

The Making of A Supercomputer



The unique design of a CRAY-1 Computer System is a customer's first assurance of system reliability; the second is the careful execution of the design, a process requiring the precision and accuracy of the Cray Research manufacturing staff in Chippewa Falls, Wisconsin.

letter from the editor

In a time when everything is becoming increasingly automated, Cray Research, Inc. is unique in producing the world's fastest computer by hand. Skilled technicians are involved from start to finish in planning, assembling, testing,

installing, and servicing CRAY-1 Computer Systems. Quality assurance is stressed throughout.

Planning and production activities for the manufacturing segment of Cray Research have been important in leading the company to its number-one position in the large-scale computer market. The proven reliability of CRAY-1 hardware is enviable, and this reflects positively on the work of the people in manufacturing.

engineering efforts," says Donna Schneider, manufacturing production manager. "Staying number one in the large-scale computer business takes significant money for research and development work."

At Cray Research, the ties between marketing, finance, engineering, and manufacturing are strong, providing the unity necessary for a large-scale computer company to be the best in its field. ■

—M.C.C.

How does manufacturing view its role?

"The goal of production is to provide a quality product on time and to produce a profit to support future

Manufacturing A CRAY-1 Computer System

(continued from page 1)

The Place

The first CRAY-1 was assembled in space rented from a shoe manufacturer in Chippewa Falls, Wisconsin. A major requirement when looking for manufacturing space was that the area have a floor

substantial enough to withstand the weight of a five-ton CRAY-1 computer mainframe.

Manufacturing is now conducted at a Cray Research facility in the Chippewa Falls Industrial Park. CRAY-1 computer systems are assembled, tested and packed for delivery in this 30,000 square foot manufacturing building.

The facility, constructed in the spring of 1977, is being expanded for the third time.

The People

More than 200 Cray Research employees (about two-thirds of the total CRI workforce in Chippewa Falls)



Cray Research manufacturing facility, Chippewa Falls, Wisconsin.

input/output

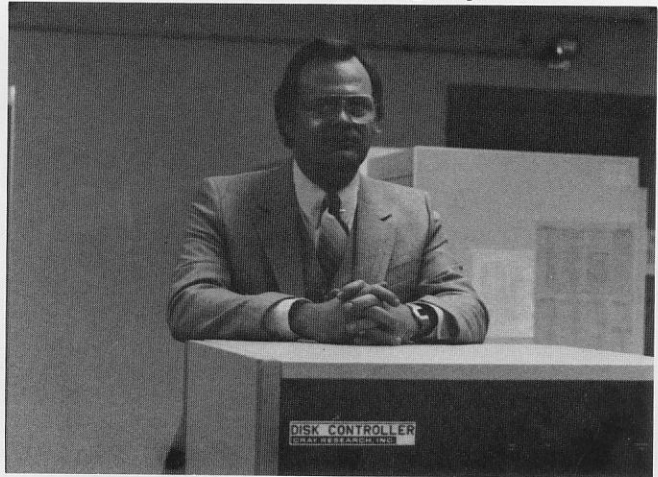
Manufacturing at Cray Research, Inc. is truly unique. For years, manufacturing in the computer industry has been a labor intensive operation requiring hundreds or thousands of assembly, test, inspection and check-out people. Buildings of 150,000 square feet to even 1,000,000 square feet were — and are — normal.

At Cray Research it is refreshing and exciting to be the leader in the large-scale computer industry, while operating with less than 200 manufacturing people and about 30,000 square feet of actual production space.

The two main reasons that Cray Research has been able to achieve these results are the unique design of the CRAY-1 Computer Systems and the high quality work of our people. Trying to do manufacturing just like other mainframe manufacturers would surely get us into a non-competitive position. We must try to be unique and different to keep our edge.

As all companies grow they tend to become impersonal, bureaucratic, non-responsive to change. Our challenge at Cray Research is to grow in numbers of people, facilities, revenues, and profits — while maintaining or surpassing our

Don Whiting, director of manufacturing, Cray Research, Inc.



present levels of high quality, performance and responsiveness to our customers. Being the biggest is not our goal — continuing to be the best in our field IS OUR GOAL. ■

—D.F.W.



Donna Schneider, manufacturing production manager, in wiring area.

are currently involved in the preparation, assembly, and testing of CRAY-1 Computer Systems or in providing technical or administrative support to the manufacturing effort.

Approximately 80 of the people are involved in the actual production work.

