The future that never was

Seven products that could have changed the industry but didn't

By Geoffrey James -- Electronic Business, 12/1/2005

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The electronics industry is in a constant state of growth and evolution. At each stage of its development, there have been key products, such as the IBM 360, the 8086 CPU and the cell phone, that have defined the industry's direction for a decade or more. Looking back at the success of these products, it's easy to assume that history was destiny and that the progress of the industry was nothing more than a logical sequence of inevitable events.

But that's just the blindness of hindsight. There have been many key points in the development of electronics at which a different product, had it proven successful, would have accelerated the development of follow-on technologies and changed the direction of the industry. On the heels of our 30th-anniversary issue (November 2005), we thought it would be interesting to look at seven products that flopped in the market but had a massive potential to influence almost every sector of the electronics industry.

The Beckman analog computer

The IBM 360 was the first commercial general-purpose computer, but in the early 1960s, when IBM released it, computer scientists were still arguing about whether computers should be designed with digital or analog circuitry.

Analog computers differ from digital computers in two important ways. First, whereas a digital bit always represents either a 0 or a 1, its analog counterpart, the op amp, can represent an infinite number of fractional values between 0 and 1. Second, analog computers are inherently parallel and able to perform many calculations simultaneously. This makes them particularly well suited for solving highly interdependent equations in which changes in one set of variables determine the value of another set.
These two characteristics make analog computers superior in many ways to digital ones. Some highly sophisticated applications, such as avionics systems, that require the interaction of multiple controls and inputs are particularly well suited for analog. At the same time, analog is a functional superset of digital. By setting upper and lower thresholds, a circuit can take an analog waveform and emulate 1s and 0s of a digital circuit.

Dozens of companies were making analog computers when the IBM 360 was released. Many of these machines were desktop models, but one company, Beckman Instruments, was building room-size machines rivaling the 360 in complexity (see photo, above). Beckman's machines were actually more sophisticated than the 360 in some ways, using push-button keyboards, rather than punch cards, for input.

Fortunately for IBM, analog circuitry was harder to miniaturize and more difficult to program than digital circuitry, so much so that when the 360 and its follow-ons were released, interest in analog computing dwindled. It was only with the advent of the cell phone and wireless computing, which need mixed-signal chips, that analog computing once again emerged in importance.

If IBM had encountered difficulties that delayed the release of the 360 and Beckman had added digital emulation to its analog computers, it's possible that a machine such as the Beckman Model 2230—which, like the 360, used the latest transistor technology—might well have established itself as the de facto mainframe standard. Rather than focusing on digital circuitry, the industry would have refined analog computing techniques, possibly resulting in the earlier market introduction of analog-intensive devices such as cell phones and WiFi modems.

The AT&T PicturePhone

According to the market research firm IDC, 67 million Webcams have been purchased since 1998 and yearly sales will reach $1.2 billion in 2005. Although that may seem impressive, it's small potatoes compared to what AT&T expected to make when it released the world's first video-enabled telephone. Developed at Bell Labs way back in 1956, the PicturePhone (see photo, above) was released in 1963, in the Chicago area. It was expected to reach three million homes and offices by the mid-1980s, generating $5 billion a year in 1965 dollars—roughly $30 billion a year in today's dollars.

Unlike the Webcam, which requires broadband connectivity, the PicturePhone operated over regular telephone lines, and unlike audio telephones, which use a single pair of wires, the PicturePhone required three pairs: two to carry the video signal in each direction and a third pair to carry the voice and the touch-tone signal. Incredibly, this technology was sufficient to provide a video connection within the boundaries of a local telephone company.

Long-distance posed more of a problem, because connections between local exchanges were multiplexed, with each wire carrying multiple calls. Because of this, each long-distance PicturePhone call would have consumed as much bandwidth as 300 regular calls, making video calls prohibitively expensive. However, when the PicturePhone was released, Bell Labs was working on video compression technology that, over time,
would have greatly reduced the resource requirements for long-distance video use.

