

COMPUTING RESEARCH NEWS

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NSF Supercomputer Center sites are announced

By Louise Arnheim

Special to CRN

First there were five, now there are four, and soon there will be two. In late March, the National Science Foundation (NSF) announced it would discontinue funding two of its four supercomputer centers: the Cornell Theory Center and the Pittsburgh Supercomputing Center (PSC).

The two remaining centers—the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign (UIUC) and the San Diego Supercomputer Center at the University of California at San Diego—will continue receiving federal support through a new program, Partnerships for Advanced Computational Infrastructure. PACI is billed by NSF as the next phase of high-end computing.

Following a three-year process of program review and proposal submission, NCSA was awarded funding for its National Computational Science Alliance (the Alliance) partnership,

The fact that federal funding to at least one supercomputing center would be cut apparently has been anticipated for some time.

and the San Diego Supercomputer Center got the go-ahead for its National Partnership for Advanced Computational Infrastructure (NPACI).

The Alliance is led by Larry Smarr, current director of the supercomputer center at UIUC, and includes the following institutions as major (proposed) partners: the California Institute of Technology, the University of California at Berkeley, the University of California at Los Angeles, the University of Maryland, the University of Michigan and the University of Texas at Austin. Together these institutions will prototype a "National Technology Grid."

According to a press release, the

grid "will serve as an early model for a full-scale Advanced Computational Infrastructure, which will be built by the computer, communications and software vendors to support our nation's computational scientists and engineers in academia, industry and government."

The Alliance is organized around four sets of teams:

- The Application Technologies Teams, which will focus on the following six science and engineering areas: cosmology, chemical engineering, environmental hydrology, molecular biology, nanomaterials and scientific instrumentation. Funding for the basic scientific research will come from team members, an NCSA press release said.

- The Enabling Technologies Teams, which will study tools for parallel computing, heterogeneous computing, and data and collaborative computing.

- Regional Partners, which includes the Committee on Institu-

tional Cooperation, the Southeastern Universities Research Association and the Experimental Program to Stimulate Competitive Research.

- Education, Outreach and Training Teams that will help users "underserved by the commercial sector"—such as K-12 students, minority groups and government agencies—become more familiar with advanced computational technologies.

NPACI, which is headed up by Sidney Karin, the founding director of the San Diego Supercomputer Center, will focus on three areas: providing a metacomputing environment to "link high-performance, geographically separated computers of different architectures over very-high-speed networks," facilitating data-intensive computing and bringing "nontraditional" groups (minorities and women) into high-performance computing.

NPACI will concentrate outreach efforts in California and Texas, which, according to NSF, account for 20% of the country's elementary and secondary students.

Included among this "partnership of partnerships," as NPACI calls it, are: NSF, Energy Department and NASA Grand and National Challenge projects; NSF, Defense Advanced Research Projects Agency and NASA Digital Library projects; National Institutes of Health

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IT companies heavily courting CS grads

By Louise Arnheim

Special to CRN

As the 1996-97 academic year comes to a close, the job outlook for computer science graduates remains bright. According to the Bureau of Labor Statistics (BLS), computer science is among the top 10 occupations experiencing faster-than-average job growth, and it will continue to do so beyond the year 2000. Not only is the demand for such expertise high, but the natural churn of the job market (such as current workers moving into management or retiring) will result in "tens of thousands" of positions opening up each year.

But as they consider job offers from employers nationwide, computer science graduates may find themselves heavily courted by companies with a particular need: information technology. According to a new report by the Information Technology Association of America (ITAA), 190,000 IT jobs nationwide remain unfilled, and demand is increasing.

At the request of its 11,000 direct member and affiliate member companies, ITAA conducted a survey of 2,000 large and midsize IT and

non-IT companies. The survey's findings, listings of other recent reports and anecdotal evidence of the IT shortage are included in the 51-page report, *Help Wanted: The IT Workforce Gap at the Dawn of a Century*. Concerned that US competitiveness in IT is at stake, ITAA focused the report on training, recruitment and education of current and future IT workers at both IT and non-IT companies.

ITAA defines IT as "the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware."

According to ITAA, the 190,000 (weighted) estimate is on the low side because its survey did not include federal, state or local governments; nonprofits; and smaller companies. To make up for the existing shortfall, companies are spending ample sums to recruit new employees, often luring them away from rival firms. For example, IT companies that had more than 100 vacancies expended more than \$750,000 annually in recruiting more employees, ITAA says.

