

Sporns is in a good position to judge. He and his colleagues have carried out just about the closest thing to whole-brain emulation given today's technology. They map human brains using a high-resolution method called diffusion spectrum imaging. They chart the long fibers that link regions of the brain together like computers on the Internet. Sporns and his colleagues have analyzed the connections between 1,000 regions and have found the brain's network is organized according to some of the same rules of other large networks—including the Internet. For example, several regions act as hubs, while most regions are connected to only a few others. Sporns and his colleagues created a computer model of this brain network and let each region produce signals that could spread down the fibers. They found their simulation of a brain at rest produced distinctive waves that spread back and forth around the entire brain similar to the way waves spread across our own.

Whole-brain emulations will become more sophisticated in the future, said Sporns, but he finds it ridiculous to expect them to be able to capture an individual's mind. In fact, mind uploading is a distraction from the truly revolutionary impact whole-brain emulations will have. By experimenting with them, researchers may discover some of the laws for building thinking networks. It may turn out human brains can work only if their networks have certain arrangements. "It's like learning the laws of physics when you want to build an airplane. It helps," said Sporns.

Discovering those laws may allow computer scientists to finally build machines that have mental processes similar to ours. Sporns thinks scientists are already moving in that direction. IBM, for example, now has a contract with the military to "fabricate a multichip neural system of about 108 neurons and instantiate into a robotic platform performing at 'cat' level."

"That is going to happen," said Sporns.

This is the best I can manage for skeptics. Uploading your mind is science fiction. But endowing robots with a humanlike cognition? Only a matter of time.

"I hope you didn't believe a word of that last talk."

I stood in a long line for the men's room during a coffee break. The women's room next door was empty. I thought how only at a meeting like the Singularity Summit would I find myself in this situation. When I heard someone talking to me, I turned to see a tousle-haired psychologist named Gary Marcus.

Good, I thought. Maybe Marcus would demolish the Singularity and leave nothing behind but smoking wreckage.

Marcus, who teaches at New York University, has spent years studying computation. Computers are good at certain kinds of computations such as sorting things into categories. But they're not good at the things we do effortlessly, such as generating rules from experience.

Marcus was annoyed by one of the talks at the Summit, in which a computer scientist promised that humanlike artificial intelligence was nigh. "Figuring this stuff out in 10 years—I don't believe it," he said.

I expected some serious curmudgeonliness when Marcus delivered his talk the following day. In his 2008 book, *Kluge*, Marcus explores design flaws in the human brain. We don't simply store information on a hard disk, for example, but embed it in a web of associations. That's why memories may escape us until something—perhaps the taste of a cookie—brings back the right associations. Marcus explains how these quirks are locked into our brains thanks to our evolutionary history. We did not evolve to be computers but animals that could learn to find food and avoid being eaten.

So I imagined Marcus would declare the human brain unimprovable, but he didn't. He stood up, explained the shortfalls of human memory and suggested memory would be a good place to start improving the human brain.

I called Marcus later and told him I was surprised. "Human enhancement is a real possibility," he replied. He thought a powerful way to enhance the brain would be with "cognitive prosthetics," a kind of onboard iPhone. The only challenge would be to decipher our brains' code well enough to let the iPhone talk to our brains. Marcus didn't see any reason scientists wouldn't eventually figure that out.

Like Sporns, Marcus agreed whole-brain emulations might turn out to be most valuable for what they reveal about the nature of intelligence. In the end that's what left Marcus worried. We just might succeed too well and program a machine with so much intelligence it can boost its own intelligence by itself.

"There are going to be machines that are cleverer than we are," he said.

It is time, Marcus said, to start planning for that world. It doesn't matter whether we live to see it or not; our grandchildren or great-grandchildren might. We owe it to them to get ready—if not for the Singularity then at least for a world different from our own.