Unfortunately, without long-distance capability, PicturePhone calls were limited to telephones so close together that it was almost as convenient to drive (or walk) to see the person you were going to call. And in those technologically naive days, users were afraid the PicturePhone would allow neighbors or coworkers to spy on them. After several years of marketing and trial installations, AT&T scrapped the PicturePhone, two years before the first issue of *Electronic Business* hit the newsstands.

Imagine what might have happened, though, if Bell Labs had released the PicturePhone simultaneously with the video compression technology that would have made it practical for long-distance calling. Back then air travel was quite expensive, and America—both consumers and businesspeople—might very well have embraced the PicturePhone, simply as a cost-saving device.

If that had happened, the electronics industry would be very different today. The AT&T monopoly, strengthened by extra revenue, would have wielded far more economic and political power. AT&T would probably have won the antitrust lawsuit that led to its breakup and would have ended up as a single, universal Internet service provider in the United States. The company would then have leveraged its monopoly in video telephony to capture the cable television market and would then have been in the position to set standards, forcing smaller firms (such as IBM and Microsoft) to toe its line.

Bushnell's Computer Space game

Video games are big business for the semiconductor industry. According to the market research firm InStat/MDR (a division of *EB*'s parent company), consumers will purchase some 35 million gaming consoles in 2005. In addition, IDC estimates that consumers will purchase some 72 million PCs for home use in 2005, many of which will be purchased for playing video games.

Although video games had been bouncing around inside research labs since the 1950s, the first video game to become popular among consumers was Pong, a coin-operated tabletop game that became a tavern fixture in the mid-1970s. (Pong's inventor, Nolan Bushnell, later created the first game console, the Atari 2600.) Despite its success, Pong was not the first coin-op video game, an honor held by Computer Space (see photo, above), which Bushnell designed and released in 1971, a year before Pong saw the light of day.

Pong was a simple table tennis emulator, but Computer Space was years ahead of its time. With two missile-shooting spaceships whizzing through a field of stars, Computer Space resembled Asteroids, a wildly popular game released eight years later. But in 1971 Computer Space was simply too weird for people accustomed to nothing more complex than pinball and pachinko. Only a few hundred were made, and most of them ended up in computer museums and private collections.
Suppose, however, that Computer Space, rather than Pong, had become the defining product for the budding video game industry. Starting with such a sophisticated game, customers would undoubtedly have demanded even more games, jump-starting the video game industry and accelerating market penetration by five to eight years. Game consoles such as the PlayStation and the Xbox would have entered the market years earlier, increasing the total number of consoles sold. This, in turn, would have generated a vast increase in semiconductor demand.

Gaming consoles might have co-opted the home PC. Some of the early game consoles had keyboard attachments, giving them the potential to offer word processing and other PC-like functions. Because the game consoles of the time cost between $200 to $400, as opposed to $5,000 for a PC, consoles might have gobbled up the home computing market if they had been introduced into the market five years earlier with office automation functionality. With such an attractive price point, could game consoles even have penetrated the corporate market, making the PC entirely unnecessary?

The Heathkit Hero robot

The continued health of Moore's Law depends on an ever growing demand for semiconductors that are ever more powerful. To maintain industry growth, the electronics industry must, every few years, create new products that require ever increasing amounts of computing power and memory density. Right now, the big drivers of semiconductor sales are cell phones and consumer electronics, but as the industry moves to 65- and 45-nanometer design nodes, continued industry growth will require additional product categories.

One potential market driver is robotics. In 2004 North American robotics manufacturers sold about 16 thousand robots, generating around $1 billion in revenue. Most of those robots were industrial models destined for factories, but consumer robots, such as iRobot's Roomba automated vacuum cleaner, seem to be growing in popularity.

