CHANNELS

A Publication of Cray Research, Inc.

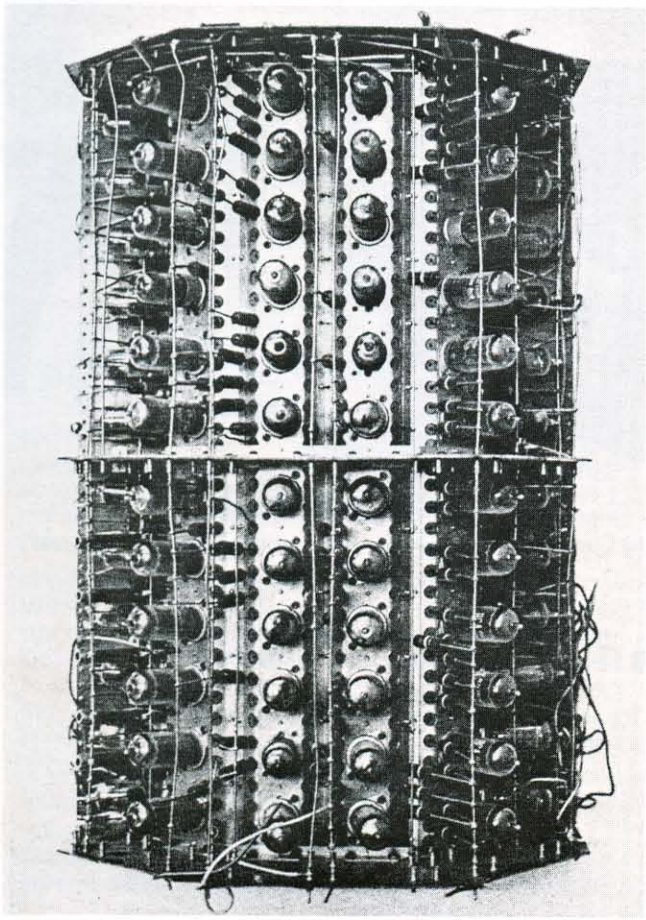
Vol. 1 No. 1

A look to the past, an eye on the future...

Thirty years ago computer technology was new and most research was carried out by universities and government laboratories. Now, computer design and manufacture is a commercial enterprise, and a number of firms have established themselves as major suppliers of computing equipment and services.

It's hard to be new in such a market, but being the best at what you do makes it easier. In the seven years since its formation, Cray Research has become the world's leading supplier of large-scale high speed computers. CRI has established its leading market position in weather, energy, and defense research and is now moving into the commercial computing and international markets.

Cray Research ended 1978 with eight CRAY-1 computer systems in the field. Early in 1979 two more systems were delivered and installed. Each of these ten CRAY-1 users has unique computing challenges and special system needs. Even a brief catalog of CRAY-1 sites reveals a substantial bit of Cray Research's history and points to highlights in the Company's development in the seven years since its inception.



A CONTRAST IN TECHNOLOGIES: A state-of-the-art computer in 1950 contained a number of chassis like the one pictured at the left. This chassis, standing at least three feet high and one foot in diameter, may be equivalent to perhaps six gate chips in the CRAY-1. Shown above is a module in a chassis of the CRAY-1. There are 24 such chassis on a million-word CRAY-1, with each holding up to 72 modules. Each two-sided module in the chassis, measuring 6 in. by 8 in., may contain up to 288 chips.

letter from the editor

On the occasion of this, the publication of our first issue, we at **Channels** have a few hopes and resolutions to share with you, our readers.

We hope **Channels** will be exactly what the name implies—a forum for the free exchange of ideas. Through this newsletter, we wish to establish communication with Cray Research customers and others interested in CRI and its products. Then, as the performance, the capabilities, and the usefulness of Cray Research products expand, we at **Channels** can make that information available. We will keep you informed on new products, company business, and installation news as well.

In return, we at **Channels** hope that you will share with us your experiences concerning applications, software enhancements, hardware performance, installation news, notes on seminars and user group meetings, and any other information that may be of interest to readers. Please feel that you can take an active role in formulating the content of future issues of **Channels.** We welcome your input! □

CHANNELS

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M/600 enhances software development

Early in February a Data General Eclipse M/600 was installed at the CRI Corporate Headquarters building in Mendota Heights, Minnesota.

The M/600 purchase is part of a continuing effort to expand the software development and benchmark computing facility at CRI. The most important acquisition in this effort is the one-half million word CRAY-1 system to be installed in April, 1979. The decision to purchase the M/600 was made by Margaret Loftus of the Software Development Department and several of her staff members after a visit to Data General's Boston headquarters for an equipment demonstration.

Currently, CRI analysts Jim Bravatto, Paul Conrow, and Bob Nell are converting the Data General Eclipse S/200 station software for use on the M/600 in anticipation of delivery of the CRAY-1 to Mendota Heights. The M/600 will serve as a local batch entry station to the CRAY-1 and simultaneously allow interactive editing. CRI's three Eclipse S/200 stations will continue to be used for hardware simulation activities and as additional batch stations to the CRAY-1.

In the past, analysts required a dedicated Eclipse S/200 as a remote station to a CRAY-1 in Chippewa Falls, Wisconsin for software development and benchmark activities. However, with the new M/600, analysts can interactively work on the M/600 while developing software on the CRAY-1. Thus, a greater volume of software enhancements can be generated and analyzed in a shorter period of time.