What's amazing to outsiders is how only 80 Cray Research employees can produce the world's most powerful Computer System, with the absolute assurance of system reliability upon delivery. Manufacturing people are proud of this fact. Careful training, supervision, and inspection are

important elements in maintaining the high quality production work in manufacturing each CRAY-1 Computer System.

Production staff work in either mechanical assembly, module assembly and test, or wiring.

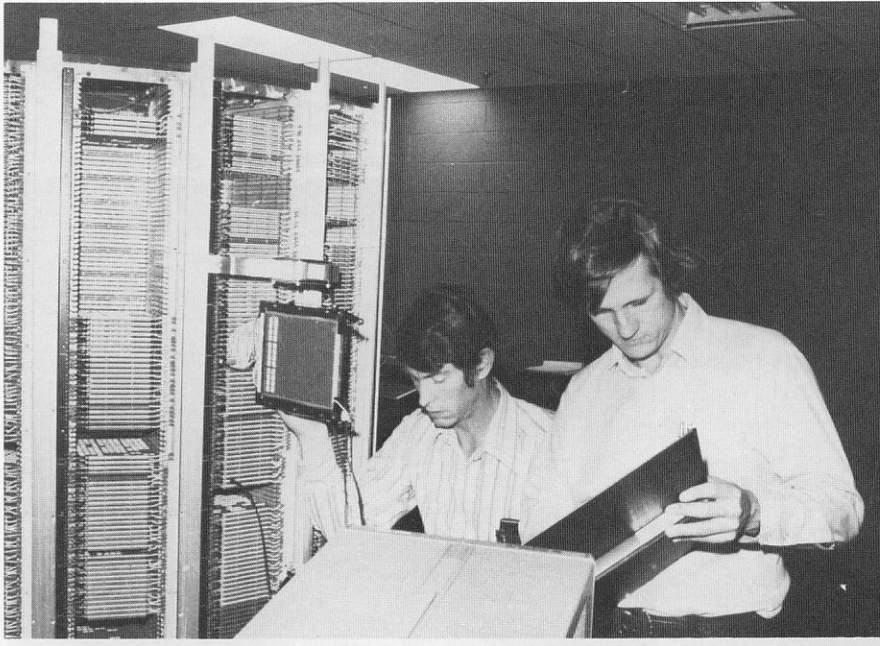
The Product

The quality of Cray Research manufacturing shows through with the excellent reliability statistics collected over 120,000 hours of use in customer sites worldwide.

Cray Research builds the central processing unit (CPU) for each computer system from custom-made components, adding peripheral equipment produced by Cray or other computer manufacturers.

Cray Research has earned and maintained a reputation for never having missed a delivery schedule.

In addition to the CPU, a typical CRAY-1 Computer System includes disk controllers and disk memory units; an I/O Subsystem or a



Maintenance Control Unit Subsystem with input/output devices (console, line printer, and card reader); a power distribution unit; a condensing unit; and two motor generator units with control cabinets.

The Plan

The manufacturing phases — production planning, purchasing, material control, production control, quality assurance, and mainframe assembly — all demand careful planning and coordination.

Every system must undergo five months of rigorous testing before installation at a customer's site.

Manufacturing is geared toward producing at the rate of approximately one computer per month. Cray's plan for 1980.

