

Text 10

Ten reasons why microprocessor define the twentieth century more than any other achievement

Flash back to 1971. China enters the United Nations. Eighteen-year-olds win the right to vote in the USA "computer on a chip" arrives that's small enough and cheap enough to fit inside business machines, toys, appliances, tools, and entertainment devices - in short, anything that is vaguely electrical. The world hasn't been the same since.

Today, thanks to the microprocessors that have followed Intel's 4004 in 1971, we're healthier, better informed, more efficient, and, in some disturbing ways, less private than we were 25 years ago. (For details about the 4004 and other significant microprocessors, see the article "Birth of a Chip". To see how technology may change in the next decade, see the article "Eight Ways to the Future.") Because microprocessors have become so much a part of our lives, the real challenge is to find devices in our business and personal lives that aren't in some way computer-controlled. Small and relatively inexpensive computers have made it possible for us to track virtually any human activity, analyze any process, and control any mechanism.

As we acknowledge the microprocessor's twenty-fifth anniversary, we should also remind ourselves that computers only process data: Knowledge is another matter. The Federal Reserve may run dozens of computer-based financial models, but in the end, it's humans who decide whether to raise or lower interest rates. Similarly, years of research in artificial intelligence have produced flexible algorithms that can adapt in well-defined ways, but only humans have the ability to comprehend and grok.

What follows is our list of 10 dramatic ways that the microprocessor has changed our world. All point to one indisputable fact. Any look at the microprocessor's impact on society is only a snapshot in time. The revolution continues.

Individual Rights: Privacy under Fire

In the past, your private documents were only as secure as the safe you locked them in at night. Today, electronic encryption secures information on disk drives so that only authorized people can read sensitive data.

But encryption also creates the possibility that criminate could electronically hide important evidence. In the U.S., federal law-enforcement officials are pushing a plan for people to give a copy of all encryption keys to the government, which will keep the keys under wraps unless there's a need to read some encrypted data. According to these officials, the encryption threat is so great that the U.S. government should continue its fight against exporting encryption technology beyond its borders.

Encryption will also provide the under pinnings for widespread electronic commerce, which could give consumers unlimited access to a world marketplace and an electronic audit trail for recovering lost or stolen funds. Nevertheless, our privacy also could be assaulted by credit-card companies, banks, and others who can easily assemble detailed dossiers on our spending habits. For example, employers in some states can legally refuse to hire cigarette smokers because of the cost of providing health care. Taken to an extreme, electronic record of spending habits could lead to a job interview such as this.

Employer: "Are you currently a cigarette smoker?"

Applicant: "No comment."

Employer: "Then would you care to explain why you bought that 20-cigarette pack of Marlboro lights at 12-32 p.m. on June 14 1997, at the Zippee Mart on Fourth and Oak?"

In the end, blind-signature schemes for digital cash and anonymous messaging using Secure IP (Internet Protocol) may be our best hope for shopping without the aid of Big Brother.

Business: The Electronic Workplace

The outward signs are everywhere PCs on every desktop, laser printers in every workgroup, electronic spreadsheets and databases bolstering every business decision. The modern office looks and works differently from its predecessor of 25 years ago, thanks to the microprocessor.

At first, computers simply translated traditional ways of working into some electronic analogy that may or may not have improved efficiency. Gradually, however, computers inspired us to work differently. Groupware products and intranets using cheap microprocessor-based computers now provide seamless communication and make it possible for managers to control larger and more diverse groups.

The good news is that many office products have never been cheaper (after adjusting for inflation). The bad news 'is that many companies need fewer managers which narrow advancement paths for many people. What's more, as workgroups become geographically dispersed, some workers find themselves cut out of essential meetings. The synergy of the water cooler disappears.

Medicine: Computed Tomography for Everyone

Every day in hospitals throughout the world, computed-tomography (CT) scanners save lives by showing doctors a 3-D map of the inner body. Microprocessors aren't the only types of computers that can do the mathematics to construct these 3-D images, but microprocessors are why CT scanners have proliferated in recent years. Early CT machines ran large minicomputers that were expensive to build and maintain, but the newest scanners use high-end workstations for processing muscle. For instance, Picker Nuclear Medicine (Highland Heights, OH) formerly powered its scanners with an Ardent Titan 1500 minicomputer that needed dual multiprocessors to generate 32 MFLOPS at peak performance. Today, the company uses a Digital Equipment Alpha workstation with a single microprocessor that can produce over 133 MFLOPS of floating-point performance. These workstations are also highly optimized for graphics, which allows real-time manipulation of 3-D images to help doctors evaluate the health of organs and zero in on diseases. And perhaps most

important, microprocessors have helped lower the cost and shrink the size of CT machines, which makes them more widely available than ever. In fact, outpatient CT centers now are common in many urban areas.

Publishing: News Gathering Becomes Collaborative

News was once something that came down to us from a handful of media outlets like a daily sermon from the mountain. The Internet levels the mountain. Almost anyone can now be a publisher, and some of the most late-breaking news and diverse opinions now arrive via electronic 'zines and e-mail lists. Usenet newsgroups also contain news nuggets often mixed with terabytes of yammering foolishness.