The M/600 acquisition demonstrates CRI's long-term dedication to software development and benchmark support. □

Systems analysts Bob Nell, Paul Conrow, and Jim Bravatto are working to convert the Eclipse S/200 station software to the M/600

The Data General Eclipse M/600 at CRI

Memory size	512 bytes
2 Removable Pack Disk Units	96 Mbytes capacity
1 7-Track Tape Unit	556/800 BPI
2 9-Track Tape Units	800/1600 BPI
1 Line Printer	900 lines/minute
1 Card Reader	1000 cards/minute

input/output

John A. Rollwagen, President

Greetings and welcome to the first issue of **Channels**, a new publication of Cray Research. I hope you find this inaugural issue interesting and that you will look forward as I do to coming editions.

As indicated elsewhere, powerful scientific computer systems like those produced by Cray Research have been around for only a very short time. In that time, however, their use has developed to a point where such systems have a major impact on all of us no matter where we are or what we do.

We at Cray Research are proud of the part that we play in the advancement of computer science and the application of computers to basic problems in protecting our environment, in finding and using new sources of energy, and in maintaining our national security.

Channels is primarily an opportunity to look at how and where Cray computers are used in these applications. This first issue presents an overview of each of the current CRAY-1 installations. In future issues, we will provide more in-depth analysis of these applications. For example, we plan to devote an issue of **Channels** to the use of the CRAY-1 in worldwide weather research. We are also planning an issue on how United Computing is making the CRAY-1 available to a broad range of commercial users in the United States and Europe.

Channels also presents us with an opportunity to report on Cray Research's own progress in developing new facilities and capabilities. In coming issues, we will cover significant developments in software and will announce new computer products.

I hope that **Channels** becomes a part of your regular reading habits. If there is any way that we can make the publication more useful and relevant to you, do not hesitate to contact us.

—J.A.R.

CRAY-1 to participate in worldwide weather study

The largest scientific experiment ever undertaken is going on right now throughout the world, and the CRAY-1 has been called upon to help. This year's inclusive study culminates a decade-long effort known as the Global Atmospheric Research Program (GARP), a worldwide venture to understand weather and climate. GARP was organized by the United Nations World Meteorological Organization and the International Council of Scientific Unions. After preliminary GARP experiments demonstrated the feasibility of large-scale research, plans for the Global Weather Experiment (GWE) became reality.

Scientists involved in the year-long GWE which began in January are monitoring the earth's atmosphere to amass the most comprehensive set of global weather data ever gathered. Researchers around the world have set up observation systems of many types to collect a variety of weather data. Almost 150 nations are involved in the experiment, each contributing to the observation system or cooperating in data processing or data storage. Total expenses for the GWE are near $300 million, with the U.S. paying one-third.

The foundation for the data collection network is the World Weather Watch (WWW), an observational program that daily provides 40,000 different weather statistics of the surface and upper atmosphere. WWW data is the basis for existing global weather forecasts; currently, the WWW intermittently incorporates more than 3400 land stations, 7000 merchant ships, and 1000 specially-rigged commercial aircraft.

In addition to the WWW data collection network, scientists will use four polar-orbiting satellites, five stationary satellites, 50 research vessels from 22 countries, 100 commercial and 10 special research aircraft, 300 high-altitude weather balloons, 300 drifting buoys, and other observational and communications equipment.

The ultimate goal of the study is to use the information gathered to determine the practical limits of weather forecasting. Scientists hope to design an improved world weather observation network, while extending the present limits of weather forecasting from the current five or six days to ten or more.

The data flow in the GWE is pyramidal. Massive amounts of raw data will be transmitted from the observation stations around the world to the preliminary computational centers in Australia, Finland, France, Japan, the Netherlands, the U.K., West Germany, and the United States. The bulk of construction-type processing, which will aid in the assembly of a final dataset, will be performed in Sweden and the USSR. The refined data will be transmitted to the European Centre for Medium-Range Weather Forecasts in Reading, England and to the U.S. Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey. On the CRAY-1 at ECMWF and on a Texas Instruments ASC system at GFDL, scientists will further assimilate data and perform consistency checks.

Scientists hope that improved weather data will help them refine computer weather models used in forecasting. Reliable weather forecasts are of great value in industries such as agriculture, construction, transportation, and energy.

U.S. groups funding the GWE include the National Oceanic and Atmospheric Administration, the National Science Foundation, the National Aeronautics and Space Administration, and the U.S. Departments of Defense, State, Transportation, and Energy. □

(continued from page 1)

Los Alamos Scientific Laboratory

The Los Alamos Scientific Laboratory (LASL) was the site of crucial CRAY-1 prototype evaluation. Historically, LASL has been a pioneer in the use of new supercomputers because its computational needs exceed the capabilities of even the largest existing computers. Thus, the lab agreed to evaluate the CRAY-1's performance for the Energy Research and Development Administration (ERDA), a predecessor of the Department of Energy. Technical consultation was provided by the Federal Computer Performance Evaluation and Simulation Center (FEDSIM), a consulting branch of the U.S. Air Force. The CRAY-1's unprecedented processing speeds qualified it for consideration as the first of a new class of computers according to ERDA standards—the Class VI computer. By April, 1976, performance testing was underway.

