HISTORY
Corporate Profile

Cray Research, Inc. was organized in 1972 by Seymour Cray, a leading designer of large-scale computers, along with a small group of computer industry associates. Cray had established himself at the forefront of computer design through his work at Engineering Research Associates, Remington Rand, UNIVAC and Control Data Corporation. His new company had a simple mission -- to lead in the development and marketing of high-performance systems (supercomputers) that make a unique contribution to the markets they serve. Cray Research began operation in Cray's own laboratory in his home town of Chippewa Falls, Wisconsin. Today, Cray Research continues to reflect Seymour Cray's personal style by fostering creativity and emphasizing small, autonomous work groups.

Success and rapid growth

Back in March, 1976, the same month the company made its first public stock offering, Cray Research shipped its first CRAY-1 to Los Alamos National Laboratory in Los Alamos, New Mexico. In May of that year, the National Center for Atmospheric Research in Boulder, Colorado ordered a Cray computer system, and by year-end the company realized its first revenue.

The culmination of five years of research, the CRAY-1 supercomputer set a new precedent for computer performance. The system incorporated ECL bipolar memory and had a capacity of one million 64-bit words and a clock period of 12.5 nanoseconds. It immediately made its mark as the world's fastest scalar processor while providing the first practical and effective implementation of vector processing. Vector processing is the repeated application of an instruction to groups of values called vectors. This high-speed repetition increases processing rates in much the same way as assembly-line manufacturing speeds up the production of goods. Scalar processing, by contrast, performs each computation as a discrete operation.

At that time, the customer base for such high-performance machines was estimated to be less than 100 organizations, primarily government laboratories. But soon other scientific and industrial research organizations expressed an interest in the unique computing abilities of the CRAY. Today more than 100 CRAY systems have been installed at customer sites, and the company has a strong list of potential customers in both government and commercial segments.

Software development and international expansion

In 1977 Cray Research released its first software versions, the Cray FORTRAN compiler (CFT) and the Cray Operating System (COS). The company's commitment to software development has remained strong through the years. Software development efforts include the design of language compilers, operating systems, utilities and applications software. A program to encourage and assist conversion of third-party and public-domain application programs for use on Cray systems complement internal development efforts.

In 1978, the first CRAY-1 destined for a commercial site was scheduled for delivery, and tentative commitments were received from several commercial organizations involved in aerospace and petrochemical research, structural engineering and automotive design. Also in that year, Cray Research became an international organization, establishing sales and support subsidiaries in England, France, Japan and West Germany.

In just six years, Cray Research had become the world's leading supplier of high-speed scientific computers. The company's success was undoubtedly due to many factors, not the least of which was its commitment to research and development. R&D spending continues to be a company priority, with more than 15 percent of revenue earmarked for R&D efforts each year.

The CRAY-1/S and a change in leadership

By 1980, the original CRAY-1 had evolved into the CRAY-1/S Series of computer systems. The maximum size of central memory was increased to four million words, and the I/O Subsystem (IOS) was added to ensure that processing speed would not be compromised by slow input/output. The IOS transfers data directly to and from central memory at extremely high rates without interrupting central processing operations. It has since become standard equipment on all CRAY computer systems. The company completed the manufacture of the last CRAY-1/S in mid-1983, phasing out the series because of the advantages of newer products.

During this time, Seymour Cray had been moving gradually away from management and increasingly towards technical development on a new computer architecture, the CRAY-2. His

that characterize today's sophisticated nuclear power plants. In addition, government laboratories are using CRAY systems to simulate the complex interrelationships among atomic particles for magnetic and laser nuclear fusion research.

Computational chemistry

Chemical reactions can occur in a matter of femtoseconds (quadrillionths of a second), a time scale too small for chemists to observe or measure directly. But simulating chemical reactions on a computer enables scientists to "step through" reactions in small enough time steps to reveal their significant features. Computer simulations of atomic and molecular systems can also provide information about reaction rates, properties and synthetic polymers and the shapes of macromolecules made of millions of atoms. The detailed and highly iterative mathematics involved for such modeling demands the computational capacities of a supercomuter. Computer simulation gives scientists a deeper understanding of the fundamental physics underlying chemical interactions, paving the way for new discoveries and new products to enhance our lives. Examples of this application for which CRAY computers are currently used include combustion and atmospheric chemistry research, polymer and drug design and the modeling of genetic material.