Someday, consumer robots may generate massive semiconductor sales, but the Holy Grail of robotics—a general-purpose robot that can perform various tasks in the home or the office—remains elusive. The problem is software, not hardware. A robotic servant along the lines of Star Wars' R2D2 or C3PO would require generalized artificial intelligence that would enable the robot to think like a human being. But despite decades of research and development in AI, scientists are still arguing about whether machines are as smart as insects.

Too bad, because if generalized AI had been developed before 1981, it could have been paired with an appropriate hardware platform that was already in place: The Heathkit Hero (see photo, above), the world's first commercially available programmable robot, had all the features necessary to become a useful robotic servant, including:

- A sound sensor that could detect the frequencies of human communication
- A light sensor that could detect the entire visible spectrum and
part of the infrared spectrum
- A motion sensor that could detect the movement of objects up to
  15 feet away
- Onboard sonar that could determine the range of objects from 4
  inches to 8 feet away
- An optical encoder that measured distances to navigate a
  predetermined course
- A head-and-arm attachment that could rotate almost 360 degrees
- A claw capable of picking up objects weighing up to a pound
- A speech synthesis chip that enabled the Hero to speak in
  complete sentences
- An expansion breadboard to interface with sensors such as
  smoke detectors and burglar alarms
- The ability to connect to a PC for program downloading

By today's computing standards, the Hero's "brains" were elegantly
simple: a Motorola 6808 8-bit CPU, with 4K of RAM and 8K of ROM.
Despite this, the complexity of the platform and the richness of the
sensor functionality guaranteed that only experienced programmers, with
a lot of time on their hands, could get the Hero to do anything interesting.
The Hero did have a R2D2-like squeaking demo, but at around $1,500
per unit, the device was far too costly to be a children's toy.

Had the Hero come equipped with generalized AI, it would have
launched an entirely new product category—the robotic servant—that
would likely have rivaled PCs in sales. With improved arms, claws
and sensors, subsequent versions of the Hero would have been able to
understand human instructions and perform simple tasks such as
fetching, carrying and cleaning. More important, a successful robotic
servant product would have doubled semiconductor sales throughout the
cyclical downturns of the 1980s and 1990s.

The Xerox Alto Workstation

Whereas the previous four products
turned out to be technological dead
ends, the Xerox Alto workstation is
widely considered an important and
seminal invention. However, the
impact of the Alto was delayed for
more than 10 years, raising the
question of how the electronics
industry would be different if Xerox
hadn't sat on its hands.

In the early 1970s, researchers at
Xerox Palo Alto Research Center
(PARC) invented the Alto, a
workstation that had the look and feel
of an Apple Macintosh, well before
that computer was developed. At a
time when the industry state of the art was character-based word
processing, the Alto used a keyboard/mouse combo to control a
bit-mapped screen with menus and icons. The hardware was equally
sophisticated, featuring a proprietary CPU, one of the first in the industry
to use microcode, allowing the designers to more easily add new
machine instructions without constructing new circuits.

Unfortunately, Xerox executives didn't understand what their scientists
had built. The Alto languished until 1981, when Xerox finally brought it to
market. The commercial version, the Star, had not only the graphical
user interface but also a list of features such as e-mail, file sharing and
network printing that wouldn't become available on PCs for years.
However, the Star lacked a spreadsheet, the "killer" application that, by the time the Star hit the market, was fueling PC growth. The Star was also several times the PC's price, forcing customers to pay too much just to use a fancy interface. It wasn't until the advent of the Macintosh, priced like a PC and armed with a spreadsheet, that graphical user interfaces began to take hold.

If Xerox had released the Alto in the 1970s at a price point competitive with the stand-alone word processors of the time, the entire computer industry would have been accelerated a decade. To provide extended networking and communications, Xerox would probably have integrated the Alto with its award-winning CP-V time-sharing system, creating an integrated office intranet 15 years before comparable technology appeared in the office. With Altos in place everywhere, there would have been no need for an IBM PC, much less for Microsoft, Compaq, Dell or Apple Computer. Intel, without the revenue from PC CPUs, might have ended up an industry backwater.