For six months following its installation at LASL, CRAY-1 Serial 1 underwent rigorous demonstration and evaluation tests for the benefit of LASL and other ERDA labs. The evaluation had two basic objectives: to assess the hardware performance of the CRAY-1 system and to determine its performance characteristics as applied to LASL's workload. Both ERDA and LASL concluded that the CRAY-1 met or exceeded all performance criteria during the trials. Subsequent testing of the CRAY-1 by independent industry analysts has confirmed the merits of the CRAY-1 in comparison with its closest competitors.

"The CRAY-1's unprecedented processing speeds qualified it for consideration as the first of a new class of computers according to ERDA standards..."

Following the six month test period, CRI signed a short-term contract with LASL and in April 1977 renewed its lease with LASL for an upgraded system. On September 12, 1977 Serial 1, a half-million word system, was replaced by a full million-word CRAY-1 equipped with automatic error correction. Because of the improved memory reliability obtained with the SECDED (single error correction—double error detection) circuitry, SECDED became a standard feature on post-Serial 1 CRAY-1's.

Scientists at the Los Alamos, New Mexico site are involved in nuclear studies and energy research programs. About 85% of the lab's efforts are directed towards nuclear research including weapons design, lasar fusion and isotope separation, magnetic fusion energy research, reactor safety, and other basic and exploratory research. Energy programs such as fossil, solar, and geothermal energy, electricity transmission and storage, and regional energy assessment and policy analysis make up the remainder of the lab's work.

LASL is a large national laboratory managed for the U.S. Department of Energy by the University of California. Each month, over 2000 users process thousands of jobs on LASL's computer network, which includes four 7600s, two 6600s, and two Cyber 70/Model 73s in addition to the CRAY-1. Because about three-fourths of the work done at LASL is classified, the network provides many security measures to protect classified information. LASL has developed its own CRAY-1 operating system to meet special and changing needs. This operating system (DEMOS) is implemented in the MODEL programming language, also developed at LASL.

The National Center for Atmospheric Research, site of the second CRAY-1 installation

National Center for Atmospheric Research

Situated in the foothills near Boulder, Colorado is the National Center for Atmospheric Research (NCAR), the site of the second CRAY-1 installation. In May 1976 NCAR signed a contract for a full million-word CRAY-1 system. This decision followed the development and extensive testing of the CRAY FORTRAN (CFT) Compiler by Cray Research. A demonstration of CFT for NCAR in March, 1976 led to confirmation of the Center's order, and the NCAR CRAY-1 was delivered in July of 1977. The Center's acceptance of the system resulted in the first sale of a CRAY-1 for Cray Research. CRI President John Rollwagen recalls that the NCAR purchase was significant because it was based on successful software as well as hardware performance.

Research at NCAR is a cooperative effort among resident and visiting staff, member universities, and government laboratories. By pooling available resources at NCAR, the atmospheric research community can carry out work that would most likely be beyond the resources of most individual universities and laboratories. NCAR provides the leadership, facilities, and logistics support to make these research programs possible. The Center is operated by the private, nonprofit

University Corporation for Atmospheric Research (UCAR), whose members are universities with doctoral programs in the atmospheric sciences. NCAR's operation is supported by the National Science Foundation.

The CRAY-1 at NCAR is used to develop models of weather conditions. Scientists use a hierarchy of increasingly complex numerical models to simulate the behavior of parts of the climatic system taken individually or together to test the interactions among the parts. Work done at NCAR is helping scientists to improve their understanding of how and why climate varies. This knowledge will help them to improve current weather prediction methods, answer questions about the impact of human activities on climate, and learn more about the possibilities of weather modification.

Vince Wayland, CRI analyst at NCAR, reports that the staff is very impressed with the combined system reliability of the CRAY-1. According to Wayland, usage of the CRAY-1 became heavy quite soon after installation due to the rapid establishment of the front-end link to a Control Data 7600. "NCAR users are really pleased with the software," says Wayland, "particularly with the ability to create their own binary libraries, the Flowtrace option in the FORTRAN Compiler, the symbolic debug option, and the relatively simple job control language."