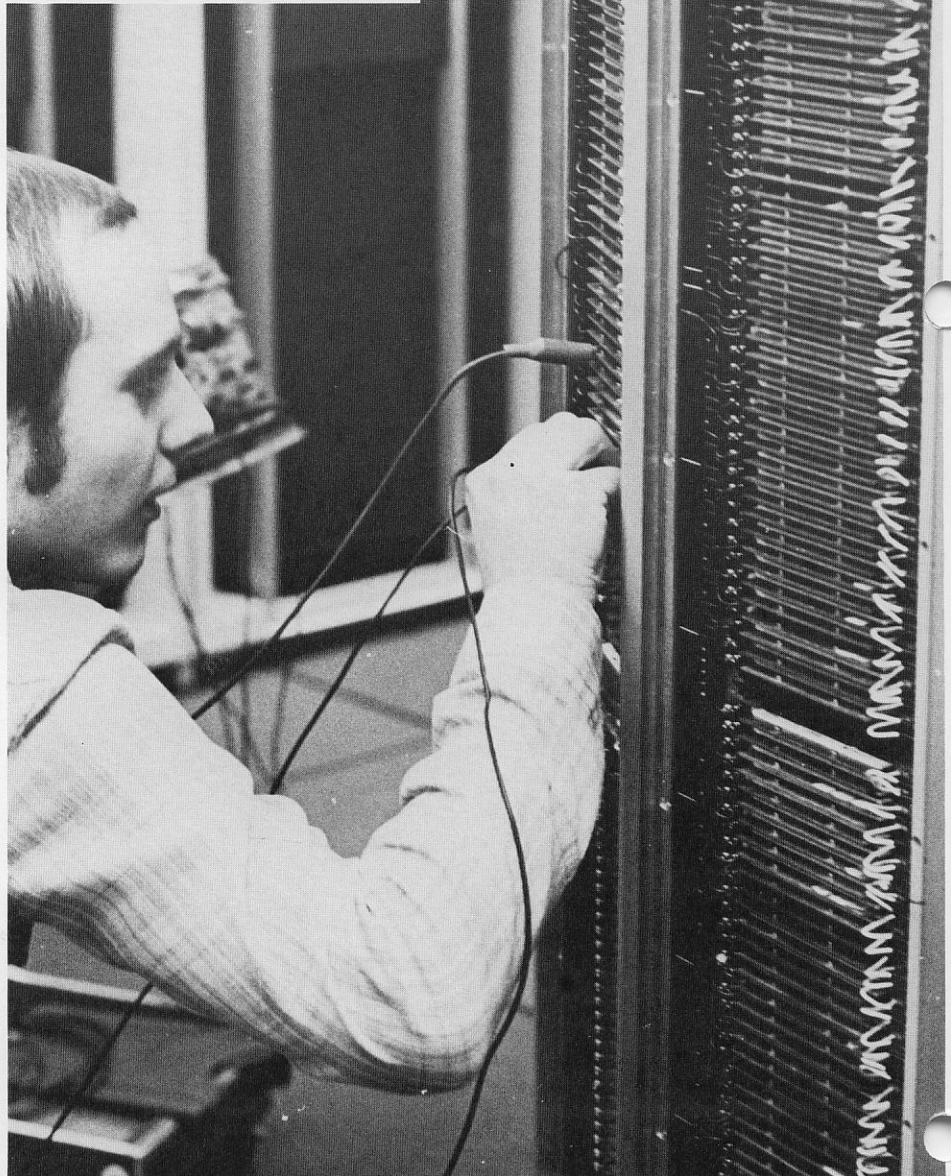
Cray Research has earned and maintained a reputation for never having missed a delivery schedule.

Testing

Testing and inspection takes place at every step along the way to ensure quality control.

The inspection group tests or visually checks every part used in production, before, during, and after assembly. After assembly, each machine is also sent to checkout engineering for system quality assurance tests.

Every system must undergo five months of rigorous testing before installation at a customer's site.



CRAY-1 Computer Systems undergoing electronic testing.

Mechanical Assembly

The mechanical assembly group performs such functions as quality assurance testing of cold bars (the aluminum sections which hold the modules in a CRAY-1); refrigeration plumbing of the compressors and associated lines; and assembly of the mainframe, power supply, and cold bars.

This allows a CRAY-1 to operate at a cool 70° fahrenheit, even while performing millions of calculations per second.

Cold bars are unique to the computer industry and important to the operation of a CRAY-1. Freon passing through tubes in the cold bars dissipates heat from the densely packed integrated circuits. This allows a CRAY-1 to operate at a cool 70° fahrenheit, even while performing millions of calculations per second.

The mechanical assembly group also does wiring, testing, and inspection of the peripheral equipment such as the power distribution unit, disk controller cabinets, interfaces and tests stands.

