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# Interface

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FEBRUARY 1986



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*The technologies used in printed circuit board production are changing rapidly. In Chippewa Falls, the company's PCB facility is adopting many of the processes used for integrated circuit production.*

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## PCB: prototype to product



*People in the PCB facility are experimenting with circuit boards that are 1" x 1" x .015" and as precise as they are complex.*

Ideas turn to reality in the company's Printed Circuit Board (PCB) facility in Chippewa Falls. This is where you'll find circuit boards that are 1" x 1" x .015" and as precise as they are complex. It's a place where 137 people build circuit boards for the CRAY X-MP™ systems, CRAY-2™ systems, and follow-on, and so-on.

As the company's first experiment with vertical integration, the PCB venture proved to be a brilliant success. When the facility first opened in 1979, it was a prototype shop designed to provide quick turnaround on engineering boards. The schedule called for 1,000 boards a month. Larry Dahl, now Director of

Manufacturing, introduced the capabilities in a small, 5400-square-foot building.

Within three years, Cray Research was building all of its own boards. Today the production schedule calls for 4,000 boards each week, and the current 25,000-square-foot facility is being expanded to 44,000 square feet to meet a growing demand for CRAY systems.

"From a PCB standpoint, we are on the leading edge of fabrication technology," noted Jim Berry, director of the PCB facility. "Our products are difficult to build, and very few companies have the capability to produce the fine-line, multilayered boards required for our products."

Walking through the PCB facility with Production Manager Dick Kelley offers insight into the complexity and care required in production. Starting with artwork provided by development teams, people in the PCB facility turn the artwork into workable print masters and inspect them. From there the masters are used to print and etch internal planes, and are inspected. The layers then are laminated together, moved to numerical control drilling, and inspected at the drill station before moving to the plasma desmearing operation. Another inspection takes place before moving the boards to electroless deposition, where metal is deposited inside the holes to make connections from layer to layer. At this point, the boards proceed to the imaging area where final signal traces are added; and the boards must pass further inspection before they are returned to plating, where signal traces are plated, etched, and inspected again. In the final stages of production, the boards are fabricated into final size and inspected once more — this time electrically. "Our inspection process helps us maintain yields that are significantly higher than outside vendors will quote," Dick remarked. "After every step in the production process, we check the boards to

ensure the quality at that point. Quality must be built into the products; it can't be inspected in after the boards are completed."

Besides extensive checking throughout the production process, many additional precautions are taken to ensure the highest quality products. Incoming materials are evaluated and tested against stringent guidelines, and the facility is monitored for temperature and humidity. "Tolerances on the products are very tight," explained Bruce Dressel, who is in charge of PCB facilities and equipment. "The products can be ruined easily at any step, so we have a strong preventative maintenance program that includes daily and weekly checks on our equipment."

Printed circuit boards are a vital part of producing quality computer systems, which is why Cray Research insists on PCB facilities and capabilities that are state-of-the-art compared with other facilities around the world. The key to success is more than a particular set of tools and techniques, however. It is primarily a result of the ability and motivation of the people; the production staff, engineers, and support staff give us the edge over other PCB houses.

Working relationships are very strong between people in PCB and other groups throughout the company. PCB engineers work closely with manufacturing and development employees on new designs and manufacturing problems. "We meet regularly to stay ahead of technology and to share feedback on the manufacturing aspects of the printed circuit boards," explained Engineer Paul Schroeder. "Early involvement with new projects prepares us for what's coming, and because we've had our input during the design stages, we view each new product as though it were our own development."

PCB continues to implement new technologies for maintaining leading-edge capabilities. PCB Engineers Randy Haslow, Kelly Svoma, Dave Swoboda, Dean Dudley,



*Jane Moen assists in an inspection process that produces the highest quality printed circuit boards available.*

Russ Eidal, Cindy Seniow, and Paul Schroeder attend technical seminars and trade shows to track new technologies that would be appropriate for PCB production.

In adapting to new development efforts, the company's PCB operation is integrating many of the processes used for IC fabrication. A scanning electron microscope is being used for verification of line definitions. Copper sputter technology, which is similar to the implant process in IC

production, inserts copper into the drilled holes. A robotic plating arm dips the boards into solutions for distinct intervals of time. Vacuum lamination and off-contact printing concepts also are procedures adopted from IC production.

