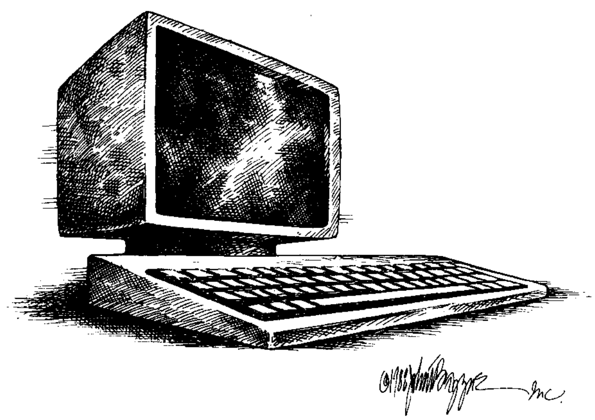
NEW TOOLS FOR A NEW AGE

by Gordon Bell

Over the last decade, the rate of change of computing power has accelerated beyond the normal technology increase of 14 percent per year—it's quadrupled every decade. Primary memory quadruples in size every three years for the same investment; secondary memory merely doubles. In the early 1990s, expect to see the power of the original Cray 1 vector-processing supercomputer (*circa* 1976) available on a desk for the price of simple workstation—about $10,000. By just about the same time, Cray promises it will have ready its advanced 64-processor Cray 4, operating at a rate of 128 billion floating-point operations per second.



This year, several companies are introducing a new class of computers,the graphics supercomputer, selling for less than $100,000. These machines boast about a Cray 1-level of power (Department of Energy Class VI) and an additional high-speed graphics processor to transform, shade, and display complex 3D objects at supercomputer speeds. By combining graphics and computation in a single system, these systems will spur the emergence of new applications that heretofore had been impossible with workstations connected via networks to supercomputers.

As technology progresses, the computing environment is clearly following these trends:

■ The computer hierarchy of PCs, workstations, mini-supers, and supercomputers is becoming fully populated, with no economy of scale for large computers (i.e., the cost to perform a computation is at least as expensive on the highest performance computers). The "main line" architecture is going to follow the vector, multiprocessor supercomputer.

■ Human interfaces, applications, languages, and operating systems are going to be compatible both horizontally (across competitive machines in a price class such as supers), and vertically (among all classes from PCs to supers) for user productivity and flexibility. Unix, now available on most of the members, is becoming the only game in town.

■ New, multiple-computer systems are going to provide more than an order-of-magnitude improvement in performance/price over the general-purpose main line. These systems are all going to require restructuring of programs to exploit the high degree of parallelism inherent when 32 to 1,024 separate computers run one job. All highly parallel computers are going to require reprogramming to some degree.

■ Poor networking is beginning to be a limit at all levels. More than an order-of-magnitude improvement is needed for local-area nets (to 100 megabits per second) and a method of interconnecting these "building" nets at higher speeds for campus areas. Wide-area networks are just reaching the one-megabit-per-second speed, but speeds in excess of 100 megabits per second are needed to connect our national research-and-development computing environments across the boundaries of academe, industry, and government.

The trend in basic systems, sans networking, is quite clear—and more exciting than at any time in the past. What's also clear is that it's up to the entire engineering community to embrace the new environment. This implies three revolutions:

■ Academe must lead in learning, texts, training, and research to exploit new high-performance, parallel computers. Today, they lag.

■ Academe and the computer-aided-design industry (the tools providers) must be responsible for shifting the knowledge-delivery paradigm to fully utilize computers instead of texts. In the 21st century, all scientific knowledge will have to be available for computer interpretation.

■ Product and process designers must adopt a quality-design philosophy based on computer-aided description, analysis, and simulation—whereby the need for experimental verification by physical prototypes is fundamentally unnecessary.

These new tools are the keys to competitiveness, and these keys lay squarely in the hands of engineers. Given significant gains in productivity, fewer designers can provide substantially better and higher quality designs in shorter time. With improved productivity, the massive engineering bureaucracies can be shrunk by at least a factor of four. And about half the engineers leaving product development must completely restructure manufacturing on a technology base.

The future is up to us, the engineers and tool builders—we have a great base to build on. All it takes is a vision—and a revolution.

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