Such recruitment efforts essentially capitalize upon the training and

investment made by rival companies. "Hiring away individuals by other firms does nothing to expand the pool of potential workers but merely shifts such individuals around in the marketplace," the report said.

Additionally, training and recruitment will not be sufficient to meet future needs, ITAA says. More than 80% of IT companies surveyed for the report anticipated their need to hire new employees would increase. "Education will be a key facet of any solution to this problem," the report said.

Undergrad interest waning

However, as demand for computer science and related degrees is rising, fewer students are electing to pursue such degrees. ITAA points out that between 1986 and 1994, the number of undergraduate degrees in computer science dropped 43%—from 42,195 to 24,200. Further, ITAA reports that interest among the next generation of college students may be waning. As evidence, ITAA refers to a study of 4 million high school sophomores. Of the 750,000 who considered pursuing science or engineering degrees, only 200,000 eventually graduated with a bachelor's

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Expanding the Pipeline

A decade in the university pipeline

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By Tracy Camp

The number of women entering the computer science pipeline and earning B.A./B.S. degrees is decreasing, which is of extreme concern because fewer women entering the pipeline means that, over time, fewer women will go on to earn their Ph.D.s in computer science.

The 1996 CRA Taulbee Survey, which was published in the March CRN, included results on the gender of bachelor's and master's recipients for the Ph.D.-granting departments that responded to the survey (Table 4 in the survey). According to this table, only 16% of the recipients awarded bachelor's degrees during the 1995-96 academic year were women.

Although 16% is extremely low, it is not substantially different from previous surveys; in the results of the 1994 and 1995 surveys, the percentage of women awarded bachelor's degrees was 18%. Thus, 16% does not sound so bad.

Or does it?

Instead of only considering the gender of degrees awarded at departments responding to the survey, I will focus on how well women are doing across all departments awarding B.A./B.S., M.S. and Ph.D. degrees in computer science. In the three tables accompanying this article, the information on numbers

Table 1. Percentage of Degrees Awarded in a CIS Field

Field of Study	% B.A./B.S.	% M.S.	% Ph.D.
General	76	81	94
Computer Programming	2	1	0
Data Processing	2	1	0
Info. Science & Systems	15	13	3
Systems Analysis	1	1	1
Other	4	3	2

of degrees awarded in computer science during the decade 1984-94 is from the Education Department's National Center for Education Statistics. (The number of degrees awarded during the 1994-95 academic year is not yet available.) The center classifies computer science departments within the computer and information sciences (CIS) category.

Table 1 shows the percentage of students within different fields of study in CIS for B.A./B.S., M.S. and Ph.D. degrees awarded. As illustrated, the bulk of the degrees awarded are in the general computer science category, with information science and systems a distant second.

Ph.D. level looks good

At the Ph.D. level, there is good news. Table 2 lists the number of Ph.D., M.S. and B.A./B.S. degrees awarded in CIS during 1984-94 and the percentage of female recipients.

The number of Ph.D. degrees awarded in CIS continues to increase. In the most recent academic year available (1993-94), the per-

centage of Ph.D. degrees awarded in CIS to women was at its highest level since 1988-89 (the year when the percentage was at its highest level). Also, the percentage of Ph.D.

degrees awarded in CIS to women in 1993-94 is 50% higher than it was a decade ago (15.4% versus 10%).

At the M.S. level, the news is mixed. The good news is that the number of M.S. degrees awarded in CIS continues to increase. The bad news is that the percentage of M.S. degrees awarded in CIS to women has steadily decreased since 1990. Furthermore, 1993-94 had the lowest percentage of women awarded M.S. degrees during the 1984-94 period.

At the B.A./B.S. level, there is only bad news. Table 2 shows that the number of B.A./B.S. degrees awarded in CIS continues to decrease, and this decrease is occurring at a faster pace for women.

This decrease is especially upsetting when one considers the total population receiving B.A./B.S. degrees. Table 3 lists the total number of B.A./B.S. degrees awarded in all fields during 1984-94 and the percentage of the recipients that were women. As illustrated, the number of B.A./B.S. degrees awarded in all fields continues to increase, and the

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Women affected by lack of visibility

By Carolyn Leighton

In a 1996 study conducted by the Freedom Forum Media Studies Center, it was found that women were quoted or referenced in only about 14% of business-related stories.