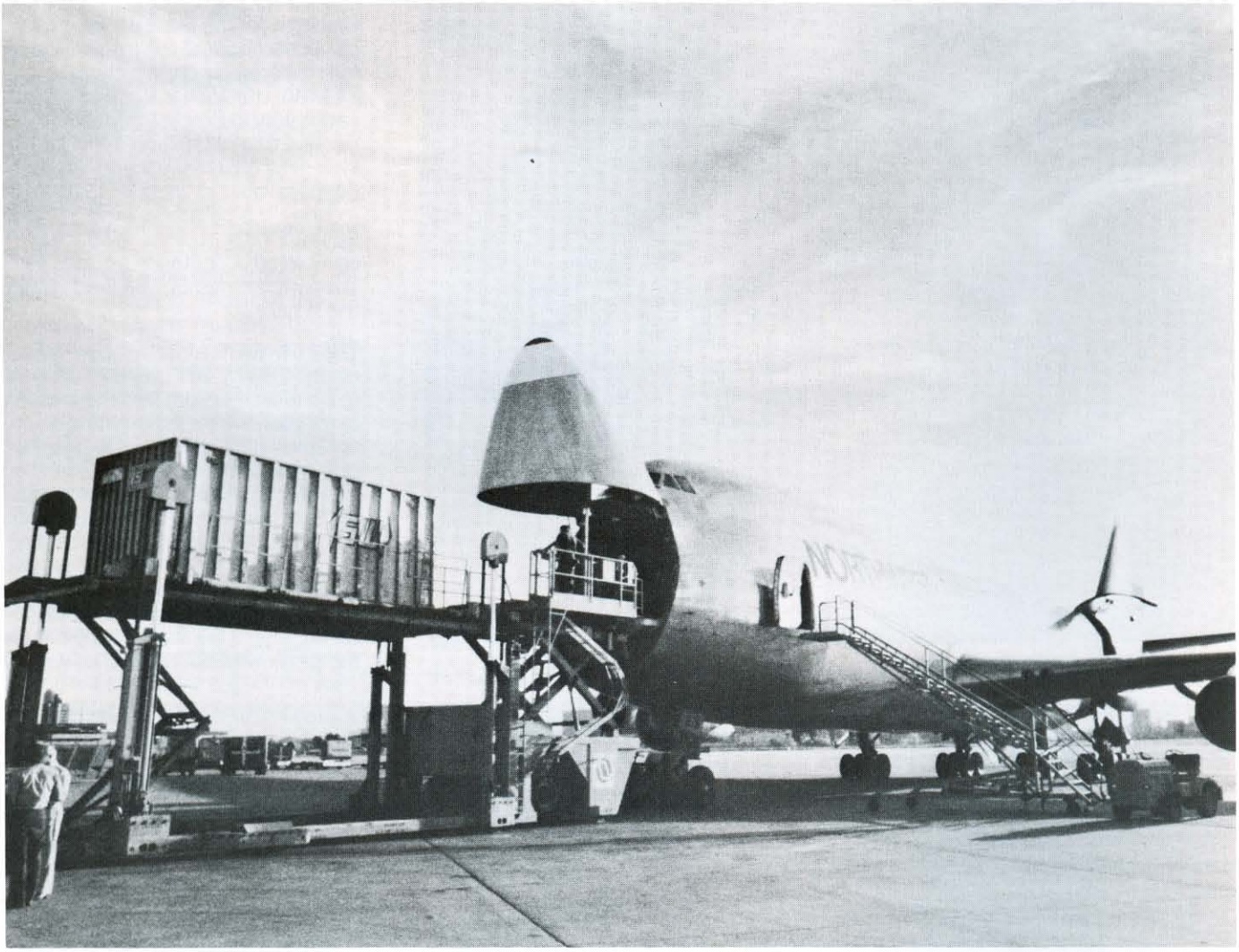
European Centre for Medium Range Weather Forecasts

After leaving LASL, Serial 1 travelled overseas, its destination the preliminary headquarters of the European Centre for Medium Range Weather Forecasts (ECMWF) in Bracknell, England. Via Minneapolis and New York, Serial 1 was sent to the United Kingdom in October 1977. Six months earlier, the ECMWF concluded a contract with Cray Research for the lease of Serial 1 for the period prior to the installation of a full million memory word system. ECMWF used Serial 1 at Rutherford Laboratory in Bracknell until the delivery of a full million memory word system to their new headquarters in Reading, U.K., in October 1978. Just recently, the permanent CRAY-1 at the ECMWF headquarters in Reading completed acceptance testing, and shortly thereafter ECMWF purchased the system.

The ECMWF is a cooperative venture established by 16 European nations to conduct research into the problems associated with medium range weather forecasting and to provide operational forecasts. The Centre was established six years ago after initial planning indicated that the benefits of reliable medium range (4-10 day) weather forecasts for Europe would be sizable. Seventeen Member States now support research at ECMWF; contributions are scaled according to the gross national product of each

The CRAY-1 Computer System: Summary of Deliveries

Customer	CRAY-1 application	Memory size	Installation	Status
Los Alamos Scientific Laboratory; Los Alamos, New Mexico	Nuclear research, energy studies, and other basic exploratory research	500K	March 1976	On lease October 1976, replaced September 1977
			September 1977	On lease September 1977
National Center for Atmospheric Research; Boulder, Colorado	Atmospheric research (long-range climatology)	1000K	July 1977	Purchased December 1977
European Centre for Medium Range Weather Forecasts; Reading, U.K.	Medium range (4-10 day) weather forecasting and research	500K	October 1977	On lease November 1977, replaced October 1978
		1000K	October 1978	On lease November 1978, purchased February 1979
U.S. Department of Defense	Defense research	1000K	January 1978	On lease June 1978
U.S. Department of Defense	Defense research	1000K	July 1978	On lease September 1978
National Magnetic Fusion Energy Computer Center; Livermore, California	Magnetic fusion energy research	1000K	April 1978	On lease June 1978, purchased July 1978
United Computing Systems; Kansas City, Missouri	Commercial computing services for engineering/scientific applications	500K	September 1978	On lease October 1978
British Ministry of Defense	Defense research	500K	October 1978	As an interim machine, replaced March 1979
		1000K	March 1979	Purchased April 1979
Lawrence Livermore Laboratory; Livermore, California	Nuclear research and energy technologies research	1000K	January 1979	On lease February 1979
Cray Research, Inc.	Software development and benchmarking	500K	April 1979	To be delivered later this month



Container holding a CRAY-1 for the ECMWF is moved aboard the carrier 747

nation. In addition to forecasting and research work, the Centre provides large-scale computing, research, and training facilities for the Member States.

