Unsung innovators: Lynn Conway and Carver Mead

They literally wrote the book on chip design

By Gina Smith
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Computerworld - There is an analogy Lynn Conway brings up when trying to explain what is now known as the "Mead & Conway Revolution" in chip design history.

Before the Web, the Internet had been chugging along for years. But it took the World Wide Web, and its systems and standards, to help the Internet burst into our collective consciousness. "What we had took off in that modern sort of way," says Conway today.

Before Lynn Conway and Carver Mead's work on chip design, the field was progressing, albeit slowly. "By the mid-1970s, digital system designers eager to create higher-performance devices were frustrated by having to use off-the-shelf large-scale-integration logic," according to *Electronic Design* magazine, which inducted Mead and Conway into its **Hall of Fame** in 2002.

The situation at the time stymied designers' efforts "to make chips sufficiently compact or cost-effective to turn their very large-scale visions into timely realities." But then Conway and Mead introduced their very large-scale integration (VLSI) methods for combining tens of thousands of transistor circuits on a single chip.

And after Mead and Conway's 1980 textbook *Introduction to VLSI Design* -- and its subsequent storm through the nation's universities -- engineers outside the big semiconductor companies could pump out bigger and better digital chip designs, and do it faster than ever.

Their textbook became the bible of chip designers for decades, selling over 70,000 copies.


Lynn Conway

"We distilled simple methods that opened up a creative area of electronic design that hadn't been accessible to computer engineers outside of a handful of companies," says Conway, who is now professor emerita at the University of Michigan.

Conway's background included a stint at Xerox Palo Alto Research Corp. (PARC), and she had experience in supercomputer design at IBM. For his part, Mead's Caltech background included work in device physics and integrated circuit design.

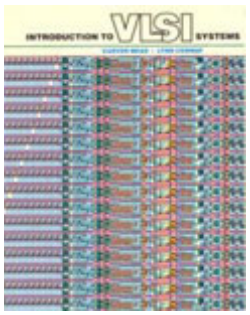
Their design revolution was all about simplicity. "We figured out how to remove tons of unnecessary design rules and optimizations, so that it all came clear," says Conway.

This was in contrast to the way chip designers at the time worked -- with different teams working on different aspects of chip design. The end result was usually far more complicated than necessary.

"We visualized a more streamlined way to do it, and we could see it was dynamite," she says. Their ideas also opened the door for innovative VLSI computer-aided design (CAD) tools that ran efficiently on personal computers. The small computers were then in just early stages of development. Conway and Mead saw that PCs would become ever more powerful as chip densities inexorably increased.

Now, if we'd been typical academics, we'd have just written papers about our observations and that would have been it. But instead, we went out and did it," says Conway, noting that at the time -- circa 1977 -- "a lot of people didn't think the new methods sounded plausible.

"Fortunately," she adds, "we had some secret weapons for launching the new methods -- powerful new computers at PARC [Palo Alto Research Center at Xerox] and access to the ArpaNet [Advanced Research Projects Agency Network]-- enabling us to reach out and share ideas with collaborators and early adopters in many of the country's leading research universities, and get them directly involved in the revolution."



The book jacket for Conway and Mead's landmark book, *Introduction to VLSI Design*

Conway taught a course at MIT in 1978 on the new methods. After a single semester and within just weeks of completing their designs, students were able to have a fabricated chip ready to test. In 1979, the course was expanded to 12 universities with similar results, using a new type of automated Internet server to coordinate everything. This method of teaching was unheard of at the time and was itself a milestone in technology history.

Within two years, more than 110 universities were teaching courses based on the Mead-Conway textbook. The Defense Advanced Research Projects Agency [DARPA] began supporting university research in this exciting new area, and it funded the ongoing operation of an Internet-based rapid-prototyping chip service called **MOSIS**. In this way, university researchers and students all around the country could get their chips fabricated at various "silicon foundries," to use the phrase Carver Mead coined for such services.

"Instead of requiring lots of people and lots of time to turn a design around, suddenly we'd given chip designers an easier, more elegant way to do things," Conway said. Many researchers and entrepreneurs then spread the revolution Conway and Mead started, she says.

Examples include the MIPS chip development at Stanford, the RISC chips at the University of California, Berkeley, the specialized graphics processors Jim Clark later built a business around at Silicon Graphics Inc., and VLSI CAD companies such as Cadence Design Systems Inc., Mentor Graphics Corp. and many others.

"We were just two people who could see where things were heading" Conway says about herself and Mead, who was unavailable to be interviewed for this article. "Mead was way ahead of his time in predicting the scaling of VLSI technology," she said. "He foresaw how really far Moore's

law still had to go, and this was a huge motivating factor in all our work."

"Without us, a VLSI design revolution would have unfolded, but it wouldn't have happened as quickly or spread out as widely" says Conway. "Instead, there was a sudden breakout by Silicon Valley entrepreneurs in the 1980s, and the silicon gold rush that started there has been going on ever since."