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Listening to Silicon

VLSI and neural network pioneer Carver Mead believes that good science is a form of channeling.

By Paulina Borsook

Carver Mead has always been a successful maverick. Two decades ago he pioneered VLSI (very large scale integration) chips - the heart and soul of inexpensive modern computers. In the 1980s, as professor of engineering and applied science at Cal Tech, he explored neural network hardware. Among his current interests are the development of cochleae and synthetic retinas implemented in silicon.

Tell me about neural networks.

Neural networks are systems that learn from experience rather than from being preprogrammed. It's not about how precisely you can remember something that was stored once, but about keeping up with the experience. Neural networks are more flexible, adaptive, just like living systems, with the ability to evolve, to learn from making mistakes. So that's a different art form than standard computing and standard algorithms. And when you work that all the way through, the individual elements can be much more organic. A transistor is much more organic than a digital switch. It's actually got its own personality. I always tell people, you should listen to the silicon, for it will tell you what it wants to do in whatever its language is. It's like anything else; you can listen to a redwood tree, too. And when you let that be part of your universe, you start finding wonderful technological things.

I heard about neural networks a lot five years ago, and now I don't hear about them as much.

Because people are doing real work with them now. Five years ago, they were the second best way to do almost any problem. Now, they're the very best way to do many problems, like character recognition. The Newton doesn't do a very good job recognizing handwritten characters; you could do it much better with a neural network. But we're not going to take over the entire world in five years. Whenever you're fighting uphill against an entrenched technology, you have to pick the right thing where you have a little bit of an edge.

It's like when TV came out, radio didn't die.

In the end, all we're talking about is presentation, interface, manageability. The Chinese invented movable type 2,000 years ago, and it's been highly evolved. It's always true that a highly evolved technology always looks slicker. When printing started, people really believed there was no substitute for those handwritten things.

They were right in some ways. There's a kind of beauty to them.

And it's true! We still go to French restaurants that still do handwritten menus, and it's charming! And it's also true that I live in a hand-built home and I paid extra for that. It was my choice. When I have the time, that thing that matters to me is being in nature. If you can't have that, then what's life about? I grew up by myself out in the woods.

Were you raised by wolves?

Not quite. But I was out in the woods most of my waking hours. It was halfway between Yosemite and King's Canyon, back in a place called Big Creek. There were a lot of wild animals. There's this wonderful book by Marlow Morgan called Mutant Message. She was this medical type who went on walkabout for four months

with these pure-form aborigines, when she began to realize the much higher order of awareness these people have. And all my science comes that way, from the psychic dimension. Anyone who is really honest about his or her source of inspiration will admit this.

Good science is a form of channeling, only with science, you also have to go work the equations. It sort of goes back and forth: You get all the inspiration, but then you have to make sure the science works. So I weave back and forth, working both sides, to try to get them to be the same. They're not different, but they're different modes you get into.

When I did the book (Introduction to VLSI Systems), I was full of the things that nobody else believed: that design is the way you add value to silicon, and not just fabrication. At the time, there was no value in software. Hardware was the big thing, and the big-machine makers were king. So I really felt like a voice in the wilderness. I really felt lonely... so I pushed myself into this space of being "against."

It is interesting to think, though, about how new technologies are fostered. What about the incubator idea, how the Internet had this wonderful sheltered babyhood, which allowed it to grow unobserved?

Nah, if you look back on it, everything had a babyhood. Personal computers had a babyhood, when no one was watching. Ham radio had a babyhood. Everything I've ever done had a babyhood. No one was watching because nobody gave a shit, because it wasn't big enough for anybody to care.

But with the amount of money going into the National Information Infrastructure, and the big corporations getting into it, there may only be time for stuff that makes money right away.

It will sort itself out. Don't worry! Evolution has a lot of dinosaurs in its path.

But don't you think with the convergence media, with the very big players, there won't be those little cul-de-sacs where people can play?

It will never happen. Don't underestimate the power of evolution to give new opportunities to new ideas. It always has, or otherwise we'd still be three-toed sloths or worse, we'd be bacteria. You gotta develop a little faith in the process. If you have any faith in humans as humans, then you gotta have faith in the process by which they came about. There's far more potential in the universe than any of us will allow to happen.

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