APPLIED INTELLIGENCE

The State of Technology in the Second Decade of the 21st Century

JAMES MARTIN

In this, the last of six related columns examining future technology, James Martin describes the most significant aspects of technology that we can expect in the second decade of the 21st century.

Early in the second decade of the 21st century, widely used low-priced computer systems will probably operate at 200 million instructions per second (mips), while high-priced personal workstations will reach 1 billion instructions per second (bips).

By the end of the decade, those speeds are likely to rise to 300 mips and 60 bips, respectively. Top-of-the-line mainframe speeds will reach 500 billion mips; top-of-the-line supercomputers will reach 80 trillion floating-point instructions per second (flops); and large artificial-intelligence (AI) engines will handle 1 trillion logical inferences per second (lips).

The number of components on mass-produced chips or wafers will have risen to 1 trillion components by the end of the decade.

One mass-produced chip or wafer will be capable of storing 64 billion bits.

Special-purpose wafers will be manufactured that contain an enormous number of parallel processors. For example, a single wafer could contain 16K 32-bit Reduced Instruction Set Computer (RISC) processors, 64K 16-bit RISC processors or 1M 1-bit RISC processors. By the year 2020, these figures may quadruple.

Biomolecular Techniques

Using biomolecular techniques, the recording capacity of optical disks in the early 2010s will be four times greater than it was in the early 2000s. For example: 4¾-inch disks will contain 128 billion bits of data and 3-inch disks will contain 16 billion bits of data.

Three-inch disks will be able to contain a feature-length movie recorded in high-definition TV. Two-inch disks will be largely replaced by solid-state RAM wafers that avoid the need for any moving parts.

By the end of the decade, optical memory, logic and neurocomputing wafers will be widely used in computers. The width of features on electronic wafers will have dropped to .01 micron, which is close to the physical limit. Rather than reduce the size of features, emphasis will be placed on producing larger wafers and lowering their cost. There will be scope for major cost reductions as electronic wafers are mass-produced like newsprint in ever-increasing quantities.

A landmark in computing will have been reached by 2020, as shown in the accompanying figure. Large neurocomputers built with optical wafers will have as many neurons as the human cerebral cortex.

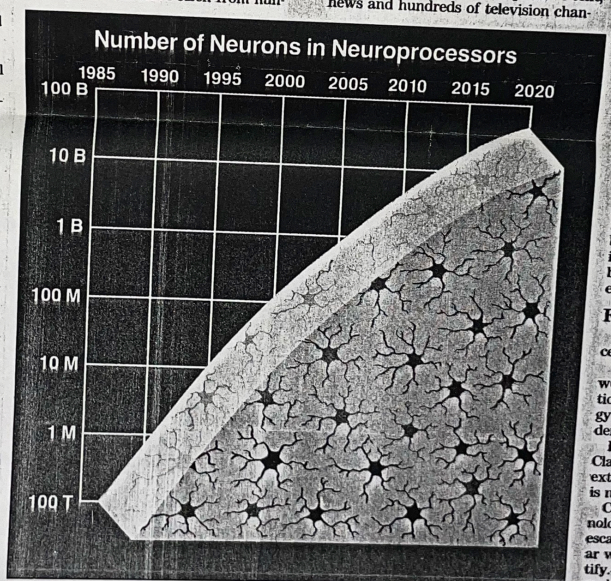
Although these devices will be extremely powerful for neurocomputing tasks such as pattern recognition, surveillance, speech recognition, robotics and optimization, they will in no way compete with the human ability to be creative, apply common sense and associate diverse ideas.

AI supercomputers will reach a landmark speed of 1 trillion lips, and software complexity will rise steadily. By the early 2010s, common sizes for large programs, in million lines of code (M loc), will be 5M loc for large commercial applications, 100M loc for large military projects, and 400M loc for complex vendor software.

Telecommunications: The revolution in transmission technology will have been largely accomplished by the early 2010s.

From 1965 to 2010, digital transmission speeds will have risen from hundreds of bits per second (bps) to hundreds of billions of bits per second. During the decade 2000 to 2010, the speed of fast single-strand optical fibers will rise from 141 billion bps to 563 billion bps. The capacity of major multifiber optical trunks will increase from 600 trillion bps to 1,000 trillion bps.

After 2010, there will be minor improvements in optical-fiber technology, but, like the evolution of the motor car after 1950, there will be no revolutionary increases in speed.



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During this period, major improvements will be made in optical-switching technology and in the plunging costs of optical computers. The optical-computer revolution will still be in its infancy in 2010.

Although the technology of optical fibers may not improve much, the way it affects society will still be evolving rapidly.

Optical fibers will be deployed in ever-growing numbers, with vast new capital expenditures on very high-speed telecommunications facilities. The raw telecommunications technology, as always seems to be the case, will be far ahead of the mature understanding of its applications.

By the end of the decade, there will be many very-large satellites of Ka-band and higher frequencies. These satellites will facilitate low-cost reception of text, news and hundreds of television channels, many of which will be broadcast with multiple sound channels in different languages.

Broadband networks and hypersonic travel will make the planet seem very small.

Because of worldwide television, information media and automatic language translation, people worldwide will have become closer and will have a greater understanding of each other's concepts and beliefs.

The world will acquire a uniformity of ideas and culture that will accompany its growing uniformity of material goods and worldwide franchised businesses.

Home facilities: Affluent homes will have 12-foot wall screens for high-definition TV.

Three-dimensional television can be displayed on these screens. Exceedingly elaborate computer games can be played on the wall-screens using highly parallel home computers of more than a billion mips with high-density optical disks.

Alternatively, users may access more-powerful remote computers via 140M bps Integrated Services Digital Network (ISDN) optical fibers. In some games, players in different homes will be interlinked.

Almost all news and current affairs programs will use windows on the screen that show the public reaction to the issues being discussed. Simulated referendums will be taken on television every night.

This will encourage a much higher level of public participation in the political process.

Home entertainment environments will come into use in which the entire ceiling and walls are a three-dimensional color TV screen.

These screens will be able to generate an environment of sylvan tranquility, spring in the Andes, earth orbit, a space battlefield, or the Kilauea volcano erupting. These entertainment facilities will be operated from cartridges or from satellite broadcasts.

Further into the Future

By 2020, it will be three-quarters of a century since the last World War.

A world war with the advanced weapons of that period would unquestionably end civilization. High-technology nations will live in an era unprecedented in history.

Prussian military strategist Karl von Clausewitz's doctrine—that "war is the extension of politics by other means"—is no longer true.

Conventional war between high-technology nations would almost certainly escalate into an end-of-civilization nuclear war which no political end could justify. Elaborate control mechanisms will evolve to prevent nations from blundering into such a war.

While low-technology nations will still fight each other using conventional weapons, viewed by billions on HDTV wall-screens, it is cautiously hoped that there may never be another war between high-technology nations. If technology continues to evolve for a hundred years of peace, it will be an era far beyond the wildest dreams of philosophers. ■

The James Martin Productivity Series, an information service updated quarterly, is available through High Productivity Software Inc., of Marblehead, Mass. (617) 639-1958. For information on seminars, please contact (in the United States and Canada) Technology Transfer Institute, 741 10th St., Santa Monica, Calif. 90402 (213) 394-8305. In Europe, contact Savant, 2 New St., Carnforth, Lancs., LA5 9BX United Kingdom (0524) 734 505.