"We are seeing our technology change with each new follow-on product," noted Jim Berry. "Fine-line traces are becoming even more

*(continued)*



The PCB facility enables the company to control the cost of current products and experiment with new designs.

refined. We are taking the CRAY X-MP system and approximately quartering it. Our whole manufacturing process is changing."

Through a sharp focus on quality and an eye toward the future, the PCB capabilities have enabled the company to control the cost of current products and to experiment with new technologies in a timely manner. "Because of our internal PCB capabilities, we no longer have to rely on outside vendors who have preconceived ideas about what can and cannot be done," said Larry Dahl. "Our PCB facility allows us to meet our current manufacturing requirements and prepares us for products that will carry us into the future."

## Employee meeting highlights: John Rollwagen and Bill Linder-Scholer

1985 was a very successful year for Cray Research. Financially:

- We had approximately \$380 million in revenues, and \$75 million in earnings.
- Approximately \$50 million of our revenue came from services.

In 1985 we installed 28 new CRAY computer systems, and reinstalled seven used systems. Of these:

- 23 were purchased
- 4 were leased, and
- 1 was installed in-house

39 contracts were signed with customers; we expected 35!

- 19 were with new customers,
- 3 were with new industries,
- 4 were with U.S. universities,

- 14 were overseas, and
- 10 were with the U.S. government.

Looking at the historical perspective:

- In 1982, we completed 16 contracts with customers. In 1983 this increased to 25 contracts, and in 1985 this figure rose to 39.

New subsidiaries opened in 1985 include:

- Australia and Switzerland.

According to Bill Linder-Scholer, assistant to the chairman and manager of the company's corporate giving program, Cray Research made the following contributions in 1985:

- \$335,000 in 54 scholarships to dependents of Cray Research employees,
- \$210,000 in 677 gifts from 210 employees, and
- \$500,000 in direct grants to education.

Of these matching gifts,

- 30 percent went to education,
- 35 percent went to health services,
- 20 percent went to the arts, and
- 15 percent went to social services.

New in 1986:

- Cray will match up to \$3,000 per employee for non-profit gifts.
- If you also volunteer where you are giving financial support, Cray will double your gift.
- If you donate 25 hours of your time to a non-profit organization, Cray will give an annual \$500 grant to the group.

## You never stop learning



*Through the efforts of our training and development specialists, Cray Research provides an environment that encourages the growth and development of all employees.*

Recall your first day at work . . . you are surrounded with strange faces and unfamiliar names, a maze of hallways with no obvious route to the bathroom, not to mention the water fountain, an unending pile of benefit packets, annual reports, and last but not least, a copy of the Cray Style.

You have reached the limit. And then along comes a solution — an end to your quandary — a telephone book, a map, and an explanation of the differences between Cray 150 and Cray 500: a solution called orientation.

Orientation is but the first of a long line of personal and professional development programs provided to Cray employees by the human resources training and development (T&D) staff.

"Our job is to create programs tailored to help employees and managers enhance work skills and job satisfaction," says Karalyn Harrington, human resources and employee development, Mendota Heights. "We aim at providing

opportunities for people to develop skills that allow them to deal with change and growth. The programs also support organizational goals by developing people to meet employment needs today and in the future."

Over the past year the T&D program at Cray Research has grown tremendously. For example, in Chippewa Falls, participant training hours nearly quadrupled from 4,658 in 1984 to 21,321 in 1985. In Mendota Heights, it jumped from 4,597 participant hours to 5,780, and in Minneapolis, which provides programs to people around the company, from 7,262 to 11,025.

And it didn't stop there. The year 1985 was a record year for training and development activities.

Thousands of hours were put into the design and implementation of quality programs by dedicated T&D staff members. And the effort paid off. Not only were employees and managers rewarded through increased personal and professional productivity, but Cray Research received an award last December from the Minnesota Chapter of the American Society for Training and Development for being "a model for the integration of training and development functions into the management and work life of the organization."

The development function has grown in other areas as well. In Chippewa Falls, for example, nearly 20 percent of the employees now are taking advantage of the tuition reimbursement program by seeking outside learning activities. Candace Louviere, human resources manager, reports that this is a jump from five percent at the beginning of 1985.

Continuity is an integral part of the program. Two courses explaining the Cray Style persist as an implicit part of all employee development programs. One course explains the principles of the document, and the other examines its relationship with Cray employees. In an attempt to keep in touch with the small-group

approach of the Style, only 15-20 participants are allowed in each course. Other familiar classes are Effective Performance Review and Managerial Coaching. They are the building blocks of the T&D program for managers. Several other programs offered to Cray employees last year were also very popular. Working with Diversity, the Support Staff Seminar, and Computer Fundamentals are just a few with excellent participant statistics.