Here are some noteworthy findings from the Women, Business and the Media Conference, co-sponsored by Catalyst and the International Women's Media Foundation:

Even as women "become a critical mass inside newspapers and networks," the number of female sources are not increasing, said Linda Wertheimer of National Public Radio.

The problem, according to Catalyst president Sheila Wellington, is "three-pronged: Women don't come forward; companies don't put them forward; and the press use women primarily for 'women's stories' such as those on work-family balance issues—rather than for business stories."

Not only are the views of half the population omitted, but credibility and advancement in the professional world can be negatively

affected by lack of visibility and name recognition.

I believe companies are poised as never before to actively recruit and open up positions of influence previously closed to women. We have heard many Silicon Valley leaders openly state they appreciate the benefits of hiring women into key positions and are looking for more effective ways to implement that process.

It was this issue that moved Women in Technology International (WITI) in 1994 to establish an annual conference and the impetus behind the establishment of June as Women in Science & Technology Month, the WITI Hall of Fame and the association's first annual CEO Recognition Award ceremony at its 1997 conference.

WITI works to highlight noteworthy talents and insights of women (some of whom remain relatively unknown outside of their workplace) and to identify sound strategies that have been used successfully by men and women working in and with technology organizations.

Are you open to a new workplace paradigm? Then think about these questions:

To management:

- Because only 2% of women occupy vice president and above positions in technology organizations (even though a significantly higher percentage are qualified), does it make sense to require a vice president or higher title when you want to add a woman (or minority) to your board?

- In looking for the best-qualified and the most capable, and considering women have often accepted lesser titles, does it make sense to continue requiring certain titles as criteria for positions you want to fill?

(For example, I have a friend who cannot get past the title of "admin," but she has effectively run her bosses' projects for years. Every time she interviews for a project manager position, they take one look at her title, and the process stops there.)

- Have you taken time to understand why effective women may be leaving your organization to start their own projects?

- Are you taking time to provide the women in your organization the support they need and require as a minority in a male-

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LETTERS TO THE EDITOR

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Letters may be edited for space and clarity.

Expanding the Pipeline

Table 2. Degrees Awarded in CIS

	Ph.D. Degrees Awarded	% Women	M.S. Degrees Awarded	% Women	B.A./B.S. Degrees Awarded	% Women
1984-85	240	10.0	6,942	28.9	38,589	36.8
1986-87	374	13.9	8,481	29.4	39,590	34.7
1988-89	551	15.4	9,414	28.0	30,454	30.8
1989-90	627	14.8	9,677	28.1	27,257	29.9
1990-91	676	13.6	9,324	29.6	25,083	29.3
1991-92	776	13.8	9,534	27.8	24,578	28.7
1992-93	808	14.7	10,171	27.1	24,241	28.1
1993-94	810	15.4	10,416	25.8	24,200	28.4

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increase is at a faster pace for women than for men. Thus, even though more women are earning B.A./B.S. degrees, the percentage of B.A./B.S. degrees awarded to women in CIS continues to decrease. This is extremely bad news.

Pipeline shrinkage

The pipeline shrinkage problem for women in computer science is a known phenomenon and is illustrated in Table 2. For example, although 28.4% of the B.A./B.S. degrees awarded in CIS during the 1993-94 academic year went to women, only 25.8% and 15.4% of the M.S. and Ph.D. degrees awarded in CIS, respectively, went to women.

One way to increase the percentage of women at the high end of the university pipeline is to get more women to enter the low end of the

Table 3. B.A./B.S. Degrees Awarded in all Fields

	B.A./B.S. Degrees Awarded (in thousands)	% Women
1984-85	968.3	50.8
1986-87	991.3	51.5
1988-89	1,016.3	52.6
1989-90	1,048.6	53.2
1990-91	1,081.3	54.1
1991-92	1,136.6	54.2
1992-93	1,165.2	54.3
1993-94	1,169.3	54.5

pipe. Hence, it is critical that the decrease in the number of B.A./B.S. degrees awarded in CIS seen during the 1984-94 decade be reversed. There is positive evidence that this will occur.

The 1996 CRA Taulbee Survey indicates that the number of B.A./B.S. degrees awarded in CIS should increase; the number of new bachelor's students enrolled in computer science Ph.D.-granting departments in-

creased 40% this year. (The increase is actually greater than 40% because more departments completed the 1995 survey). Furthermore, this 40% increase follows a 5% increase in 1995.

