The Microchip Turns Fifty: Lessons for Innovators

Fifty years ago this week [Mon 4/25/2011], the U.S. Patent Office issued a patent to Robert Noyce for his invention of the integrated circuit. This invention may be a half-century old, but it is immediately relevant to your life.

Today we call integrated circuits microchips, and they lie at the core of modern electronics like the smallest doll in a Russian *matryoshka*. The smart phone in your pocket, the car you drove to work, the machine that brewed your coffee, and the television you watched while waiting for your caffeine fix all have at their heart an updated version of Noyce's integrated circuit. Peel back enough layers, and you will find these devices at the technical core of Apple, Facebook, Google, Pixar, and many of the other companies that have today captured the imagination of the world.

The inventor is as intriguing as the invention. In 1957, Noyce, the Iowa-born son of a Congregationalist minister, was one of eight young men who co-founded Fairchild Semiconductor, the first successful silicon firm in Silicon Valley. Several dozen companies – including AMD, National Semiconductor, LSI Logic, and the venture capital firm Kleiner Perkins Caufield and Byers – were started by former Fairchild employees. In 1968, Noyce and Gordon Moore, another Fairchild co-founder, launched Intel, today the world's largest chip company. Noyce also mentored many young entrepreneurs, including Steve Jobs.

At the most basic level, a microchip is a complete electronic circuit built on a tiny chip of silicon. The microchip made possible electronics that were smaller, faster, cheaper, and more reliable than ever before. And the story of the chip's invention contains two lessons that today's inventors and entrepreneurs would be wise to heed.

Lesson #1: invention is not a job for prima donnas. Jack Kilby of Texas Instruments devised a microchip at nearly the same time Noyce sketched out his ideas – and after years of protracted legal battles, the men are considered co-inventors.

Moreover, even Noyce's microchip was a team effort. His ideas relied heavily on the work of his Fairchild co-founder Jean Hoerni. Another co-founder, Jay Last, headed the team that figured out how to convert Noyce's intriguing ideas into practical reality. Without all of these men, there likely would not have been a microchip at Fairchild.

Think of Noyce's role as that of a pitcher who has just thrown a perfect game. The record books note only that the pitcher threw a perfect game, but anyone who watched saw that the outfielders caught a dozen fly balls, the first baseman nearly broke his neck to step on the bag an instant before the runner, and the catcher called for pitches perfectly calibrated to each batter's weakness.

This is the way of much modern invention, particularly in high-technology. Any inventor who eschews collaboration for going it alone may be at a disadvantage.

Lesson #2: breakthrough inventions sometimes need to be invented twice – first in the lab and then again in the market.

In the beginning, the sole customer for the microchip was the U.S. military – and it is easy to see why. Microchips were extremely reliable and very small, but they could cost up to fifty times more than a device that was identical in function but built with discrete transistors, resistors, and capacitors strung together the old fashioned way.

It took nearly four years for the microchip to gain acceptance in the commercial market. At the time, there were many explanations, beyond price, for the lag. Many engineers and circuit designers did not want to buy a microchip containing already-designed circuits. They feared the little chip would put them out of work, and they also claimed that they, who had years of experience, were far better equipped to do the design work than employees at an upstart semiconductor company. There were technical objections, as well.

In the spring of 1964, Noyce, who by this point had left the lab for general management, effectively re-invented the microchip for commercial purposes. He believed that "the selling of new ideas is an engineering problem," but the solution he hit upon was not a technical or design overhaul.

Instead, Noyce drastically cut the price. Fairchild began selling its low-end microchips for less than it would cost a customer to buy the individual components and connect them – and less than it was costing Fairchild to build the device. In effect, Noyce was betting that experience curves and economies of scale would enable the company eventually to build the circuits for so little that it would be possible to make a profit even on the seemingly ridiculously low price.

It worked. Within a year, the commercial market for microchips exploded. And a precedent had been set. As Gordon Moore once put it, ever since Noyce's 1964 decision, in the semiconductor industry, "Whenever there's a problem, you lower the price."

I have been asked what Noyce, who died in 1990 at the age of 62, would think of social networking and today's globally connected smart phones and tablet computers. He would love it all. As early as 1965, he was eagerly anticipating the day when the microchip would be widely available in the form of "portable telephones, personal paging systems, and palm-sized TVs." He liked to say that when electricity was used only to drive the big motors in mills and on shop floors, it did not do much to change society. But once the fractional horsepower motor came on the scene, putting electricity's potential into people's hands in the form of sewing machines, fans, and power tools – that was when the real change happened.