Like NCAR, ECMWF uses its CRAY-1 to simulate atmospheric conditions using data in weather models they have developed. The ECMWF CRAY-1 is front-ended by a Control Data Cyber 170/Model 175 in ECMWF's huge new computer room. Starting in mid-1979, the CRAY-1 will be used half-time for operational purposes, 25% for research by the Centre, and 25% for research by the Member States. Remote job entry links will be established for the Member States beginning later this year.

Agencies of the U.S. Department of Defense

In December 1977 Cray Research finalized its first multi-system order: a contract for the installation of two CRAY-1 Computer Systems for two agencies of the U.S. Department of Defense (DOD). Delivery dates for the systems, each with one million words of memory, were January and June of 1978.

The DOD agencies involved have been among the leaders in the use of large-scale computers for years, according to CRI Eastern Regional Sales Manager Charles Puglisi. Puglisi reports: "The customers are delighted with CRAY-1 performance. The reliability far exceeds that of any other large system that they have had."

The National Magnetic Fusion Energy Computer Center

The National Magnetic Fusion Energy Computer Center (NMFECC) was founded in 1974 as part of a nationwide effort to explore the generation of electricity through nuclear fusion. The NMFECC provides computational support to all major MFE research groups in the country via its powerful computer network. The Center added a CRAY-1 to its network in April, 1978.

Realizing the benefit of pooling information, codes, data, manpower, and computer resources, MFE researchers devoted themselves to establishing the NMFECC. The U.S. Energy Research and Development Administration considered need, anticipated demand, and research priorities in establishing the Center. Today, more than 800 researchers from national laboratories, universities, and industry have access to the Center's computers. The Center is operated by the Lawrence Livermore Laboratory for the Division of Magnetic Fusion Energy of the Department of Energy. The NMFECC is located adjacent to the Lawrence Livermore Laboratory in Livermore, California. At the NMFECC, a CDC 7600 serves as front-end to the Center's million-word CRAY-1. The Center also operates and maintains a CDC 6400 computer for file management and two PDP-11/50

computers, one for central communications control and the other for network control. Large scientific calculations and large code development and debugging are handled at the Center.

The NMFECC has established User Service Centers (USC's) at seven key MFE research centers in the U.S. The USC's make possible local processing of smaller calculations. Two USC's are in Livermore, one for Lawrence Livermore Laboratory and the other for the NMFECC. The five remaining USC's communicate with the national Center through PDP-11/40 remote communications control processors. Each USC has a PDP-10 computer as a local support processor; this enables the USC to serve as a remote output or remote job entry station for the network Center. The USC can also function as a concentrator, linking terminals to the main computers at Livermore.

Thirty other fusion research groups around the country have access to the Center through dial-up telephone lines from remote terminals. These groups fully use the interactively interrogatible feature of the NMFECC network. Eventually, the NMFECC plans to provide miniature USC's to the largest of the non-USC sites, allowing them full in/out capabilities to the network Center.

Lawrence Livermore Laboratory Computer Center

The Lawrence Livermore Laboratory (LLL), located in Livermore, California, is operated by the University of California for the U.S. Department of Energy. To support its nuclear research program and other research projects, LLL has one of the largest high-speed research computer facilities in the world, the Livermore Computer Center (LCC). The second CRAY-1 to be installed in Livermore, California was delivered to the LCC in January 1979. This million-word CRAY-1 is the latest acquisition by LCC, known for its giant Octopus network. The Octopus includes two CDC STAR-100s, four CDC 7600s, one CDC 6600, and one SDS Sigma 7/Sigma 3.

LLL was established in 1952 by the U.S. Atomic Energy Commission. The Soviet Union's initial nuclear weapons test was the stimulus behind establishing LLL, one of the country's two nuclear weapons development laboratories. Founders of the Lab strove to explore different areas of weapons development from those being investigated at Los Alamos Scientific Laboratory.

Today LLL is engaged primarily in nuclear weapons design. Research work is also continuing in energy technologies, environmental studies, and other fields of national concern.

United Computing Systems, Inc.

"The most powerful computing resource in the world is at United Computing. And it's available to you," reads an advertisement of United Computing Systems, Inc. (UCS). The international computer services company was able to boast after their CRAY-1 was delivered to the UCS National Datacenter in Kansas City, Missouri last September. The UCS acquisition of a half-million memory word (upgradable) system makes UCS the first remote computing services operation to offer access to a CRAY-1.

United Computing, a subsidiary of United Telecommunications, was formed in 1967. UCS's central Datacenter in Kansas City serves an international data communications network. Additional computational power is provided by major computer complexes in Boston, Massachusetts and London, England. Customers throughout the United States, Canada, and Western Europe can access the CRAY-1 through UNINET, UCS's communications network. Users in 150 UNINET cities can access UCS's three Datacenters via toll-free telephone lines.

The CRAY-1 is moved into ECMWF's new headquarters building in Reading, England

The UCS CRAY-1 has become part of United Computing's APEX system. A Control Data Cyber 170/Model 175 front-ends the CRAY-1. The APEX system also includes a Cyber 170/Model 174 and three CDC 6600s. APEX/SL is a time-sharing system that provides remote job entry, remote batch, and local batch services. UCS found that the CRAY-1 required little conversion effort in accommodating existing software for themselves and their customers.