The number of B.A./B.S. degrees awarded in CIS at Ph.D.-granting departments should dramatically increase in the near future. In addition, one would expect to see a corresponding increase in the number of B.A./B.S. degrees awarded in CIS at non-Ph.D.-granting departments.

One question, however, remains. How will the future increase in the number of B.A./B.S. degrees awarded in CIS affect the percentage of women recipients? During 1984-94, the decrease in the number of B.A./B.S. degrees awarded was at a faster pace for women than for men.

Will the increase in the number of B.A./B.S. degrees awarded in CIS occur at a faster pace for women? Or will women continue to lag? The Taulbee Survey does not classify the new 40%-plus bachelor's students in CIS by gender so one can only

speculate on what the outcome will be.

Crediting the Web

The CRA Taulbee Survey proposes that the Web contributed to the increase in the number of new bachelor's students in CIS, and I agree. The Web has brought more attention to our field than anything in the past.

Furthermore, I believe that women like the Web as much as men do. The Web is a type of computer tool that is used for a purpose or goal, which many women like, and some studies have indicated that many Web surfers are women.

Thus, I expect that the increase in the number of B.A./B.S. degrees awarded in CIS will be at a faster pace for women than for men. To ensure that this expectation does materialize, the number of B.A./B.S. degrees awarded to women should be closely monitored.

If the percentage of women earning B.A./B.S. degrees in CIS continues to decrease, loud alarms should be sounded. A further decrease in the percentage of women earning B.A./B.S. degrees in CIS would be detrimental to the rest of the pipeline and to the community at large.

Camp is a member of the ACM Committee on Women and is an assistant professor in the Computer Science Department at the University of Alabama. Her principal research interests are mobile computing and networking. Contact her at e-mail: camp@cs.ua.edu.

Transitions

Stephen Y. Itoga became chair of the Department of Information and Computer Sciences at the University of Hawaii in July 1995; the department will offer a Ph.D. in computer science starting in fall 1997.

Randy H. Katz was the first chair of the Department of Electrical Engineering and Computer Science from the computer science side at the University of California at Berkeley.

David S. Warren was appointed chair of the Department of Computer Science at the State University of New York at Stony Brook.

Have you changed jobs, been promoted or appointed to a key committee or task force? For example, we are interested in listing the new chairs of CS, CE or related departments or colleges; new heads of research laboratories; or key changes in granting agency personnel. Send announcements to crn@cra.org.

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dominated environment?

To women at all levels:

- Have you made the commitment to develop your skills and perform your job to the highest standard possible?
- Do you provide the kind of support to your colleagues that you want from others?
- What are you doing to increase your visibility?
- Are you promoting yourself enough to ensure you are known and considered when the opportunities occur?
- Are you holding back your creative, unique contribution in your job because you fear looking different or being stereotyped?
- Are you taking full advantage of professional networks?
- Are you too focused on what you want rather than on what your organization needs?

• Have you explored to the fullest extent possible what you might be doing to sabotage your own success?

- Have you been open to feedback that may not be positive but may be useful?
- Are you using your energy being angry rather than working to solve the problem?

For more information about WITI, its mission or its 1997 conference June 4-6 in Santa Clara, CA, contact the organization at tel. 800-334-9484; e-mail: info@witi.com; URL: <http://www.witi.com>.

Leighton, the founding executive director of WITI, has founded three start-up companies and was one of McGraw-Hill's top 100 women in computing in 1996. She made a personal career decision to leave her last position as president of Criterion Research to dedicate herself full time to the advancement of women in science and technology.

Conferences & Workshops

Upcoming CRA workshops

In response to requests of attendees at the 1996 CRA Conference at Snowbird, the Computing Research Association (CRA) is sponsoring two workshops: one on academic careers and another on effective teaching.

The workshops will be held June 4-6 in Denver at the Oxford Hotel and will immediately follow the International Symposium on Computer Architecture (ISCA '97). We encourage you to register early because space in the workshops is limited, and hotel rooms are in short supply during the workshops.

Junior faculty and senior graduate students should be encouraged to attend, as the CS&E community believes such workshops can help lead junior faculty to successful careers.

For more information or to access a registration form, go to CRA's Web page at <http://www.cra.org> and click on What's News, send an e-mail message to info@cra.org or call 202-234-2111.