The applications we describe here are the best developed commercial uses of supercomputers. While these applications continue to be refined, many new uses are being explored and developed. Among these newer applications, CRAY systems are being used in computational physics and astrophysics, image processing, motion picture graphics and symbolic processing related to expert systems and artificial intelligence. The need for large-scale computing has made CRAY supercomputers indespensible tools for many scientific applications. As the need for large-scale scientific computing grows, the growing family of CRAY supercomputers will continue to enhance the research capabilities of scientists around the world.

CRAY supercomputers give researchers the processing speed and memory size to conduct complex simulations of physical phenomena. Using CRAY systems, three-dimensional models with unusual geometries and many interacting variables can be run fast enough to make computer simulation a practical and cost-effective way to do scientific research.

Scientists and engineers worldwide rely on CRAY systems to simluate phenomena too time-consuming, dangerous, expensive or difficult (or impossible) for direct experimentation. CRAY systems are designed for problems that require manipulating very large databases and/or solving large sets of linear equations. While computers have been used to conduct numerical simulations for many years, the extraordinary processing power of CRAY systems had made them tools for state-of-the-art research providing more accurate, more detailed, more enlightening and more profitable results.

Using CRAY systems, scientists and engineers have expanded their knowledge of the universe and solved practical design problems in many fields. Today's primary applications for CRAY systems are described below.

Aerodynamic simulation

Airplane designers have long relied on wind tunnel tests to evaluate the aerodynamics of airplanes and airplane parts. But wind tunnel testing requires the time-consuming and costly construction of physical test models. Wind tunnels are also expensive to maintain and cannot detect certain airflow phenomena. CRAY supercomputers enable airplane designers to computationally evaluate and modify designs in less time and more cost-effectively than they could by relying solely on wind tunnel tests. Aerodynamic simulations performed on CRAY computers can pinpoint areas where aircraft designs need to be modified before any physical test models are built. Building fewer test models can save companies considerable time, money and other valuable resources. In addition, the ease with which designs can be modified on a computer gives engineers freedom to experiment, encouraging innovation. The same benefits of computational analysis using CRAYs are currently being enjoyed by several auto makers that conduct aerodynamic simulations of car and truck designs.

Seismic data processing

Many oil companies and geophysical contractors now use supercomputers to help them locate petroleum deposits. CRAY systems are used around the world to process the large volumes of data generated by reflection seismology, a technique used for geological exploration. The technique involves inducing a shock into the ground, usually with specially designed hydraulic devices, and recording the sound waves reflected back to the surface. Analyzing this data can reveal geological structures associated with petroleum deposits. However, the amount of data needed to accurately profile a large volume of earth can be immense and the required analyses are staggeringly complex. Only large-scale computers like the CRAY can perform the detailed analyses on these large data sets in a timely and cost-effective way. Seismic data processing on CRAY systems can minimize the likelihood of drilling unproductive wells, thereby saving petroleum companies valuable resources.

Petroleum reservoir simulation

A number of major oil companies use CRAY computers to simulate the complex flow phenomena that characterize petroleum recovery operations. Such operations typically involve injecting water or water plus a surfactant into a reservoir to mobilize the trapped oil and push it to the surface. However, to determine the best recovery strategy for a particular reservoir, engineers must consider the underground temperature and pressure, the chemical makeup of the petroleum and the reservoir's geology. Accurately simulating the complex interactions of these variables for large volumes of earth requires the kind of massive computing power CRAY systems provide. Because an increase in reservoir output of only a few percent can translate into millions of dollars, CRAY computers have become highly cost-effective tools for the petroleum industry.