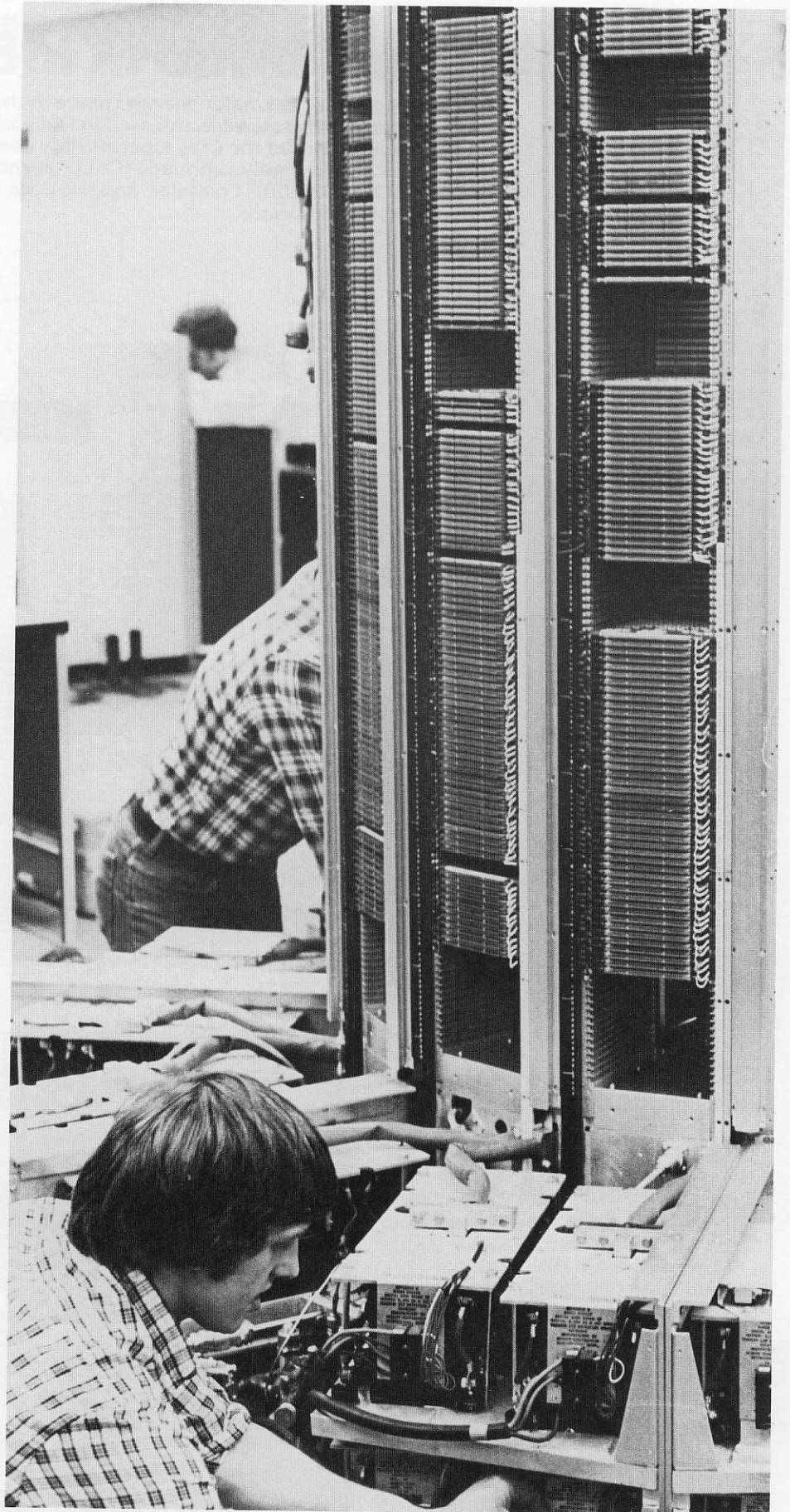
Mainframe (CPU) Wiring

CRAY-1 mainframes, the semicircular structures that stand about six feet high, are assembled from cast aluminum chassis, module boards, and precisely measured and hand-soldered lengths of wire.

The mainframes are wired in thirds, with four vertical columns of module boards in each third. After the wiring of the sections is completed, the three sections are connected, forming the semicircular structure.

The circular design was chosen to allow shorter wire and circuit connections so that calculations can be done more quickly and efficiently.

The CRAY-1 Computer System design, the thorough testing of each system, and the pride that the manufacturing people take in each machine—these are the most important factors behind the Cray Research guarantee of exceptional system-reliability with every CRAY-1 Computer System installed. ■



Mechanical assembly

software release program

This article summarizes major changes made in the 1.07 version of Cray software, released in December. 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

Provided with this release are the CFT linkage macros. The **CFT linkage macros** handle linkage between CFT-compiled routines and CAL-assembled routines. These macros can be used to maintain compatibility across the various versions of CFT.

Also, a new format type has been added to the **DUMP control statement, format M**, which dumps a portion of memory in mixed hexadecimal and octal (ASCII code).

The **WAIT and NOWAIT parameters** on the **DISPOSE control statement** and the **WAIT parameter** on the **PDD macro** (when used in conjunction with **DISPOSE**) have been implemented.

The **WAIT parameter** on the **DISPOSE control statement** allows the user to delay job processing until a disposed dataset has been staged to the front-end system. The job will resume processing immediately when the **NOWAIT parameter** is specified.

