NASA installs massively parallel processor

Ware Myers, Contributing Editor

A massively parallel processor, containing 16,384 processors in an SIMD (single-instruction, multiple-data) configuration, was installed at NASA Goddard Space Flight Center in May 1983, reported Paul B. Schneck in a paper presented to the International Conference on Computer Design at Port Chester, New York, November 1. The large size of this array processor is made necessary by the enormous data rates of the current generation of earth-imaging satellites. Landsat-4, for example, generates data at $8.5 \times 10^7$ bits per second; a single frame contains over $10^8$ bits.

A satellite image consists of thousands of pixels that can generally be subjected to the same operations at the same time. That makes it possible to distribute these operations among thousands of processing elements, or PEs. In turn, the large number of PEs provides a processing rate that keeps up with the tremendous workload. Image-processing tasks such as geometric correction, correlation, registration, feature selection, multispectral classification, and area measurement are required to extract useful information from this mass of data.

Goddard initiated a program for this purpose as far back as 1971. In the following years its engineers conceived the basic elements of the massively parallel architecture. In 1979 the center awarded a contract to Goodyear Aerospace Corporation, Akron, Ohio, to construct the MMP. Goodyear already had experience in the development and operation of the Staran parallel processor system, which had been used in a number of applications—fast Fourier transforming, sonar postprocessing, string search, file processing, bulk filtering, and radar processing, as well as image processing. The MMP, on the other hand, was specifically designed to process satellite imagery at high speeds. However, studies indicate that it can be applied to such diverse areas as weather simulation, aerodynamics, reactor diffusion analysis, and computer-image generation.

The MMP array is managed by a control unit and communicates with a host computer through a program-and-data-management unit. The array is composed of 16,384 one-bit-wide PEs in a $128 \times 128$ pattern. Operating at a 10-MHz clock rate, it processes up to $1.6 \times 10^{11}$ instructions per second.

"This computational capability, coupled with an I/O rate of $1.2 \times 10^9$ bits per second, allows near real-time processing," Schneck said, "thus decreasing operational complexity and cost."

Each processing element consists of a full adder, capable of performing the 16 functions of two binary variables; six registers; and an internal data bus. Eight PEs are housed on an HCMOS custom chip produced by Solid State Scientific Corporation. The chips are mounted on 88 boards, all housed in a single frame, thus simplifying the distribution of control signals.

A bit-serial machine, the MMP performs most rapidly on short, integer operands, which are the kind found in satellite imagery. With all PEs operating on an array of data, it adds eight-bit integers (nine-bit sum) at an execution speed of 6553 million instructions per second; it multiplies them (16-bit product) at 1861 MIPS.

Selective Update covers topics of current interest in computer graphics research and application. It also features conference previews and reports as well as short technical news stories. We welcome contributions from readers.

All submissions to Selective Update should be sent to Jerry Schneider, Selective Update Editor, IEEE CG&A, Dept. of Civil Engineering, University of Washington, Mail Stop FX-10, Seattle, WA 98195.

Proceedings of surfaces symposium to be published

The proceedings of the SIAM Surfaces Symposium are being published as a special issue of the Rocky Mountain Journal of Mathematics. The symposium was held at the meeting of the Society for Industrial and Applied Mathematics at Stanford University, July 1982.

The need to effectively represent and manipulate surfaces arises in many areas of science and engineering. The proceedings emphasize the use of surfaces for the interactive design of three-dimensional objects and for the representation of physical and biological data. Interpolation methods are treated in detail, including both triangular interpolants and distance-weighted interpolants. Also included are several new extensions to four-dimensional surfaces. Both practitioners and researchers in the areas of CAD/CAM, computer-aided geometric design, computer graphics, and numerical analysis will find these proceedings of interest. (For an overview, see R. E. Barnhill, "A Survey of the Representation and Design of Surfaces," IEEE Computer Graphics and Applications, Vol. 3, No. 7, Oct. 1983, pp. 9-16.)

The proceedings, as well as the symposium, were organized by Robert Barnhill and Gregory Nielson. Included in the proceedings are papers by Peter Alfeld, Hiroshi Akima, Robert Barnhill, A. K. Cline, Thomas Foley, Richard Franke, Thomas Jensen, Peter Kochevar, Charles Lawson, Gregory Nielson, R. L. Renka, K. Salkauskas, Larry Schumaker, Sarah Stead, and Grace Wahba.

Inquiries about the proceedings should be addressed to Thomas L. Sherman, Rocky Mountain Mathematics Consortium, Dept. of Mathematics, Arizona State University, Tempe, AZ 85287; (602) 963-3788 (mornings).
Interactive computer graphics course available on videotape

A videotape short course, "Introduction to Interactive Computer Graphics," is available from AMCEE, the Association for Media-Based Continuing Education for Engineers. The course, developed by Francis S. Hill, a professor of electrical and computer engineering at the University of Massachusetts-Amherst, is designed to introduce the concepts and provide the necessary tools for writing graphics programs.