With success and support underway, the T&D plans for 1986 are more ambitious than ever. According to Gary Hines, senior management development specialist, plans for managerial development include new courses in Strategic Planning, Administrative Fundamentals, Communication Skills for Managers, and Project Management.

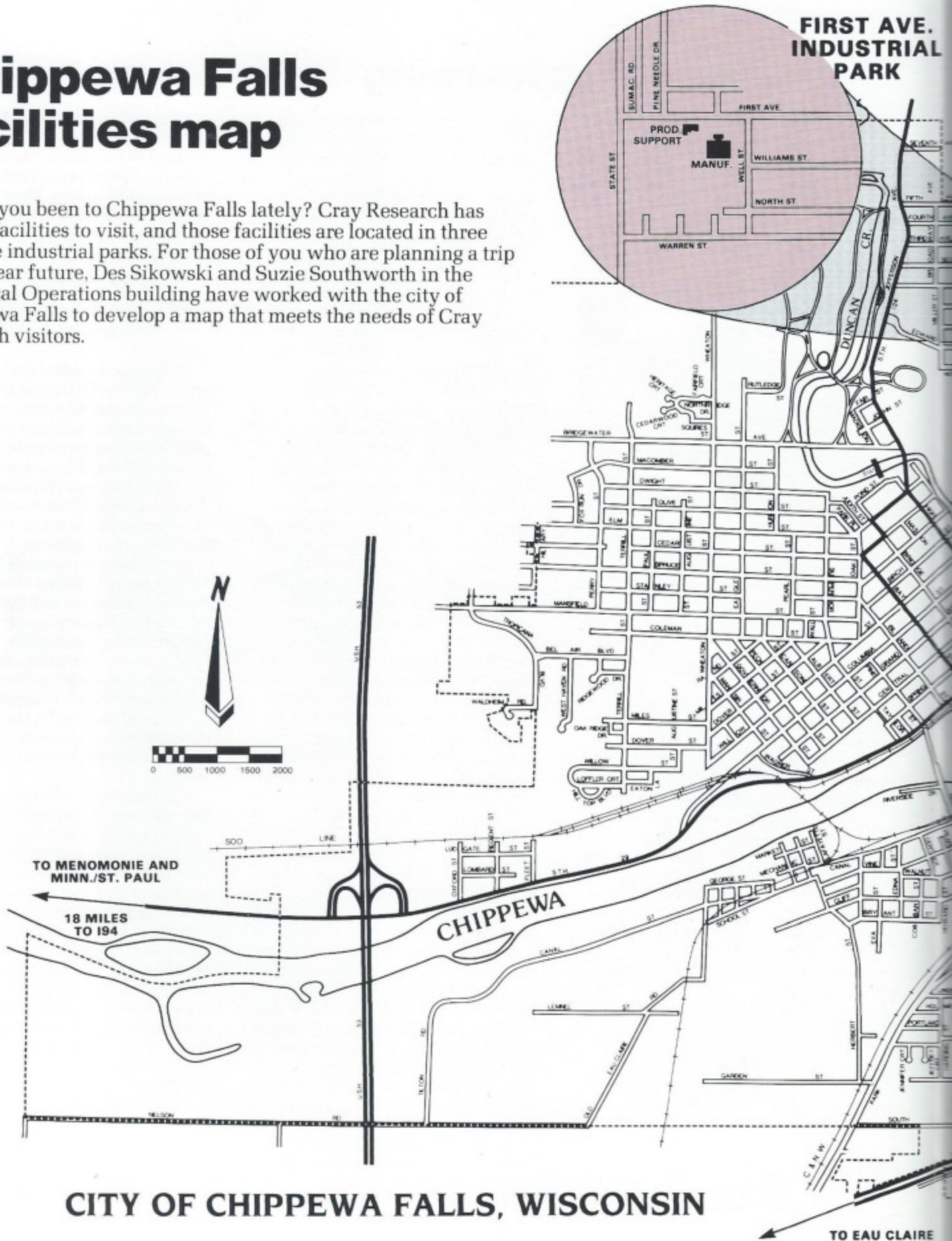
In employee development, Mary McDiarmid reports that Managing Personal Growth, which is a course on how to enhance your current position, and a repeat of the Computer Fundamentals course for non-technical people will be two of the features in 1986. In addition, T&D is designing a course for people who are considering management and want to know the requirements involved.