On the **PDD macro**, **WAIT** is equal to **ON** or **OFF**, depending on whether job processing is to be delayed or resumed, respectively.

CFT

A **symbolic debug package** has been implemented. It can be invoked by calling the library subroutine **SYMDEBUG** in a running program, or by specifying the **Z** option in the **CFT control statement** along with the **DEBUG control statement**.

CFT now provides the utility routines **CLEARFI** and **CLEARFS** to prohibit floating-point interrupts; **SETFI** and **SETFIS** to permit floating-point interrupts; and **SENSEFI** to determine the current interrupt mode.

A set of **subroutines** can read or write IBM style 32 bit floating point numbers is provided.

The **D, E, F, G** and **O** format specifications will now edit both real and double-precision list items. ■

The 27th Mersenne prime. It has 13395 digits and equals 2⁴⁴⁰⁷ - 1.

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Cray News from around the World

Century Research Corporation (CRC), Tokyo, Japan, received a half-million word CRAY-1 Computer System in January.

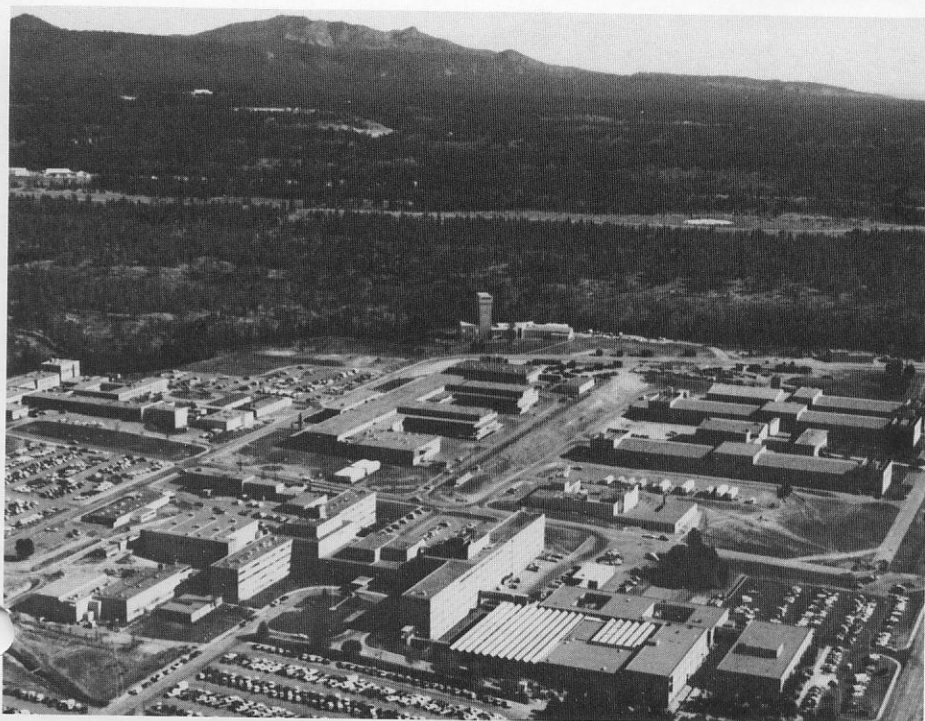
A million word CRAY-1 Computer System was delivered to **Kirtland Air Force Base**, Albuquerque, N.M., on February 19.

Under a prime-contract with Arnold Engineering Development Center, Arnold Air Force Station, Tenn., the New York based **Grumman Data System Corporation** placed an order for a CRAY-1 model S/250, with a quarter-megaword, field-upgradable memory. Installation is scheduled for the second quarter of 1981.

A poster of the **27th Mersenne Prime** is available through Creative Publications, Inc., Palo Alto, Cal. This colorful, computer-generated poster lists the 13,395 digits that comprise the largest Mersenne Prime number. Its primeness was determined on April 8, 1979 using the Lucas-Lehmer test. The test was programmed on a CRAY-1 computer by David Slowinski and Harry Nelson. ■



Century Research Corporation



Los Alamos Scientific Laboratory

A Second CRAY-1 for LASL

Los Alamos Scientific Laboratory (LASL), site of the first CRAY-1 prototype evaluation, received its second CRAY-1 Computer System in mid-November, 1979.

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 now includes the newly installed CRAY-1 Computer System, the CRAY-1 installed in 1976, four Control Data 7600s, and three CDC 6000 series computers.

Scientists at the Los Alamos, N.M. site are involved in nuclear studies and energy research programs. ■



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