brutally evident that none of the replies were authored by individuals with any kind of even passing familiarity with the Singularity and the state of modern Futurist concepts. Keep downplaying it folks - that tactic works SOOO well for ostrich's...

28. RE: The Singularity Is Coming—Now What?
I keep waiting for someone to do a true ecosystems analysis of a singularity. Organisms, including computers, need energy and a wide range of elements. Are these available? We've got an energy crisis entwined with global warming, and we're already seeing wars in Africa over coltan and in the Middle East over oil (useful for plastics as well as energy). Similarly, we would need a much more sophisticated energy and information distribution system than we have now, at least in the US. And computers take more energy than human brains for a fraction of the functionality, and we need to make them much more energy efficient. So, my guess is that, without some vastly more sophisticated infrastructure, we aren't going to see Kurzweil's singularity any time soon. Better yet, we need people actually running systems analyses on these predictions. Even if we don't know the details, we can guess about energy and information fluxes, and start figuring out what kind of system might handle them. After all, we already have solar-powered nanomachines that turn soil into sophisticated products. They're called plants. We may in the future have a tree that grows wrist-watches, but it will need to be fertilized with lithium to grow the batteries, and it will take 5-10 years to start producing watches. That may be the future.

27. RE: The Singularity Is Coming—Now What?
Website: http://www.matware.com.au
If you think about any area of technology in a capitalist democracy it is reasonable to expect that in any particular orthogonal technology segment there will be a, slow rise (as people come to grips with what they are doing), a gold rush (as all the smart kids get into it) and an homogenisation (as the big players try to carve out a monopoly). Once the homogenisation process has started it is reasonable to expect the rate of technology development will slow and when Cost/Benefit approaches 1 the monopoly owner will just start making the widget in different colours and call it innovation hence Windows 95-->Windows 7. What does all this mean for the Singularity, well I wouldn't be banking on CPU technology or OS technology to lift you out of your fleshy body, and nano-tech is way way to young. That leaves bio-tech (a controlled industry), autonomous robotics, networked/distributed computing, GPU/Massively parallel computing and open source (it's a meme that can drive technology with no C/B calcs or homogenisation). Or put another way : http://www.overthinkingit.com/2008/09/23/the-

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