The course includes demonstrations of graphics applications, as well as programming projects and problems. It teaches techniques for creating mathematical representations of curves and surfaces; scaling, rotating, and translating graphics; interactive design of curves and surfaces; modeling three-dimensional objects; and design and use of menus and input devices.

Including 13 color videotapes, a study guide, and a textbook, the course is available for a flat rental fee of $975; it can be purchased for $4810. A preview package is available for $115.

For further information, contact Laura Rob, AMCEE, Dept. 84, 225 North Avenue, N.W., Atlanta, GA 30332-0210; (404) 894-3362.

Research firm offers information for factory automation vendors

An information service that provides continuous primary research on the manufacturing automation marketplace has been introduced by International Data Corporation. According to Tony Friscia, program manager, the Computer Integrated Manufacturing Service, or CIMS, "will assist factory automation vendors by identifying market trends and opportunities in all production and design automation market segments."

IDC has estimated an annual compound growth rate of 23-24 percent for the overall factory automation equipment market in this decade (see figure below). CIMS will segment this growth by examining four major market areas:

- Computer-aided design and engineering, planning and control software, production and assembly systems, and industrial control subsystems.

CIMS will provide quantitative analysis of these areas in frequent and timely technical reports, Friscia says. This information will be supported by detailed studies of end-user requirements, buying patterns, and perceived strategic directions in specific industries.

CIMS is one of several IDC information services offered to vendors of computer-related equipment and/or services. For more information, contact Laura Greenfield, IDC, Five Speen St., Framingham, MA 01701; (617) 872-8200.


NCGA conference to report on standards development

Everyone is talking about standards, but not everyone really knows what it all means. At Computer Graphics '84, the fifth annual conference of the National Computer Graphics Association, a special industry standards program is planned to help make sense of this critical aspect of the computer graphics industry.

"We are taking three approaches to providing information on standards at the conference," said David H. Straayer, chairman of the standards sessions. "Some people need detailed knowledge of how a specific standard works and others want to learn about actual applications. A third group wants to know about trends, general directions, and the impact on the industry. We are aiming at meeting all three needs."

For the industry expert or manager with long-range interests, there will be a panel session on specific standards, their intended uses, and the relationships between them. Attendees will learn what has been approved and by whom, what is at the draft stage, and how they can get involved in the process. A related technical session will cover the application of standards in the working environment. "Designed more for product development staff and applications programmers, this session will show how people are using standards to do their work and to do it better," said Straayer.

A tutorial session on the Graphical Kernel System (GKS) will present the standard and teach programmers how to use it.

Complete information on Computer Graphics '84, scheduled for May 13-17 at the Convention Center in Anaheim, California, is available from Department ZF, National Computer Graphics Association, 8401 Arlington Blvd., Suite 601, Fairfax, VA 22031; (703) 698-9600.
Productivity measures understate benefits of CAD/CAM systems

Companies continue to achieve productivity improvements through the introduction of computer-aided design and manufacturing systems into their design and engineering operations. But the overall benefits are generally more than meets the eye, an Arthur D. Little, Inc., survey shows.

For one thing, present CAD/CAM system productivity measurements are limited to design-output-per-manhour ratios between CAD/CAM and manual methods, said Daniel J. Borda, who prepared the survey. "One must also remember that the ultimate purpose of these systems is not to produce more engineering output in less time, but to produce a higher quality, more cost-effective end product."

A technically detailed, 100-page report on the survey covers the effects of CAD/CAM systems on organizations and productivity, methods for calculating engineering productivity, productivity ratios for major applications, integration of CAD/CAM in a computer-integrated manufacturing environment, and typical chargeback fees and methods for CAD/CAM services. In addition, the report analyzes some of the technical and management issues that have developed since the firm conducted its first CAD survey two years ago.

According to Borda, the report is based on survey responses of nearly 300 business organizations in the United States and abroad. Titled "CAD and Productivity," it sells for $595 and is available through the Arthur D. Little CIM Group, 25 Acorn Park, Cambridge, MA 02140.

AEC CAD market to exceed $1 billion by 1987

The architecture, engineering, and construction market, the fastest-growing area of CAD use, will reach $1.1 billion by 1987, according to an IDC report based on a survey of users and vendors.

Acceptance of low-cost (under $100,000) systems is an important factor in market growth. Small design firms (80 percent of design firms have less than 10 employees) now regard CAD as a necessary tool. In addition, industrial and government organizations expect to purchase low-cost systems for specific applications, such as space planning and facilities management. By 1987, shipments of low-cost systems will reach $400 million.

Use of CAD in AEC applications differs from use in other major applications in terms of user types, equipment configuration, and system utilization. Over three quarters of surveyed sites reported that most of their CAD users were not dedicated CAD operators. Only 16 percent had organizations specifically dedicated to CAD. As a result, average daily utilization of CAD stations in AEC is only 74 percent of the rate for mechanical design applications. AEC applications are more likely to employ monochromatic displays and pen plotters than systems for other CAD applications, the survey found. AEC users show interest in using color displays for interference checking and electrostatic printer/plotter for high-speed, high-volume drawing production.