The philosophy of T&D is "to increase long-range productivity by seeking and implementing means to maximize employees' skills and contributions." The goal is to "enable employees to improve and enhance individual effectiveness and provide opportunities for personal and professional growth." When working together, the opportunities provided by T&D and the enthusiasm and involvement from Cray people create an environment of growth and development — what better way to support Cray Research's overall objectives?

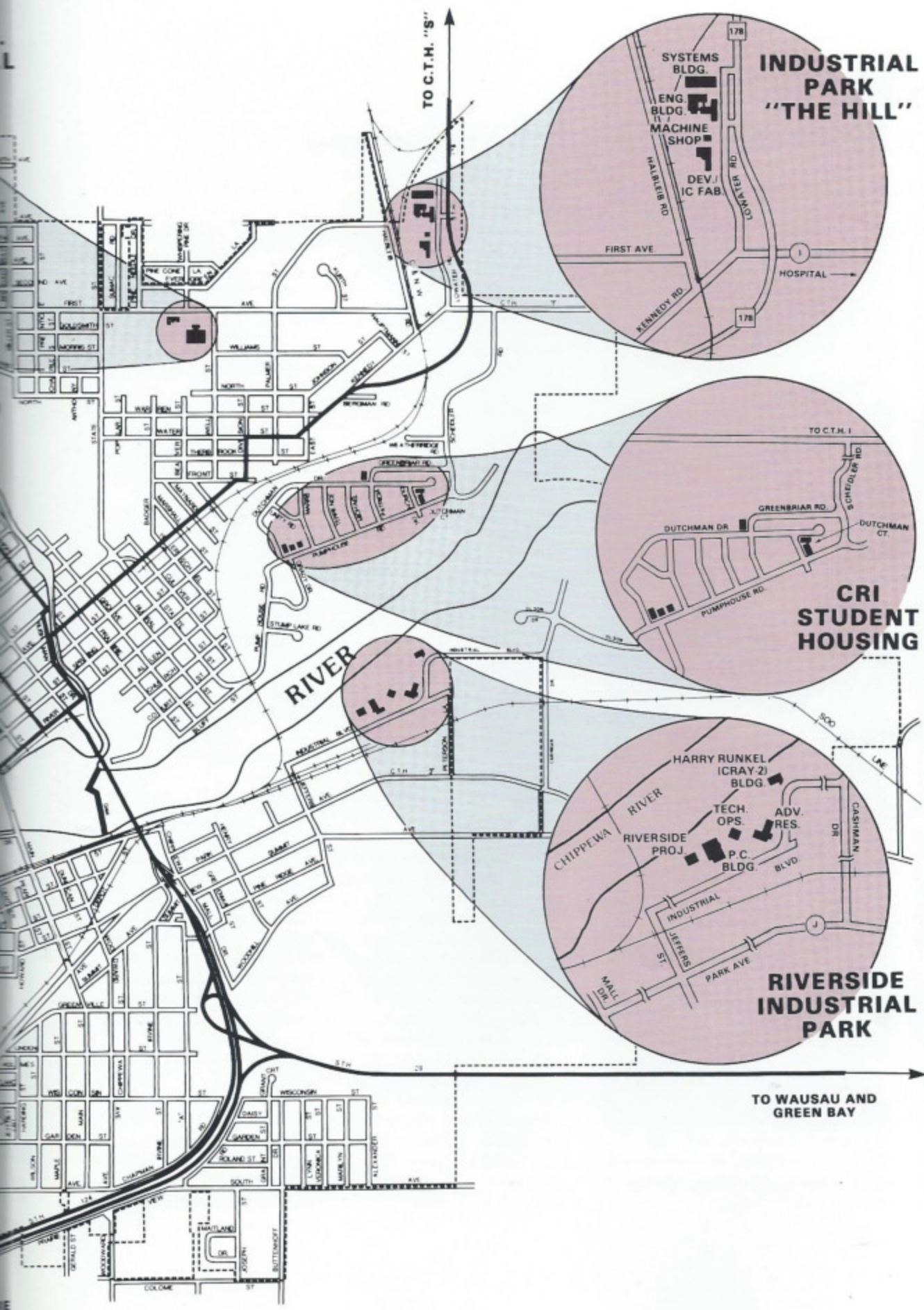
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## Chippewa Falls facilities map

Have you been to Chippewa Falls lately? Cray Research has eleven facilities to visit, and those facilities are located in three separate industrial parks. For those of you who are planning a trip in the near future, Des Sikowski and Suzie Southworth in the Technical Operations building have worked with the city of Chippewa Falls to develop a map that meets the needs of Cray Research visitors.