Major newspapers are responding by blending their traditional print products with on-line information from their own Web sites. Reporters now receive e-mail correspondence from larger cross sections of sources to broaden the reporting of their stories. When the NEW York Times ran a major week-long exploration of downsizing in America earlier this year. It sponsored conferences at its Web site. Elizabeth Osder, content development editor, says the printed edition actually included some quotes and information from the electronic discussions in the stories that ran later that week. Also, Microsoft's joint venture with NBC News points to a similar blending of TV news and Web sites for information delivery. Nevertheless, printed publications won't disappear anytime soon. The Web is great for conferencing, research, or for poking around randomly for information, but newspapers and magazines are still more convenient to read and faster to browse. Paper has great bandwidth.

Messaging: E-mail Distributes Democracy

Electronic mail opened up the corporate world by replacing formal chains of command with fast and more interactive communications (even though words may often be misspelled. sentences may be filled with questionable grammar and thoughts may not always be fully formed). All of this relies on microprocessors in desktop machines and In modems that move the information,

Then there's "Dilbert." Scott Adams, the comic strip's creator, uses e-mail to receive ideas for future cartoons from readers. A few of "Dilbert's" cartoon predecessors relied on snail mail for input from readers, but thanks to e-mail, "Dilbert" may be the most interactive cartoon ever. Of course, this can be painful if you are a manager whose new initiative. "Totally Quality, Total Equality," becomes the target of a future "Dilbert" episode.

Science: DNA's Mysteries Unzipped

Biologists still don't completely understand DNA, but they've made great strides in the last decade, thanks to microprocessors. The mathematics of sequencing large parts of the genome has spawned a new field of computational molecular biology. Special silicon chips make it possible to speed sequencing even more.

The benefit: Researchers can now use genetic profiles to predict which individuals are more likely to contract certain diseases. But cheap and effective genetic tests can make people uncomfortable. For example, some U.S. soldiers recently refused to have their cells included in a military DNA database because they feared the data hidden in their DNA could be used against them later. Similarly, will health insurers be able to resist the temptation to deny coverage to those with a predisposition to, say, diabetes?

Transportation: Smarter Automobiles Now Rule the Road

Gone are the days when driving a powerful car meant you burned gas like it was free and fussed over a carburetor for hours. Microprocessors now run the engines so efficiently that many standard-size cars get up to 30 miles to a gallon and enough torque to make passing fun. And as a bonus, the latest engines can go for 100,000 miles without a tune-up, thanks to the microprocessors.

The technology doesn't end there. Air bags open when a microprocessor detects Impact. Car CD players fight skips by reading ahead several seconds and filling in lost gaps before it's time to play the data. Which processors do car makers favor? Many of the CPU families we're familiar with in our desktop systems have versions that serve as embedded processors. This includes the PowerPC, Motorola's 680x0 line, and many Intel chips. What's next for semiconductor-managed cars? Auto makers are exploring custom OS'es to network the dozen or more CPU's common in automobiles. Talk about the Infobahn.

Communications: Worldwide Dial Tones

Cellular phones - the lifeline for both road warriors and stranded hikers - are just microprocessors hooked up to a radio antenna and optimized for processing radio signals. For example, Motorola's VeComp chips, the next generation of processors designed for wireless networks, use a PowerPC core. The core runs the phone's OS and handles details about calling numbers. The chips also come with a single instruction/multiple data (SIMD) array of ALU's for digital signal processing.

Although the beep of cellular phones has had a substantial effect in industrialized nations, changes elsewhere are even more extraordinary. Large parts of Africa may never be wired for traditional phone service, because cellular systems are substantially cheaper to launch. The microprocessor has made it possible for some countries to go from almost no phones to ubiquitous phone service.

Banking: Easy (Too Easy?) Credit for All

Twenty years ago, credit cards were for a privileged few because verifying transactions was tedious. If you made a large purchase, the store clerk called a central operator and read the value over the phone. Thanks to microprocessors, the dangers and inefficiencies of cash-only transactions are disappearing, but in their place we have credit-card debt that

is strangling some people who have found that plastic is too easy to use. For better or for worse, the microprocessor allows for cheap terminals at practically every cash register in the country. Embedded microprocessors built around old versions of the x86 line and modems running at 2400 bps cost little. Because stores can now verify every transaction, finance companies can easily enforce credit limits and stop fraud. This lowers the risk of putting credit cards into the hands of millions of people worldwide. Consider growth rates in this decade alone. In 1990, Visa reported carrying \$174 billion through its networks, but by 1994, the company processed \$293 billion, an average annual growth of 17 percent. What's more, credit cards pay for even the most everyday. Ten years ago, practically all grocery purchases were in cash. By August 1995, low-cost supermarket verification terminals helped Visa carry \$1 billion in grocery charges.

Entertainment: Animation Opens Up a New Dimension

The microprocessor dramatically changes how artists produce animation by making it possible to create true, 3-D worlds that move. Previously, artists constructed animated cartoons using 2-D creatures moving against a fixed 2-D background like a game of cardboard cutouts. Advertisements have embraced this technology as well: Every product seems to get up, move and dance across the screen today. The result is more-realistic-looking animation and some reduction of the immense amount of resources needed to produce cartoons. For example, Toy Story used the smallest staffer any animated Disney feature to date, yet it was entirely 3-D. Disney and Pixar estimate that they used over 800,000 hours of computing time on Silicon Graphics workstations and Sun SparcStations to build the final 500 GB worth of pixels that audiences viewed in the film.