Structural analysis

The mathematical method known as finite element analysis is widely used in the aerospace, automotive and civil engineering industries. Engineers using this method analyze physical structures with a two- or three-dimensional grid that divides a structure into a number of well-defined elements. The effects of temperature- and pressure-related stress are calculated for each element, as well as the effect of each element on its neighbors. Finite element analysis can be used to describe the overall impact of various loads and constraints on a complex structure. CRAY systems allow engineers to conduct rapid finite element analyses, resulting in improved engineering efficiency and more structurally sound and lightweight components. Furthermore, CRAY systems allow for detailed analyses of structures too large or complex to be analyzed on any other computers.

Meteorology

Meteorologic laboratories in the United States, Canada and Europe rely on CRAY computers to run models of the Earth's atmosphere. These models are used for weather forecasting and climatological research. To be useful, the models must accurately account for numerous variables, such as thermal and fluid dynamics; physical phenomena such as evaporation and condensation, solar heating, cloud movement and often additional factors such as temperature, humidity, pressure and wind velocity. Modeling the intricate interactions of these variables for enormous spatial volumes is a task for which CRAY computers are ideally suited. CRAY computing speed enables meteorologists to analyze data quickly, an important consideration since after-the-fact forecasts are of little use. Also, modeling meteorological phenomena on a larger-than-local scale, as is done in pollution monitoring, makes CRAY-size systems a necessity.

Electronic design

Designers of electronic circuits are increasingly using computer-aided design (CAD) methods that enable them to design and test circuits by simulating them on a computer. The complexity of today's electronic devices and demands for faster turnaround make high-speed computers like the CRAY an invaluable tool for CAD. CRAY systems are useful for simulating not only logic circuit layout, but also overall system architecture, timing and design-rule checking. CRAY systems used for circuit design enable engineers to modify designs repeatedly without incurring the expense of building and testing actual devices at each step in the design process. In fact, Cray Research is designing future CRAY systems with proprietary and commercially available CAD software running on a CRAY-1/M system in Chippewa Falls, Wisconsin.

Nuclear energy research

As nuclear reactors grow in complexity and safety concerns grow as well, new designs require the use of the most advanced computer systems available. Computer simulations of nuclear power plants are used extensively in design and licensing processes in several countries. CRAY computers used in nuclear energy research help to design reactors, implement automatic process control, train operators, analyze reactor conditions and determine accident mitigation procedures. Safety analyses using computers are necessary since it is impractical to run accident experiments on full-scale nuclear reactors. Only supercomputers like the CRAY provide the computing power needed to simulate the intricate fluid flow, heat transfer and neutronics phenomena

enthusiasm for new technologies led him to step aside as chairman of the board in November 1981. Today, Mr. Cray is an independent contractor to the company and continues to serve as a director and member of the Executive Committee. He now devotes most of his time to research at his laboratory in Chippewa Falls, where he is developing yet another generation of supercomputers.

The CRAY X-MP and CRAY-1/M

In April 1982, Cray Research announced the CRAY X-MP Series of Computer Systems, a landmark product offering system throughput improvements up to five times that of the CRAY-1/S. The CRAY X-MP was unique in having two central processing units -- each more powerful than the CRAY-1/S uniprocessor --snaring a common central memory. The X-MP clock cycle time of 9.5 nanoseconds was a speedup over the 12.5 nanoseconds for the CRAY-1/S. The X-MP Series was also significant because it was the first CRAY computer not designed by Seymour Cray. Rather, it grew from the efforts of Steve Chen's research and development group, also working in Chippewa Falls. Mr. Chen joined Cray Research in 1979. He currently heads the X-MP development team and serves as Vice President of Development.

Also announced in April 1982 was the Solid-state Storage Device (SSD), developed to enhance CRAY X-MP performance by providing fast access to large datasets and temporary storage for system programs. While traditional disk storage units transfer data at rates of approximately four million bytes per second, the SSC offered transfer rates of 100 million to 1000 million bytes per second.