CITY OF CHIPPEWA FALLS, WISCONSIN



**INDUSTRIAL PARK "THE HILL"**

SYSTEMS BLDG.  
 ENG BLDG.  
 MACHINE SHOP  
 DEV / IC FAB

WALTERS RD  
 FIRST AVE  
 KENNEDY RD  
 REYER RD  
 HOSPITAL

**CRI STUDENT HOUSING**

TO C.T.H. I  
 GREENBRIAR RD  
 DUTCHMAN DR  
 DUTCHMAN CT  
 PUMPHOUSE RD

**RIVERSIDE INDUSTRIAL PARK**

HARRY RUNKEL (CRAY 2) BLDG.  
 TECH. OPS.  
 ADV. RES.  
 P.C. BLDG.

RIVERSIDE PROJ.  
 CHIPPEWA RIVER  
 INDUSTRIAL  
 JEFFERS ST  
 PARK AVE  
 CASHMAN DR

TO WAUSAU AND GREEN BAY

## Benchmark (n): a standard by which others may be measured

"There are three things that sell a CRAY computer," says Carl Diem, director of marketing support, "performance, performance, and performance. CRAY computers are the best

systems on the planet, and it's our job to demonstrate that those systems are the most suitable machines for scientific, engineering, and national defense markets."

In addition to benchmarking services and

technical consultation on the CRAY X-MP and CRAY-2 systems, marketing support includes functional groups for proposals and guest services. Ninety-nine percent of their work is directly related to supporting sales efforts, and these efforts escalate each year as CRAY computers evolve as the standard by which other systems are measured. In 1985, marketing support handled 105 projects compared with 76 projects in 1984.

When prospective customers are interested in acquiring new computer capabilities, they submit a benchmark, or a set of programs to their marketing representative and pre-sales analyst. This team then works with the benchmarking group in Mendota Heights to convert the codes and modify them to run at optimal speed on a CRAY machine.

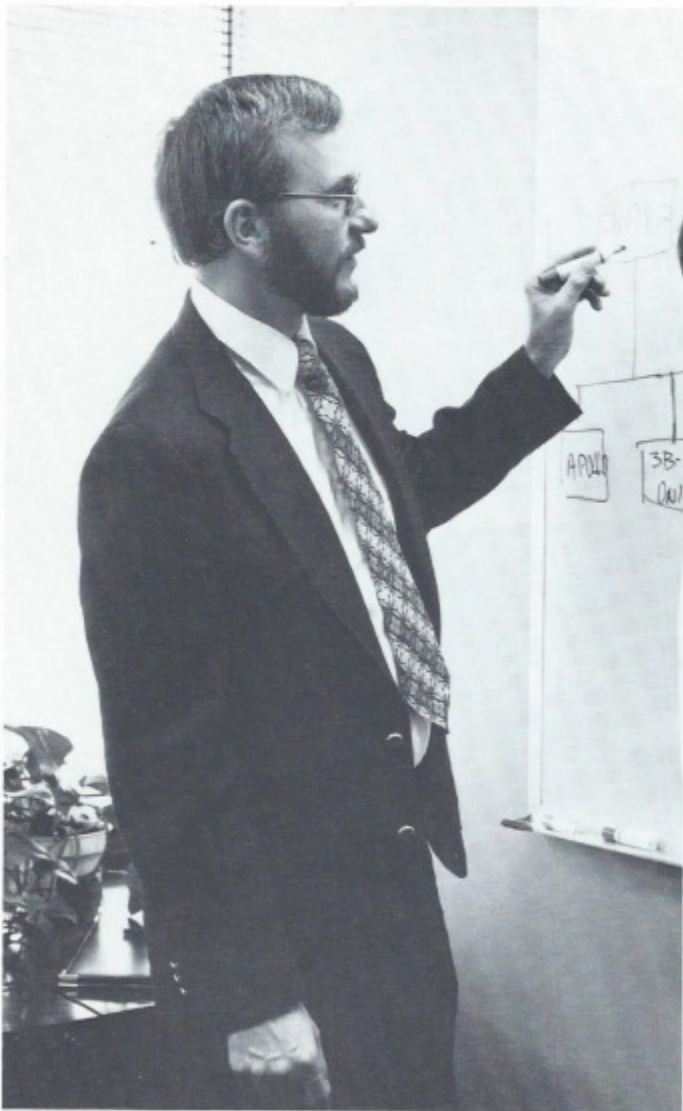
In this capacity, the benchmarking group fills the role of instructor as well as technical expert. "Our level of involvement with the field organization varies by the degree of experience they have with the system being benchmarked," remarked Bob Numrich, who handles benchmarking activities on the CRAY-2 system. "Sometimes the pre-sales analysts and marketing representatives are familiar enough with the desired hardware and software that they need very little help with