CRA ACADEMIC CAREERS WORKSHOP

The CRA Academic Careers Workshop is oriented to both men and women, unlike previous CRA career workshops, which were oriented toward women's issues. The target audience is faculty in the beginning years of their careers and senior graduate students contemplating an academic career. The workshop will begin June 4 at 2 P.M. and conclude June 5 at noon.

"I'm very excited about the speakers at the Academic Careers Workshop. By holding the workshop right after the International Symposium on Computer Architecture, we've been able to get department chairs and college deans to volunteer to give the kind of career advice we all wish we'd had at the beginning of our careers," workshop organizer David Patterson said.

Workshop sessions include:

- The tenure process.
- Selecting and managing a research project.
- Getting funding.
- Networking with other researchers.
- Time-management/family issues.

Workshop presenters include:

- Janice Cuny (CRA-W co-chair, University of Oregon).
- Susan Eggers (NSF Presidential Young Investigator, University of Washington).
- John Hennessy (Dean of the College of Engineering, Stanford University).
- Mary Jane Irwin (Vice chair of CRA and ACM, Pennsylvania State University).
- David Patterson (CRA Board chair and past Computer Science Department chair, University of California at Berkeley).
- Bobby Schnabel (Associate dean of academic affairs for engineering, University of Colorado at Boulder).

CRA EFFECTIVE TEACHING IN CS&E WORKSHOP

The purpose of CRA's Effective Teaching in Computer Science and Engineering Workshop is to help new faculty members teach more effectively. This highly interactive workshop includes theoretical material on learning styles and instructional objectives, and practical tips on effective lecturing, creative problem-solving and collaborative learning. Attendees will actively participate individually, in pairs and in small groups.

The workshop will begin June 5 at 2 P.M. and end June 6 at noon.

This workshop is intended for new faculty members teaching college and university courses in computer science and engineering. If space is available, more experienced faculty are welcome to attend.

The workshop leader is Michael R. Williams, a professor of computer science at the University of Calgary. For more information on the workshop leader, see <http://www.cra.org/Activities/conferences/effective.htm>.

REGISTRATION FEES & ACCOMMODATIONS

The registration fee include all workshop meals. Cancellation requests received by CRA on or before May 13 will result in a full refund of the registration fee. No refunds will be made after this date. You may send a substitute in your place.

CRA Academic Careers Workshop (only) — June 4-5

CRA members	\$150
Nonmembers	\$175
Students	\$115

CRA Effective Teaching Workshop (only) — June 5-6

CRA members	\$125
Nonmembers	\$150
Students	\$90

Both Workshops

CRA members	\$250
Nonmembers	\$300
Students	\$170

Accommodations

The workshops will be held at the Oxford Hotel; tel. 303-638-5400. CRA has reserved a limited number of hotel rooms for attendees. The group rate is \$125 (plus 11.8% tax) per night. If you require a room, please that indicate on your registration form and return it no later than May 14; include the first night's deposit (equal to the room rate) with your registration.

Grace Hopper Celebration

The second annual Grace Hopper Celebration of Women in Computing conference will be held Sept. 19-21, 1997, at the Fairmont Hotel in San Jose, CA. Professionals and academics in computer science and computer-related fields and students pursuing graduate study are encouraged to attend. The Computing Research Association sponsors the conference.

The Grace Hopper Celebration is a world-class technical conference presenting the significant contributions of women to the computing field. Inspired by the legacy of Adm. Grace Murray Hopper, a pioneer in the field of computing and an inspiration to women and scientists everywhere, the conference encourages women by making visible the possibilities, success stories and rewards available to women in computing. At the first Grace Hopper Celebration, held in Washington, DC, in 1994, more than 450 women computer scientists and students exchanged ideas and updated their knowledge, fostering collaboration among individuals working in various fields of computing.

Enabling communication

To promote this type of fellowship, the conference features technical talks by many of the most successful women in the computing field as well as panels, technical topic sessions, workshops and birds-of-a-feather sessions. The speakers are leaders in their fields and represent the major technical computing disciplines and the academic, government and industrial communities. A partial list of speakers for the 1997 conference includes Sandra Baylor of IBM Corp., Anita Borg of Digital Equipment Corp., Marina Chen of Boston University, Joan Feigenbaum of AT&T, Jeanne Ferrante of the University of California at San Diego, Deborah Joseph of the University of Wisconsin, Judith Klavans of Columbia University, Amy Pearl of Sun Microsystems Inc. and Pamela McCorduck, author of *The Futures of Women*.