The Connection Machine

Whereas Xerox had a product it didn't bring to market, Thinking Machines marketed a product it didn't have. MIT graduate Daniel Hillis founded Thinking Machines in 1982, with a plan to build the Connection Machine, a massively parallel supercomputer that could emulate the structure and behavior of the human brain. As Hillis envisioned it, these "thinking machines" would provide AI as a network service to PCs, workstations, minicomputers and mainframes.

The idea was interesting enough to attract funding from the U.S. Defense Advanced Research Projects Agency (DARPA), which hoped that the Connection Machine would eventually lead to the kind of AI that would be needed to build intelligent robotic soldiers.

As Hillis tried to build a working prototype, CEO Sheryl Handler spent millions on fancy offices, gourmet chefs, and flashy marketing. With its glitzy brochures and space-age cabinet designs, Thinking Machines became the apotheosis of high-tech cool, anticipating by 15 years the worst excesses of the dot-com era.

Major conflicts developed behind the scenes, as it became clear that the lack of a generalized artificial intelligence program made Hillis' concept of a thinking machine an impossible dream. Controversy over the target market delayed the product until 1985, giving competitors a chance to release rival designs.

However, DARPA was so committed to the Connection Machine that it subsidized sales to keep the company in business. By the time competitors discovered the DARPA subsidies and cried foul, it was too late. Thinking Machines struggled for a few months with massive overhead and an obsolete product set before declaring bankruptcy in August 1994.

Suppose, however, that Thinking Machines hadn't been burdened with bad management and that the developers had managed to achieve some rudimentary level of generalized AI. The Connection Machine would likely have captured the bulk of the market for supercomputers.
and, if it had fulfilled its promise, dozens of research labs would have dipped into their pockets to buy the machine that turned sci-fi and machine intelligence into a reality.

The Alpha chip

Advanced Micro Devices' recent lawsuit against Intel is ample evidence of how thoroughly Intel dominates the CPU business. Even though it looks likely that IBM will capture the market for game console chips, it's clear that Intel will remain the dominant CPU chip vendor for many years to come.

The Alpha chip

That sterling future wasn't a foregone conclusion in 1992, when Digital Equipment Corporation (DEC) released the Alpha chip. At 200 megahertz, the initial version of the 64-bit Alpha was more than three times as fast as Intel's state of the art, the 66-MHz 486 DX2. More important, Microsoft had promised to port Windows NT to the Alpha, a combination so formidable that some industry analysts were predicting that Intel's market share in CPUs would shrink to less than 50 percent within three years.

Unfortunately, the Alpha ran into the "chicken and egg" problem. To use Alpha's extra horsepower, developers had to recode their applications, something few were willing to do without a customer base. Potential Alpha customers, on the other hand, didn't see the logic of buying a system that, without customized programs, didn't run any faster than a standard Intel system.

DEC tried to persuade developers to port to Alpha/NT, but the company was simultaneously trying to get those same developers to port their applications to both DEC's proprietary VMS and its semiproprietary version of UNIX. The developers understandably scratched their heads and waited to find out which operating system was DEC's "real" business. Microsoft, frustrated by DEC's ambivalence, was forced to cancel NT on Alpha when customers failed to materialize.

But what if DEC had focused entirely on making the Alpha successful on NT? With Windows applications running two to three times as fast as on the Alpha as on the Intel chip, Alpha might easily have replaced Intel as the de facto computing standard. A newly successful DEC would probably have looked to acquire a PC manufacturer, to round out its systems products. Because Compaq was soon to encounter its own market difficulties, the most likely PC firm for DEC to acquire would have been Compaq—instead of the other way around.

Geoffrey James, a frequent contributor to Electronic Business, obviously has too much time to think.

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