optimizing the code for best performance. At other times our department provides instruction as well as expertise."

Meeting the needs of the prospective customers is the primary objective of the marketing support and benchmarking teams. Customers have a strong understanding of their needs and rely on vendors to demonstrate methods to solve those problems. The request for proposal outlines the tasks that need to be solved, and it is up to the benchmarking group to show how those problems can be accomplished in the most cost-effective way. In some instances customers could solve their problems most efficiently with a CRAY X-MP system, and in other instances a CRAY-2 system would be the best approach to the problem.

"Benchmark times are reviewed closely by the prospective customer," commented Rosie Klein, manager of proposal services. "Benchmarking has to make sure the numbers reflect the best use of our machines because the evaluation criteria included in a proposal compare the responses and performance of our products against those of other vendors."

Showing the benefits of the CRAY architecture to prospective customers is the main goal of pre-sales presentations. "One of the ways that we optimize the codes for maximum



Pete Sydow explains that for benchmarking purposes, "wall clock time" is preferred over MFLOPS. Wall clock time tells the customer how well the machine uses the central processing unit, memory, input/output processors, compilers, and operating system.





Marketing support and benchmarking teams review a customer proposal and help decide on the most cost-effective solution to the problem. Above, Bob Numerich runs a benchmark on the CRAY-2.

performance is to incorporate scientific libraries into the codes," explained Vito Bongiorno, manager of benchmarking and SCILIB. "Our scientific library (SCILIB) is a collection of codes that often are used in scientific programming markets such as computational fluid dynamics, structural analysis, and petroleum engineering. Using variations of standard scientific programming codes can expedite the benchmarking process."

By modifying job control language, benchmarking also can take advantage of the Solid-state Storage Device, buffer memory,

various disk drives, and compilers to use the unique features of the CRAY architecture effectively.

When measuring the performance of a CRAY computer, benchmarking uses "wall clock" times for their standard. "MFLOPS don't tell the whole story," comments Pete Sydow, manager of analyst services. "They only measure peak speeds on certain problems. Wall clock time includes the central processing unit, memory, input/output processing, the compilers, and the operating system. It tells the customer how well the code uses resources on

the machine, especially through the job scheduler."

Keeping current with new hardware and software is critical for the benchmarking group. "The environment in which a CRAY computer is working today is becoming more and more complex," said Pete Sydow. "We're using different machines, and we're beginning to use different operating systems. Things were relatively simple ten years ago compared with the options we work with today."

In general, the physical size of benchmarks is getting much larger — they include more codes and more complex programs. "Customers are trying to simulate a slice of life — what's going on in their shop," Vito commented. "They also want to try out a few codes they would like to be capable of running in the future. More of this can be expected in the future."

To accommodate marketplace demands,

benchmarking continues to develop new strategies for demonstrating the power of CRAY computer systems. "Presently, we have the capabilities to benchmark all the CRAY X-MP machines in COS and the CRAY-2 systems in UNICOS. In the near future, we will be benchmarking the CRAY X-MP systems in both COS and UNICOS, while continuing to benchmark the CRAY-2 in UNICOS," Vito noted. "Even with the migration to new products and new operating systems, the goal of benchmarking remains the same. We want to demonstrate the performance of whatever machines we're running and to show the best use of CRAY architecture. It's our responsibility to show that with a CRAY computer, the number of operations per dollar is a better deal than any other machine can offer."



Through pre-sales presentations, Clay Kirkland, Vito Bongiorno, and Carl Diem show the benefits of the CRAY architecture to prospective customers.