The goal of technical topic sessions is to highlight a broader range of work by women engineers and researchers within the computing fields. The topic sessions will run in parallel, providing an opportunity for

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Awards & Honors

NAE elects 85 new members

The National Academy of Engineering recently elected 85 new members and eight foreign associates. This brings the total US membership to 1,893 and the number of foreign associates to 153. NAE membership is among the highest professional distinctions accorded to engineers, and membership is given to those who have demonstrated "unusual accomplishment in the pioneering of new and developing fields of technology," according to NAE. Newly elected engineers in computer science and related fields are:

Ruzena Bajcsy: Professor and director, General Robotics Active Sensory Perception Laboratory, Department of Computer and Information Science, University of Pennsylvania. For development of "active perception" methods and for leadership in the community.

Donald D. Chamberlin: Research staff member, Computer Science Department, IBM Almaden Research Center. For contributions to the SQL database query language.

Henry Fuchs: Federico Gil Professor, Department of Computer Science, University of North Carolina at Chapel Hill. For contributions to computer graphics hardware and algorithms.

Steven P. Jobs: Chief executive officer, NeXT Software Inc. For contributions to the creation and development of the PC industry.

Alan Kay: Apple Fellow, Advanced Technology Group, Apple Computer Inc. For inventing the concept of portable personal computing.

Robert M. Metcalfe: Vice president for technology, International Data Group. For the development of the Ethernet.

Alan F. Shugart: Co-founder, president and CEO, Seagate Technology. For contributions to disc memory devices and interfaces for PCs.

Charles Simonyi: Chief architect, Microsoft Corp. For developing widely used desktop productivity software.

Robert F. Sproull: Vice president and Sun Fellow, Sun Microsystems Inc. For work in computer graphics and digital printing.

Michael R. Stonebraker: Professor, Department of Electrical Engineering and Computer Science, University of California at Berkeley. For development and commercialization of relational and object-relational database systems.

Margaret H. Wright: Distinguished member of the technical staff, Bell Laboratories, Lucent Technologies. For development of numerical optimization algorithms and for leadership in the applied mathematics community.

Takeo Kanade (Foreign Associate): Whitaker Professor of Computer Science and Robotics and director, Robotics Institute, Carnegie Mellon University. For contributions to computer vision and robotics.

Cook wins Canadian award

Stephen A. Cook of the Department of Computer Science at the University of Toronto was awarded the Canadian Council's Walton Killam Memorial Prize for Engineering/Computer Science. The \$50,000 (Canadian) Killam Prizes are Canada's most distinguished annual awards given in recognition of outstanding achievements by Canadians in any of the disciplines in the natural sciences, health science and engineering.

Cook originated the field of NP-completeness and helped establish strong links between mathematical logic and complexity of computations. His 1971 paper "The Complexity of Theorem Proving Procedures" is universally regarded as the most important paper in theoretical computer science, an announcement from the Canadian Council said.

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attendees to hear talks specifically related to their own fields. For the first time, technical topic sessions at this year's conference will feature shorter talks by students and young professionals just starting their careers.

Workshops, panels, seminars and birds-of-a-feather discussion groups will be included on the agenda both days of the conference and present an unparalleled opportunity for students and professionals in the field to meet and exchange their views and experiences. Workshops at the 1997 conference will impart information valuable to attendees just beginning their careers and to those who have already established themselves within the field. Topics to be covered range from a session exploring the need for and art of self-promotion to "Women in the History of Computer Science," a retrospective of the contributions of women to the development of modern

computing.

Birds-of-a-feather sessions will convene for women of color, Asian women, Hispanic women, African-American women, lesbian/bisexuals, female graduate students, female junior faculty members and young professional women, providing an opportunity for members of these groups to share their special experiences and discuss the different challenges and obstacles encountered by women in these categories. The birds-of-a-feather sessions, a popular component of the Grace Hopper Celebration program, provide a natural forum for networking and mentoring.

Supporting the conference

Thanks to many supporters from government, industry and the professional associations, the 1994 conference enabled more than 450 women to come together and share

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Amir Pnueli, a professor of computer science at the Weizmann Institute of Science in Israel, received the Association for Computing Machinery's 1996 A.M. Turing Award in March.

Pnueli was honored "for seminal work introducing temporal logic into computing science and for outstanding contributions to program and system verification," an ACM announcement said.