The CRAY-1/M Series of computer systems was announced in September 1982. The M Series used MOS memory technology, thus providing roughly comparable performance to the CRAY-1/S at a substantially lower price. The CRAY-1/M was available with one, two or four million words of central memory and was fully compatible with existing CRAY-1 software. With the CRAY-1/M, supercomputer power became a practical option for a broadening range of users in the automotive, petroleum, chemical and electronics industries. The CRAY-1/M was discontinued in 1984 with the introduction of new models of the CRAY X-MP.

The enhanced CRAY X-MP

Announced in July 1984, the enhanced CRAY X-MP Series took multiprocessing a step further and reset the standard of value for supercomputers. They remain the core Cray Research product line today. The top-end CRAY X-MP/48, with its four central processing units and eight million words of central memory, offers performance up to ten times that of the CRAY-1. The re-engineered X-MP dual-processor models are half the size and require half the power of their predecessor systems. A 1024-million-word SSD was also introduced in July 1984.

Today, Steve Chen and his group are working on a follow-on system to the X-MP. Current plans call for this system to be based on silicon using very large scale integration. Future products in this line are expected to increase the upper limit of the X-MP performance range and provide additional cost-performance advantages.

The CRAY-2 and future generations

Announced in June 1985, the CRAY-2 represents a significant departure from conventional computer technology. Its circuitry is bathed in a continuously circulating liquid fluorocarbon coolant. The circuits themselves are arranged in layered modules with circuit interconnections made in all three dimensions. The CRAY-2 is a four-processor, 256-million-word system offering performance approximately six to twelve times that of the CRAY-1. It runs on an interactive operating system based on AT&T UNIX™ System V and a powerful FORTRAN compiler based on the proven Cray Research CFT FORTRAN compiler.

Cray Research announced the CRAY-2 following the installation of a fully-configured system at the National Magnetic Fusion Energy Computer Center at the Lawerence Livermore National Laboratories in Livermore, California. At the time of the announcement, two additional CRAY-2 orders had been placed; one for the Numerical Aerodynamic Simulation facility at the NASA Ames Research Center in California and one for the University of Minnesota's Supercomputer Institute.

Seymour Cray is already deep into the design of a follow-up to the CRAY-2, with current plans calling for the system to be based on gallium arsenide technology. Gallium arsenide's electron mobility is four to five times that of silicon, allowing for faster switching speeds and lower power consumption. This allows components to be stacked more densely than with silicon, thus reducing the distance electrons must travel. These features give gallium aresenide technology the potential to significantly improve supercomputer performance in the near future. To support Seymour Cray's design efforts, Cray Research established a gallium arsenide fabrication facility in Chippewa Falls in 1982.

Today and tomorrow

Advances in technology and improved price/performance ratios have characterized each step in the evolution of the Cray product line. Today, Cray Research is recognized as the leader in supercomputers, with more than two-thirds of the worldwide installed base. The company employs over 2000 people and operates manufacturing and development facilities in Chippewa Falls and Rice Lake, Wisconsin and the Minneapolis, Minnesota area. The company has 14 domestic sales and support offices and eight subsidiary operations in Canada, Western Europe and Japan.

CRAY computers ushered in a new age of computational science. Today they continue to expand the boundaries of scientific inquiry. CRAY computers --with their fast scalar and vector processing abilities, very high speed I/O and multitasking capabilities --provide balanced performance to today's supercomputer user. The company's ongoing research and development efforts point toward a future of systems that are even more powerful and to new standards in supercomputer value.

Supercomputer applications

CRAY supercomputers are generally acknowledged to be the most powerful general purpose computing systems available today. Their rapid processing speeds and large memories enable scientists to conduct research in a novel way. Along with the traditional methods of science -- developing theories and testing them by physical experiment -- researchers using CRAY systems can simulate, or model, complex physical phenomena numerically.

Although modeling physical phenomena had always been possible in theory, many of the problems that most interested scientists and engineers were too complex to run on conventional computers. Even if a problem could be described mathematically, it might take days, weeks or even months to solve with conventional computers because of their slow processing speeds and small memories.