## News Briefs

### University of Texas System orders CRAY X-MP supercomputer

On December 30th, Cray Research announced that the University of Texas system has ordered a CRAY X-MP/24 computer system, including a 32-million-word Solid-state Storage Device, valued at approximately \$14.5 million. The system, which will be purchased, will be installed in the first quarter of 1986 at the Balcones Research Center in Austin, Texas.

The CRAY X-MP computer will be at the heart of a center for high-performance computing being established by the University of Texas system. The computer will be used for basic and applied research by all 14 campuses in the system.

### Automobile mileage

The IRS has increased the automobile mileage allowance to 21 cents per mile. Effective 1/1/86, Cray Research adopted this rate for mileage reimbursement on expense reports.

### Money market fund: a new option for U.S. employees

A money market investment option is being added to the Deferred Profit Sharing and Investment Savings Plan effective April 1, 1986. The new money market fund, along with the existing stock fund and bond fund, provides a third investment option to better fit the financial needs of employees. The decision to add this third option is a result of interest expressed in employee meetings and in response to requests by employees to allow more choice in the investment selection process.

The money market fund is the most conservative of the three funds and will offer preservation of principal and interest rates. Its goals are to earn a moderate rate of interest and keep investments secure. This fund is diversified, which means that it invests in many different short-term opportunities, such as bank certificates of deposit, U.S. government treasury bills, and U.S. government bonds. Short-term investments such as these make the money market fund a very secure option.

The new money market fund will be managed by the IDS Trust Company of Minneapolis, a subsidiary of IDS Financial Services, Inc. and American Express Company. IDS was founded in 1894, and has grown steadily through the years. Today it stands as the 14th largest investment management company in the U.S. IDS Trust manages a total of \$27 billion in assets, of which \$6 billion represents contributions from corporate-sponsored savings programs. IDS is a complete financial services company, with 5,000 employees and operations in 500 locations throughout the U.S.

The existing stock fund and bond fund will continue to be managed by the investment firm of Investment Advisors, Incorporated (IAI) of Minneapolis. IAI has been managing the Profit Sharing Investment Portfolio since the Plan's inception in 1978.

Complete information on the new money market fund will be distributed to employees in late February. An open enrollment period will be held in early March to give all eligible plan participants (as of April 1, 1986) an opportunity to consider this new investment choice. During the open enrollment period, eligible employees will be able to make changes affecting the allocation of their accounts to the three funds and change their level of contributions to investment savings, regardless of the date of their last investment change.

### For your next public address

Chippewa Falls recently purchased a number of portable public address systems. Next time you are planning to speak in front of a large group of visitors or colleagues in Chippewa Falls, you may request the use of one of these systems by contacting the people listed below.

#### Contacts for PA systems

Don Hable —  
Development x1457  
Tom Zwiefelhofer —  
Tech Ops x4314  
Karen Anderson —  
Manufacturing x2136  
Jane Woodcock —  
Harry Runkel x4719

### Ooops!

The December/January issue of *Interface* incorrectly stated that the company designed, tested, and released a 256-million-word Solid-state Storage Device (SSD) in 1985. Actually, the company does not have a 256-million-word SSD; we have a 128-million-word SSD that uses 256K chips. Thanks to Mary Ahrens in the Western Region for pointing out this error.

### Thanks for the holiday

The Human Resources Department is happy to announce the addition of a new holiday for Cray Research employees, which brings the total of paid holidays to ten. "The new holiday generally will fall in March or April to coincide with a school holiday or to extend another holiday during the year," said Ginger Hagen (Mpls). "The date in 1986 will be March 28, which as it turns out, is the Friday before Easter." The holiday was established following a task force study done by Gene Johnson, Dave Svendsen, Marc Harding, and Dorothy Olson. Happy Easter!

## Cray Research on Jeopardy!

How many of you are fans of the day-time television program "Jeopardy!"? If you happened to see the program aired on January 9th, you were well-qualified to answer an entry under "Business and Industry for \$500." The clue was: "Nicknamed 'Bubbles' and looking like a hot-tub, the CRAY-2 is the world's fastest of these." The contestant guessed: "a submarine."

## Fourth Quarter Financial Results

On January 23rd, Cray Research reported revenue of \$380,158,000 for the twelve-month period ended

December 31, 1985, a 66 percent increase over the \$228,752,000 reported last year. Net earnings for 1985 were \$75,610,000, up 67 percent from 1984 net earnings of \$45,352,000. Earnings per share were \$2.49 in 1985 compared with \$1.53 in 1984, a 63 percent increase.