His landmark 1977 paper "The Temporal Logic of Programs" resulted in a major breakthrough in the verification and certification of concurrent and reactive systems.

The ACM A.M. Turing Award is given annually for technical achievements in the field of computing deemed by a jury of leading professionals to be of lasting and significant importance to the computing community. It is accompanied by a prize of \$25,000, contributed by Lucent Technologies Inc.

Also, Peter J. Denning, associate dean for computing and chair of the Department of Computer Science at George Mason University, received the 1996 Karl V. Karlstrom Outstanding Educator Award. Denning was honored for his long-standing efforts to shape the computing field and convey its nature to computer scientists and the broader scientific community.

This annual award recognizes an outstanding educator for advancements in teaching methods and for effecting new CS&E curriculum development. It carries a prize of \$5,000, which is supplied by the Prentice-Hall Publishing Co.

Other 1996 ACM award winners include:

Distinguished Service Award. Awarded on the basis of value and degree of service to the computing community.

Winner: Hal Berghel, University of Arkansas.

Outstanding Contribution to ACM Award. The award is given to individuals selected on the value and degree of service to ACM.

Winner: Robert M. Aiken, Temple University.

Grace Murray Hopper Award. Awarded to the outstanding young computer professional of the year.

Winner: Shafira Goldwasser, Massachusetts Institute of Technology.

Paris Kanellakis Theory and Practice Award. This new award honors specific theoretical accomplishments that had a significant and demonstrable effect on the practice of computing.

Winners: Leonard Adleman, University of Southern California; Whitfield Diffie, Sun Microsystems Inc.; Martin Hellman, Stanford University; Ralph Merkle, Xerox Corp.; Ronald Rivest, Massachusetts Institute of Technology; and Adi Shamir, Weizmann Institute of Science (the six founders of public-key cryptography).

Doctoral Dissertation Award. Presented annually to the author(s) of the best doctoral dissertation(s) in computer science and engineering. The award includes \$1,000 and publication of the dissertation(s) by Springer-Verlag.

Winners: Xiaoyuan Tu, University of Toronto, and Carl Waldspurger, Massachusetts Institute of Technology.

1997 ACM Fellows named

The Association for Computing Machinery recognized 41 of its members for their achievements in computer science and information technology and their contributions to further ACM's mission. These new inductees join the 240 current Fellows, bringing the total to 281 ACM Fellows from around the world.

The 1997 ACM Fellows are:

Ian Akyildiz, Georgia Tech
Jean-Loup Baer, Univ. of Washington
Victor Basili, University of Maryland
Roger R. Bate, Software Engineering Inst.
Barry Boehm, Univ. of Southern California
Imrich Chlamtac, Boston University
Daniel Couger, University of Colorado
W. Bruce Croft, Univ. of Massachusetts
Gordon B. Davis, Univ. of Minnesota
David Dobkin, Princeton University
Herbert Freeman, Rutgers University
Hector Garcia-Molina, Stanford Univ.
Irene Greif, Lotus Development Corp.
Yuri Gurevich, University of Michigan
John Hennessy, Stanford University
Zvi Kedem, New York University
Richard Kemmerer, Univ. of California
Harold Lawson, Lawson AB (Sweden)
Der-Tsai Lee, Northwestern University
Richard Lipton, Princeton University
Nancy Lynch, MIT

Daniel Menascé, George Mason University
Raymond Miller, University of Maryland
Ronald Perrott, Queen's University (UK)
Nicholas Pippenger, Univ. of British Columbia
Vaughan Pratt, Stanford University
John Reif, Duke University
Ray Reiter, University of Toronto
Paul Schneck, Mitretek Systems Inc.
Robert Sedgewick, Princeton University
Kenneth Sevcik, University of Toronto
Micha Sharir, Tel Aviv University
Alan C. Shaw, University of Washington
Ben Shneiderman, Univ. of Maryland
Kenneth Steiglitz, Princeton University
Donald Towsley, Univ. of Massachusetts
Elaine Weyuker, AT&T Research
Peter Widmayer, ETH Zentrum
Robert Wilensky, University of California
Philip S. Yu, IBM T.J. Watson Research Ctr.
Paolo Zanella, European Bioinformatics Inst.