"...Our installation will dispel the myth that the CRAY-1 is strictly a system for scientific applications."

UCS expects that their CRAY-1 will be particularly attractive to problem solvers in government, public utilities, energy, and engineering industries. The CRAY-1 is also suitable for very large data processing tasks, FORTRAN programs too large for "conventional" computers, and multi-national users (via UCS's international communications network). Additionally, UCS anticipates that potential CRAY-1 purchasers may come to the UCS machine for experience before installing their own. Jack Lorenz, President of United Computing, says "Our installation will dispel the myth that the CRAY-1 is strictly a system for scientific applications."

U.K. Ministry of Defense

In April 1978 the government of the United Kingdom agreed to acquire a CRAY-1 computer system to be installed at the U.K. Ministry of Defense (MOD) in 1979. From October 1978 until March 1979 the MOD customer had access to CRAY-1 Serial 1 in Bracknell, England. A permanent system with a full million words of memory was installed at the customer's site last month. The system was purchased after completion of acceptance testing.

Hardware and software user support for the MOD CRAY-1 system is supplied by Cray Research (U.K.) Ltd., a sales and service subsidiary of CRI, formed in 1978.

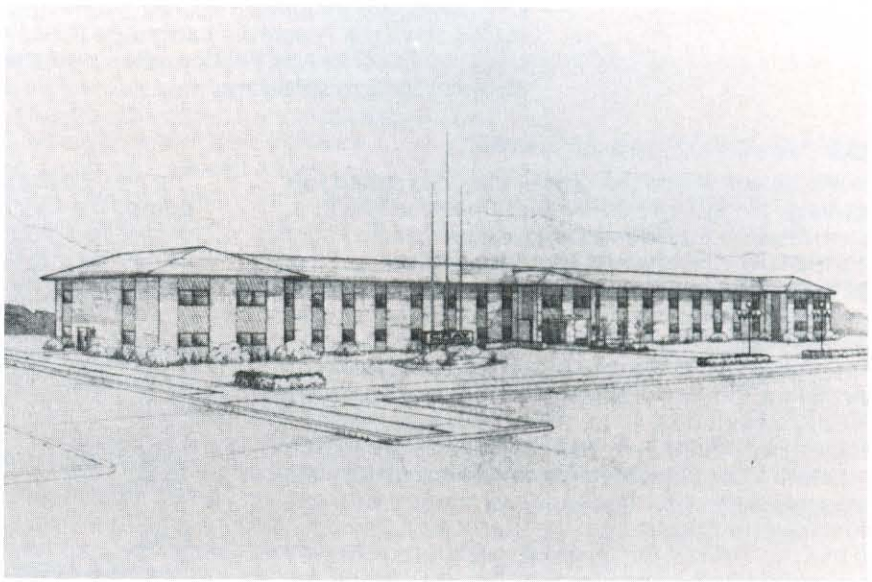
And what of the future? Cray Research is extremely optimistic about its strength in the large-scale high speed computer market. The Company's bold plans for the future derive from a strong past performance. Cray Research is working to meet the challenges of its current and future customers through its continuing research and development efforts. □

Printed circuit boards and power supply components are exposed as engineers install the CRAY-1 at UCS

CRI facilities grow in number, size

Cray Research has been building a future for itself, literally speaking. The construction of three new facilities and the expansion of a fourth are part of an effort to meet present and future needs for manufacturing, research, and office space for the Company.

In an action that's becoming a habit, Manufacturing completed yet another addition to its structure in Chippewa Falls, Wisconsin. The addition of 4400 square feet to the west end of the Manufacturing facility brings total floor space to near 30,000 square feet. The building, located in the Chippewa Falls Industrial Park, provides office and workshop space for Manufacturing and also houses some elements of the continuation and development engineering departments.

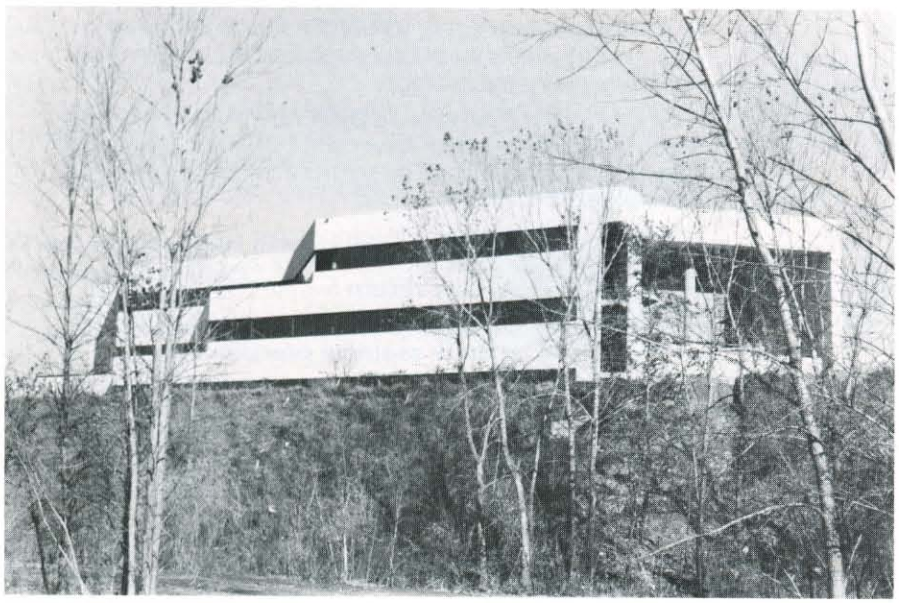


Architect's rendering of the new R & D facility

Later this year, work will be completed on a new Engineering facility in Chippewa Falls adjacent to the Manufacturing building. The new facility, providing 31,875 square feet of office and laboratory space, will allow consolidation of several R & D and continuation engineering elements now housed in other Chippewa Falls locations. Planned and designed by CRI personnel, the facility will be equipped with a temperature control system that recycles heat produced by computer support equipment.

