A Tech Industry Pioneer Sees a Way for the U.S. to Lead in Advanced Chips

Markoff, John

FULL TEXT

It has been six decades since Ivan Sutherland created Sketchpad, a software system that foretold the future of interactive and graphical computing. In the 1970s, he played a role in rallying the computer industry to build a new type of microchip with hundreds of thousands of circuits that would become the foundation of today's semiconductor industry.

Now Dr. Sutherland, who is 84, believes the United States is failing at a crucial time to consider alternative chip-making technologies that would allow the country to reclaim the lead in building the most advanced computers.

By relying on supercooled electronic circuits that switch without electrical resistance and as a consequence generate no excess heat at higher speeds, computer designers will be able to circumvent the greatest technological barrier to faster machines, he claims.

“The nation that best seizes the superconducting digital circuit opportunity will enjoy computing superiority for decades to come,” he and a colleague recently wrote in an essay that circulated among technologists and government officials.

Dr. Sutherland's insights are significant partly because decades ago he was instrumental in helping to create today's dominant approach to making computer chips.

In the 1970s, Dr. Sutherland, who was chairman of the computer science department at the California Institute of Technology, and his brother Bert Sutherland, then a research manager at a division of Xerox called the Palo Alto Research Center, introduced the computer scientist Lynn Conway to the physicist Carver Mead.

They pioneered a design based on a type of transistor, known as complementary metal-oxide semiconductor, or CMOS, which was invented in the United States. It made it possible to manufacture the microchips used by personal computers, video games and the vast array of business, consumer and military products.

Now Dr. Sutherland is arguing that an alternative technology that predates CMOS, and has had many false starts, should be given another look. Superconducting electronics was pioneered at the Massachusetts Institute of Technology in the 1950s and then pursued by IBM in the 1970s before being largely abandoned. At one point, it even made an odd international detour before returning to the United States.

In 1987, Mikhail Gorbachev, the last Soviet leader, read an article in the Russian newspaper Pravda describing an astounding advance in low-temperature computing made by Fujitsu, the Japanese microelectronics giant.

Mr. Gorbachev was intrigued. Wasn't this an area, he wanted to know, where the Soviet Union could excel? The task of giving a five-minute briefing to the Soviet Politburo eventually fell to Konstantin Likharev, a young associate professor of physics at Moscow State University.

When he read the article, however, Dr. Likharev realized that the Pravda reporter had misread the news release and claimed the Fujitsu superconducting memory chip was five orders of magnitude faster than it was.

Dr. Likharev explained the error, but he noted that the field still held promise.

That set off a chain of events through which Dr. Likharev's tiny lab was granted several million dollars in research support, making it possible for him to build a small team of researchers and, eventually, after the fall of the Berlin Wall, relocate to the United States. Dr. Likharev took a physics position at Stony Brook University in New York and helped start Hypres, a digital superconductor company that still exists.

The story might have ended there. But it appears that the elusive technology may be gaining momentum once more because the costs of modern chip making have become immense. A new semiconductor factory costs $10 billion to $20 billion and takes up to five years to complete.

Dr. Sutherland argues that rather than pushing on more expensive technology that is yielding diminishing efficiencies, the United States should consider training a generation of young engineers capable of thinking outside the box.

Superconductor-based computing systems, where electrical resistance in the switches and wires falls to zero, might solve the cooling challenge that increasingly bedevils the world's data centers.

CMOS chip making is dominated by Taiwanese and South Korean companies. The United States is now planning to spend almost one-third of a trillion dollars of private and public money in an effort to rebuild the nation's chip industry and regain its global dominance.

Dr. Sutherland is joined by others in the industry who believe that CMOS manufacturing is hitting fundamental limits that will make the cost of progress intolerable.

"I think we can say with some assurance that we're going to have to radically change the way we design computers because we really are approaching the limits of what is possible with our current technology based on silicon," said Jonathan Koomey, a specialist in large-scale computing energy requirements.

As it has shrunk the size of transistors to the size of just hundreds or thousands of atoms, the semiconductor industry has been increasingly bedeviled with a variety of technical challenges.

Modern microprocessor chips also suffer from what engineers describe as "dark silicon." If all the billions of transistors on a modern microprocessor chip are used simultaneously, the heat they create will melt the chip. Consequently, entire sections of modern chips are shut down and only some of the transistors are working at any time —making them far less efficient.

Dr. Sutherland said the United States should consider alternative technologies for national security reasons. The advantages of a superconducting computing technology might first be useful in the highly competitive market for cellular base stations, the specialized computers inside cellphone towers that process wireless signals, he suggested. China has become a dominant force in the market for the current 5G technology, but next-generation 6G chips would benefit from both the extreme speed and significantly lower power requirement of superconducting processors, he said.

Other industry executives agree. "Ivan is right that the power problem is the big issue," said John L. Hennessy, an electrical engineer who is the chairman of Alphabet and a former president of Stanford. He said there were only two ways to solve the problem —either by gaining efficiency with new design, which is unlikely for general purpose computers, or by creating a new technology that is not bound by existing rules.

One such opportunity might be to fashion new computer designs that mimic the human brain, which is a marvel of low-power computing efficiency. Artificial intelligence research in a field known as neuromorphic computing has previously used conventional silicon manufacturing.

"There is really the potential of creating the equivalent of the human brain using superconducting technology," said Elie Track, chief technology officer of Hypres, the superconducting company. Compared with quantum computing technology, which is still in early experimental stages, "this is something that can be done now, but regrettably the funding agencies haven't paid attention to it," he said.

The time for superconducting computing may not yet have arrived, partly because every time that the CMOS world seems about to hit a final obstacle, clever engineering has surmounted it.

In 2019, a team of researchers at M.I.T. led by Max Shulaker announced that it had built a microprocessor from carbon nanotubes that promised 10 times the energy efficiency of today's silicon chips. Dr. Shulaker is working with Analog Devices, a semiconductor maker in Wilmington, Mass., to commercialize a hybrid version of the technology.

"More and more, I believe you cannot beat silicon," he said. "It's a moving target, and it's really good at what it does."

But as silicon is nearing atomic limits, alternative approaches once again appear promising. Mark Horowitz, a Stanford computer scientist who has helped start several Silicon Valley companies, said he was unwilling to discount

Dr. Sutherland’s passion for superconducting electronics.

“People who’ve changed the course of history are always slightly crazy, you know, but sometimes they’re crazy right,” he said.

DETAILS

Subject:	Brain; Design; Computers; Microprocessors; CMOS; Semiconductors; Personal computers; Transistors; Computer industry; Engineers; Efficiency
Business indexing term:	Subject: Computer industry
Location:	United States--US
Identifier / keyword:	Computer Chips; Factories and Manufacturing; Computers and the Internet; Superconductors; Sutherland, Ivan; Content Type: Personal Profile; United States
Publication title:	New York Times (Online); New York
Publication year:	2023
Publication date:	Apr 19, 2023
Section:	technology
Publisher:	New York Times Company
Place of publication:	New York
Country of publication:	United States, New York
Publication subject:	General Interest Periodicals--United States
e-ISSN:	15538095
Source type:	Blog, Podcast, or Website
Language of publication:	English
Document type:	News
ProQuest document ID:	2802764216
Document URL:	https://stats.lib.pdx.edu/proxy.php?url=https://www.proquest.com/blogs-podcasts-websites/tech-industry-pioneer-sees-way-u-s-lead-advanced/docview/2802764216/se-2?accountid=13265
Copyright:	Copyright 2023 The New York Times Company
Last updated:	2023-04-24

Database: U.S. Major Dailies

LINKS

Linking Service