



John C. Hollar: History of Computing

Charles Severance

John C. Hollar, president and chief executive officer of the Computer History Museum, describes the museum's focus and exhibits.

For anyone visiting the San Francisco area, a visit to the Computer History Museum in Mountain View is an important stop. The Bay Area is home to Silicon Valley, center of the universe for many of the past 30 years' worth of technological breakthroughs.

It's difficult to "see" Silicon Valley as you drive around, but the Computer History Museum gives a unique opportunity to learn about the people and technologies that have an ever-increasing impact on our lives. You can view my interview with John C. Hollar, the museum's president and chief executive officer, at www.computer.org/computingconversations.

Beyond Babbage

The Computer History Museum focuses on both the technical artifacts that make up our computational past as well as the human stories of the challenges, risks, and failures that led to the breakthroughs that define our field. One of the earliest artifacts in the museum is the Babbage difference engine that computes polynomials using mechanical computation:

I love the Babbage Engine because it's a model of the way great innovation

works. Charles Babbage was a brilliant mathematician, working on a problem that involved books of log tables filled with typographical errors. All the calculations had to be done by hand, transcribed by hand, typeset by hand—the margin for error was phenomenal. Babbage dreamed of a special-purpose, extremely sophisticated calculator that would take all the guesswork and human intervention out of generating these tables. It was exactly the right approach to exactly the right problem. The difficulty was that like many entrepreneurs, Babbage had a brilliant idea but couldn't get it funded. He never got further than building a piece of it, but he created the blueprints for the full engine in fantastic detail.

Although Babbage designed his difference engine in great detail, he never knew if it would actually work. In 1985, some 150 years after its conception, engineers and specialists at the London Science Museum undertook building a difference engine based on Babbage's original plans. They completed the first difference engine in 2002, and you can view it in London:

A second engine was built, so the first one is in London, but the second one is here at the museum in Mountain

View, California. It's the complete Babbage Engine, because Babbage not only envisioned this enormously complicated two-ton machine with 8,000 moving parts, he also envisioned a printer and a stamper that would create the plate from which the book could be printed. Babbage dreamed of warehouses full of these machines being driven by steam engines so they would be constantly calculating. Our machine, which we crank every day at 1 p.m. Pacific time, now works exactly as Babbage envisioned. As brilliant as he was, he couldn't get it funded and died embittered, wondering what the world might have been if he had been able to create it. Generations later, entrepreneurs worked from those plans and brought them to life.

In the 1930s and 1940s, computing moved from mechanical to electronic devices, triggered initially by technological breakthroughs followed by rapid innovation as well as problems and conflicts:

I love our recreation of the Atanasoff-Berry computer. First, it's the only one that exists. It was built exactly according to the plans that John Vincent Atanasoff and Clifford Berry devised at Iowa State in the 1930s. As you might recall, it was the subject of a very famous patent dispute that

destroyed all of Eckert and Mauchly's original patents based on the ENIAC and the birth of electronic computing. As Gordon Bell says, "It was the dis-invention of computer." You can stand in that gallery here, which is called "the birth of the computer," and you can see the ABC computer in all of its simplicity standing right next to the JOHNNIAC, [John] von Neumann's famous computer and one of the first Williams-Kilburn tubes and the Engima encoding machine right next to a film about code breaking in World War II. So much of history comes together in the space of about 1,000 square feet with the real machines sitting there.

The Rise of Circuits

In our field, amazing breakthroughs, innovation, and rapid innovation are always followed by the scaling-up and practical applications of the new technologies. By the 1960s, IBM was designing the 360 architecture that's still in wide use today:

The IBM 360 is a great story, not only the system itself but also because it was a "bet the company" decision by Tom Watson. In the 1960s, he spent what today would be the equivalent of about \$60 billion in research and development money on a single project that succeeded and charted IBM's course for the next half-century. If it had failed, it would have sunk the company.

The electronic computing revolution went from vacuum tubes in the 1930s to transistors in the late 1940s to the invention of the integrated circuit in the late 1950s. Sixty years later, our current technology is still based on increasingly powerful and sophisticated integrated circuits. The invention of integrated circuits both created and gave the name to Silicon Valley:

We have a replica of Jack Kilby's notebook open to the page from Sep-

tember 1958 where he reports for the first time his whole design for his version of the integrated circuit. Sitting there in Texas Instruments, he's told by his bosses in the middle of a Texas summer, "Don't work on this idea, Jack—we all know you're in love with it, but you have another job." They all leave on vacation, and what does Kilby do but spend the month working on the integrated circuit. Everyone

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comes back in September, he hooks it up to an oscilloscope, and it works exactly as he predicted. At the very same moment, out in Silicon Valley, at Fairchild, Noyce, Moore, Hoerni, and Last are working on the same idea, and within a period of months, literally the "big bang" in computing has happened, and everything changes.


Once we had the integrated circuit in hand, we quickly went from invention to engineering. The goal was to make cheaper and faster integrated circuits. Gordon E. Moore coined Moore's law, which stated that the number of transistors we could put onto an integrated circuit would double about every two years. He predicted the trend in a paper in 1965, and it has been remarkably accurate even to the present day:

The semiconductor gallery is a really special one—we have wonderful examples of wafers as small as a nickel and as large as a dinner plate, and you can see the evolution over time of how complicated it is to make a microprocessor and how difficult the science is.

As is always the case, once a scientific or engineering breakthrough

happens, the real money is in applying these new technologies to solve human problems. The creation of increasingly powerful and inexpensive integrated circuitry unleashed a torrent of new applications for computing technologies:

When you go down what I call "application alley" at the museum, you see in very quick succession how we went from artificial intelligence to robotics to graphics to music to art. And then [you move on to] Xerox PARC, the birthplace of the graphical interface, the mouse, and the chorded keyboard that Doug Engelbart invented. [You see] the first Pong machine—the birth of Atari and all the gaming companies that came after it—as well as the personal computer, the Apple/IBM PC battles, and a million different flavors of PCs that flourished. You go through this in very quick succession after you tour the integrated circuit, and you come to a world that we're experiencing in a very personal way now, but once you've walked through it, you know that we're only still at the beginning.

As we've moved from the era of mechanical computing to cell phones that are more powerful than the massive supercomputers of the past, it's important for all of us in computer science to understand what it took to create our current technologies, so that we can best imagine how we might make our own contributions and continue to evolve our field. For more information about the museum, visit www.computerhistory.org. 

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