This fall, work will begin on a 5400 square foot Printed Circuit Board lab. This new facility will be located south and slightly west of the Engineering facility in Chippewa Falls.

In Mendota Heights, Minnesota, work was completed last November on a 25,000 square foot Corporate Headquarters building. The construction allowed consolidation of employees from three Minneapolis locations. The three-story structure houses a computer room, two classrooms, several conference rooms, and offices for personnel, software development and maintenance, marketing and marketing support, publications, and training as well as corporate offices. Eventually this facility, too, will be heated by its computer equipment. Not long after the dust had settled from the move, plans were begun for a 40,500 square foot addition to the headquarters building, with construction to commence in the spring. □



The new CRI Corporate Headquarters building fits the lay of the gently rolling hills just to the east of the Minnesota River

software release **summary**

This article summarizes major changes made in the 1.05 version of Cray software, released in April, 1979. Cray software includes the Cray Operating System (COS), the Cray Assembly Language (CAL) Assembler, the Cray FORTRAN (CFT) Compiler, and the Data General Station software.

COS

A major feature added this quarter to COS is **rolled job recovery.** If a software or hardware failure requiring a system restart occurs after jobs have been initiated but not yet terminated, the operator may choose to recover those jobs that were in execution. Any jobs in execution that are recoverable are restarted at the point of last rollout. If a job was rolled out and back in again and then executed a function that makes the system unable to determine whether the job can be successfully restarted from the roll dataset image, the job is declared irrecoverable. Jobs declared irrecoverable are rerun from the beginning if possible. If a job is irrecoverable and is ineligible for rerun, it is returned to the input queue and terminated with an informative message in both the user and system logs. A job that has initiated but has never been rolled out cannot be recovered since there is no roll image to recover.

Also, there have been some enhancements to the **job rerun** feature. Now, the system recognizes if a job has performed certain functions that have lasting effect on the system (such as functions that make changes in the contents of permanent datasets or the Dataset Catalog). When a user performs one of these functions, COS declares the job ineligible for rerun. This status is normally permanent; however, the user may override the system by using the new RERUN and NORERUN control statements or macro instructions.

The **NORERUN** control statement or macro allows the user to specify whether COS is to recognize functions that cause a job to become not rerunnable. The current rerunnability of the job is not affected.

The **RERUN** control statement or macro allows the user to unconditionally declare a job to be either rerunnable or not rerunnable. If RERUN is used to declare a job rerunnable, the subsequent execution of a non-rerunnable function may cause the system to declare the job not rerunnable, depending on whether a NORERUN control statement or macro is also present.

A new parameter on the ASSIGN control statement allows the user to designate a dataset to be memory resident. A **memory resident dataset** is wholly contained within one buffer and remains in memory at all times. A user may declare a dataset to be memory resident to reduce the number of I/O requests and disk blocks transferred, thereby increasing system throughput. All I/O performed on the dataset takes place in the dataset buffers in memory and system I/O routines write the buffers to disk only if they become full. A memory resident dataset cannot be made permanent, nor may it be disposed to another mainframe.

The new DEBUG control statement produces a **symbolic dump.** The user may thus obtain a printout of the contents of specified program variables from a dump dataset. This allows the user to see conditions at the time the program terminated or the job step ended. Typically this is used after an EXIT statement and displays the contents of program memory registers along with their FORTRAN or CAL names.

A new parameter on the DUMP control statement allows the user to specify one of **five format types for a dump.** Via the AUDIT control statement, the user may now obtain a **list of all permanent datasets expired** as of a certain date or date and time.

CAL

Two pairs of **list options** have been added to both the CAL control statement and the LIST pseudo instruction. The XNS/NXNS pair designate inclusion or exclusion of nonreferenced local symbols in the cross reference listing. The WEM/NWEM pair enable or disable listing of warning messages. This is particularly useful for recursive vector applications.

The assembler has also been revised to include the optional **vector population count instructions** and the optional **programmable clock instructions.**

CFT

NAMELIST input and output is now available. The input routine accepts both CDC- and IBM-style NAMELIST input. Several callable routines are provided to allow explicit user control of NAMELIST formatting.

A new compiler directive, **VFUNCTION,** allows a user to provide CFT with a list of user-supplied CAL routines that CFT may call in a vector loop.

This quarter the FORTRAN-78 **DIMENSION** statement has been implemented. Both lower and upper bounds may be specified for a subscript. The specifications may consist of arbitrary expressions.

Most DO-loops that include temporaries set to a vectorizable expression are now vectorized. Also, the FORTRAN-78 **alternate return** feature is implemented.