The 74-page report, titled "Use of CAD in the AEC Market," is priced at $1000. For further information contact Deborah Kelly or Neil Kleinman at IDC's Pacific Technology Center, 1448 15th St., Santa Monica, CA 90404; (213) 458-1681.

Siggraph calls for award nominations

Siggraph, the Association for Computing Machinery's Special Interest Group on Computer Graphics, is accepting nominations for its Computer Graphics Achievement Award. The annual award recognizes recent significant accomplishments in the field of computer graphics. The recipient receives a $500 cash prize.

Areas of accomplishment to be considered for this award include both theory and applications, such as the development of algorithms, hardware design, innovative applications of computer graphics, and works of art.

Nominations are due by March 1, 1984, and should include (1) the name and address of the individual being nominated; (2) a description of accomplishment(s) to be considered by the selection committee, along with a statement of the significance of the accomplishment; (3) the nominator's name, address, and telephone number.

The award will be presented in Minneapolis on July 25 at Siggraph '84, which runs July 23-27. For registration information, contact the Siggraph '84 Conference Office, 111 East Wacker Drive, Chicago, IL 60601; (312) 644-6610.
Expert computer systems may help designers

Expert systems—a portion of the science of artificial intelligence—may someday work alongside design engineers in the development of new machines and devices. These systems will be valuable because they will retain thousands of previous technical decisions not normally remembered by human designers.

An expert system is a computer program that has "captured" the experience, knowledge, and judgment of human experts in a field and organized that expertise for use by other practitioners.

An expert system being worked on by J. R. Dixon of the University of Massachusetts, Amherst, and M. K. Simmons of General Electric, performs a design primarily by redesigning existing designs. In an article in Computers in Mechanical Engineering ("Computers That Design: Expert Systems for Mechanical Engineers," American Society of Mechanical Engineers, New York, Nov. 1983), Dixon and Simmons point out that "many actual [design] problems are in fact redesigns, [and] an initial design is usually available as a starting point."

Even if an initial design is not available, the computer can generate one by interrogating a human expert. "The system then iterates to an acceptable design through evaluation and redesign," the two engineers say. "For each redesign, the system formally evaluates specific characteristics of the current version in accordance with criteria and scales established in consultation with human experts."

The design process, whether carried out by human experts or computer programs, is a long series of large and small decisions. These decisions fall into two categories: planning decisions that determine the course of design, and technical decisions that determine the actual product. Planning decisions establish the next problem or question to be addressed in order to proceed with the design effectively. Technical decisions concern choices of materials, sizes, part shapes, manufacturing processes, and so on.

"The search for innovative designs is often hampered by a lack of access to relevant ideas that might stimulate the designer," Dixon and Simmons say. An expert system that makes that type of information readily available to the designer through an intelligent interface could enhance a designer's creativity.

There is some concern in the engineering community that computer systems requiring little understanding of underlying principles will lead to misuse, poor design, and ultimately to a decline in the level of human designers' expertise. Dixon and Simmons suggest that "those who design expert systems will do well to take this concern seriously, and to ensure that they develop systems from which the users will learn to become experts as well as to obtain design assistance."

IEEE Computer Graphics and Applications is planning an issue featuring articles on expert systems in computer graphics applications in early 1985. Those interested in contributing should contact Carl Machover, Machover Associates, Inc., 199 Main St., White Plains, NY 10601; (914) 949-3777.

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Animation shows nuclear shock wave passing missile launcher

Ware Myers, Contributing Editor

"We start with hydrodynamic equations that describe the flow through a fluid, in this case the shock wave from a nuclear explosion through the atmosphere," explained James C. Baker, a scientist at S-Cubed, San Diego, California. S-Cubed is a basic and applied research firm that makes use of computer simulation and animation techniques in the analysis of various scientific and military problems.

Baker was referring to a simulation program that produces tens of thousands of numbers representing air pressure at thousands of points over a time period.

To make the numbers more meaningful, S-Cubed converted them into a short, animated videotape that shows an air blast moving past a hard, mobile missile launcher. The pressure at each point in the air surrounding the launcher is color coded.

The simulated air blast is a result of a hypothetical nuclear explosion specified as "one megaton at a height of 2000 feet—7590 feet from the target," according to the narration accompanying the videotape. The target was one of three conceptual designs developed by General Dynamics Corporation for the US Air Force Ballistic Missile Office as part of a summer study of hard, mobile missile launcher concepts. General Dynamics' structural engineers needed to know the overpressure patterns to which these designs would be subjected immediately following the arrival of a nuclear shock wave.

Study approach. S-Cubed's scientists set up the hydrodynamic equations for the shock wave and divided a plane of air through the structure into about 6000 cells. The purpose of using so many small cells is to show the blast effects at a high level of detail. A number of variables were calculated on a Univac 1100/81 computer. These included velocity in two directions, pressure, density, energy, and temperature. These variables change with time, so the simulation was run for about 3000 cycles. One of the variables, pressure, was selected for visualization by means of animation.

An S-Cubed programmer wrote a program to read the pressure output of