Included in 1984 net earnings was a benefit of \$6,047,000, or 20 cents per share, that was the effect of a deferred income tax reversal.

Revenue for the fourth quarter of 1985 was \$84,741,000 compared with \$70,891,000 a year ago; net earnings were \$12,039,000 versus \$15,988,000 in the last quarter of 1984; and earnings per share for the quarter were \$.39 compared with \$.54 last year. Ten new computer systems were installed during the fourth quarter of 1985, compared with nine

installations for the same period a year ago.

During 1985, 28 new CRAY computer systems were installed, of which 23 were purchased, four were leased, and one was installed within the company. By comparison, of the 23 new computer systems installed in 1984, 12 were purchased, nine were leased, and two went to company sites. There are now 115 CRAY computer systems in locations around the world.

John Rollwagen said the company achieved its objectives for the year. "Our plans are to install 40 new computer systems in 1986," he said, "with 60 percent of those systems already under contract and most of the remainder allocated to specific customers."

### Cray Research, Inc. and Subsidiaries

## Consolidated Summary of Earnings (Unaudited)

(In thousands, except per-share data)

	Three months ended December 31		Twelve months ended December 31	
	1985	1984	1985	1984
Revenue	\$ 84,741	\$ 70,891	\$ 380,158	\$ 228,752
Operating costs and expenses	63,775	45,818	247,799	164,651
Operating income	20,966	25,073	132,359	64,101
Other income (deductions)	335	988	3,484	2,790
Earnings before income taxes	21,301	26,061	135,843	66,891
Provisions for income taxes (net of tax benefit of \$6,047 in 1984)	(9,262)	(10,073)	(60,233)	(21,539)
Net earnings	\$ 12,039	\$ 15,988	\$ 75,610	\$ 45,352
Earnings per common and common equivalent share (1)(2)	\$ .39	\$ .54	\$ 2.49	\$ 1.53
Average number of common and common equivalent shares outstanding	30,617	29,780	30,370	29,679

(1) Adjusted for the 2 for 1 stock split effective August 16, 1985.

(2) Includes a reduction of income tax expense of 20 cents per share for the year ended December 31, 1984 reflecting a change in the provisions covering Domestic International Sales Corporations in accordance with the Deficit Reduction Act of 1984.



## CRAY, Cray, or cray

by David E. Frasch

What is it: a person, a name, a company, a product? The answer, of course, is all of the above. Seymour Cray gave his name to the company he founded in 1972, and that name has become a treasured asset. It can be used in a remarkable number of ways, including references to Cray Research and its products.

Increasingly, the word "Cray" is used in reference to the company or its products by the outside world in references such as "Mini-Crays," "Crayettes," and "units of Cray." These references are improper and could lead to Cray Research going the way of Kleenex, Jello, Aspirin, and Linoleum. That is, many brand names were once esteemed trademarks, but are now generic names.

The trademarks owned by Cray Research are valuable. They are symbols of quality that distinguish our products from those of our competitors. With the help of our trademark counsel, Attorney Paul Welter, a few guidelines have been developed that may help the company retain its good name and reputation.

- The word "Cray" is a trademark and also a trade name. Cray is a trade name when it refers to the company, e.g. Cray Research,

Inc. It should not be identified as CRAY Research. It is a trademark when it refers to a product line, e.g., CRAY computers.

- A registered trademark should be accompanied, at least on its first use in a document, with the registration symbol ®. Trademarks that are not yet registered should carry the designation ™.
- When referring to our products, we should be using all capital letters and a complete description of the system, e.g., CRAY X-MP, CRAY-2, CRAY-1/S.
- A trademark is an adjective and should not be used as a noun. Proper use of a trademark involves accompanying it with the generic or descriptive term that it modifies, e.g., a CRAY-2 computer.
- Trademarks must be spelled exactly as they are registered. Singular to plural or possessive cases require care. Proper reference would be "CRAY computers," or "a CRAY X-MP system by Cray Research." However, it would be improper to refer to "CRAY'S X-MP," or "the CRAY."

Cray Research has remarkable products. If each of us takes an interest, we can keep our name from being as disposable as Kleenex.

If you know of misuses of our name or trademarks, please pass along the examples to me in Chippewa Falls so they can be added to our collection of improper assaults against our good name.

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David Frasch serves as Technology Counsel for Cray Research. His office is located in the Development Building, and he can be reached at extension 1450.

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