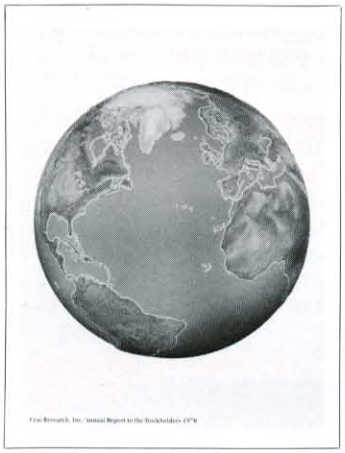
A new control card option allows all **double precision arithmetic to be done as single precision.** □

Corporate Register

Bill Scholer, Corporate Communications Coordinator

1978 in review

As the cover of the Company's recently published annual report suggests, 1978 was a year of expanding horizons for Cray Research. Significant advances in two major areas and an exceptionally strong financial performance made it possible for the Company to expand its CRAY-1 computer system production capability and plan confidently for a future of diverse possibilities.



First and foremost, 1978 was a year of encouraging marketing developments for Cray Research. The previous twelve months' efforts had firmly established the CRAY-1's leading market position in the weather, energy, and defense research environments, the company's initial market sphere. In 1978, our sales force developed strong CRAY-1 interest in the commercial markets and overseas.

The Commercial and Foreign Markets

Installation of a CRAY-1 in United Computing Systems' information services network in September 1978 put Cray Research equipment in a commercial environment for the first time. Firm commitments for CRAY-1 systems by Bell Laboratories, Murray Hill, N.J. and Century Research Center Corporation of Japan and a tentative commitment by Boeing Computer Services Company confirmed the fact that there is a substantial and growing commercial market for large-scale computers such as the CRAY-1.

1978 was a year of strong interest in the CRAY-1 overseas as well. To meet this interest, the Company established marketing representation in France and Japan and pursued active CRAY-1 interest in West Germany and Australia. Cray Research (U.K.) Ltd., a sales and service subsidiary based in Bracknell, England, was established at midyear.

Structured Growth

These marketplace advancements were matched by structured growth in manufacturing and engineering capabilities during 1978. By the end of the year, the Company had doubled its original machine production rate of four systems per year, nearly tripled its original 10,000 square feet of manufacturing space, and increased its total work force by more than 50% over the previous year's total.

During 1978, the Company assembled, delivered, and successfully installed five CRAY-1 computer systems—two for the U.S. Department of Defense, one for the National Magnetic Fusion Energy Computer Center (Livermore, California), another for the ECMWF, and one for United Computing Systems' National Datacenter in Kansas City, Missouri.

Also during 1978, Cray Research built and occupied a new corporate headquarters building in Mendota Heights, Minnesota and began construction of a permanent research and development facility adjacent to its manufacturing building in the Chippewa Falls (Wisconsin) Industrial Park.

Research and Development

Highlights of the Company's research and development efforts in 1978 were the expansion of software system support efforts from one to six CRAY-1 sites and the establishment of regular quarterly software releases that implement new operating system and FORTRAN compiler features and enhancements. The Company also introduced FORTRAN optimization that allows significantly improved scalar processing rates.

Cray Research intensified its hardware development efforts in 1978 in response to the challenge of providing its present and future customers with a second generation computing system. Initial efforts focused on technology and architectural enhancements for the CRAY-1. Work on the CRAY-2 is proceeding with emphasis on external software compatibility.

Financial

Cray Research recorded its second profitable year in 1978 and began 1979 in a strong financial position. The sale of a computer system in July 1978 virtually guaranteed the Company profitability for the year, but in fact Cray Research operations were profitable for the fourth quarter strictly on the Company's base of leased systems, and that provided another milestone in the Company's development. □

FINANCIAL HIGHLIGHTS	1978	1977	Change
For the year:			
Revenue	**$17,177,000**	11,394,000	+ 51%
Earnings before income taxes	**$ 4,716,000**	2,027,000	+133%
Pre-tax return on revenue	**27.5%**	17.8%	—
Earnings before extraordinary item	**$ 2,601,000**	1,027,000	+153%
Return on revenue	**15.1%**	9.0%	—
At end of year:			
Working capital	**$ 7,498,000**	9,083,000	− 17%
Net investment in leased systems and spares	**$14,810,000**	7,175,000	+106%
Total assets	**$28,952,000**	18,558,000	+ 56%
Long-term debt	**$ 4,670,000**	3,321,000	+ 41%
Stockholders' equity	**$20,638,000**	14,636,000	+ 41%

CRAY RESEARCH, INC.

Sales Offices

Domestic

Eastern Regional Sales
10750 Columbia Pike, Suite 602
Silver Spring, Maryland 20901

≈

Central Regional Sales
1440 Northland Drive
Mendota Heights, Minnesota 55120

≈

Mountain Regional Sales
75 Manhattan Drive, Suite 3
Boulder, Colorado 80303

Houston District (Petroleum)
3121 Buffalo Speedway, Suite 400
Houston, Texas 77098

≈

Western Regional Sales
101 Continental Boulevard, Suite 456
El Segundo, California 90245

Seattle District
536A Medical and Dental Building
Everett, Washington 98201

≈

International

Cray Research (U.K.) Limited
James Glaisher House
Grenville Place
Bracknell, England