Washington Update

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Research Resources; Energy's Lawrence Berkeley, Lawrence Livermore, Los Alamos and Pacific Northwest national laboratories; and NASA's Jet Propulsion Laboratory. NPACI's partner sites include the California Institute of Technology, the University of Texas, the University of Michigan, the University of Maryland, the University of California, the University of Virginia and Stanford University.

PACI funding will be about \$65 million annually, which, according to NSF, is "similar to previous levels." Although PACI is designed for a 10-year run, the cooperative agreements for the two partnerships are for five years. An independent review of the program will take place during the fourth year of operation.

At a recent press conference announcing the PACI partnerships, Karin said the new program would enable scientists to "seamlessly acquire data from instruments from one place, massage it at another and analyze it at yet another." He said the new effort was a "much more integrated, much more broadly based-program."

Also at that press conference, Smarr suggested using the term "superinfrastructure" instead of "supercomputer" to talk about the future. "That's what the next 10 years are about," he said.

The Pittsburgh and Cornell supercomputing centers will be given a year's operating budget and two years to phase out operations. However, both the University of Pittsburgh (along with Carnegie Mellon University) and Cornell University have announced plans to keep their respective centers operating and to seek funding from alternative sources.

The actual mechanics of the transition and how it will affect current users, however, are unclear.

Current users of the Pittsburgh facility include researchers at the Center for Analysis and Prediction of Storms (based at the University of Oklahoma), scientists at the Los Alamos National Laboratory who use PSC for modeling of the Earth's magnetic field, pharmaceutical chemists at the University of California at San Francisco working on DNA simulation and an astrophysics group at the University of Arizona conducting modeling of supernovas.

The Cornell Theory Center serves 2,000 users. According to a center spokesperson, anywhere from half to two-thirds of those users will be affected by the transition.

What made the Alliance and NPACI proposals "winners?" According to Robert Borchers, NSF division director for Advanced Scientific Computing, "in essence, they 'got it.'" Both proposals, he said, encompassed a vision of distributed computing and partnering, and both "are highly complementary." They went "beyond the vision," he added.

"The quality of the proposals we received from NCSA and NPACI represent a breadth of vision beyond what we had even hoped for," said

Paul Young, senior adviser to NSF's Computer and Information Science and Engineering Directorate. "The proposals expanded the roles and impact of the leading-edge sites. The partnerships will maintain the country's lead in computational science. They will further the use of computers in all disciplines of research and offer new educational opportunities for people ranging from kindergartners through Ph.D.s."

Computing Research News learned that during the proposal process, NSF had suggested to PSC that it partner with UIUC. However, because the arrangement would have required the Pittsburgh facility to move its computers (as well as several staff members) to Illinois, PSC did not pursue that option. In addressing a reporter's question about closing the Pittsburgh supercomputer center in particular, Karin said the center "has been a valuable resource" and noted that the PSC had formed "a strong bond" with Cray Research Inc.

Similarly, Smarr noted that both Pittsburgh and Cornell had "provided real service to the country" over the past 12 years, but that the issue was "simple arithmetic." The fact that federal funding to at least one supercomputing center would be cut apparently has been anticipated for some time. Looking forward to the new program, Smarr said, "Supercomputers are not being de-emphasized, but re-emphasized."

Smarr also noted how the closing of the John von Neumann Supercomputing Center (at Princeton University) eight years ago occurred in a shorter time period than that allotted for PSC and the Cornell center.

The recent announcements are the culmination of an evaluation process that began three years ago. In fall 1994, the National Science Board, which oversees NSF, instructed the foundation to review the supercomputer centers. A few months later, a task force chaired by Ed Hayes of Ohio State University was convened to study these issues. The NSB used the *Report of the Task Force on the Future of the NSF Supercomputer Centers Program* to develop future plans.

During a pre-proposal round in spring 1996, 10 applicant bids were reviewed. These pre-proposals were reviewed and returned to bidders a month later. In September 1996, NSF received six PACI proposals (four from the existing supercomputer centers; two from other institutions).

A panel of experts narrowed the bids down to the four supercomputing centers, and site visits were set up for October. Then, beginning late last year, a panel met to make recommendations to NSF, which in turn made its recommendation to NSB. On March 28, the two winning partnerships were announced.

NSF's Supercomputer Program began in 1985; five centers were established at that time. Funding for the current program ends this fiscal year, with PACI program funding beginning in fiscal 1998.

Frist to chair subcommittee

Sen. John McCain (R-AZ), chair of the Committee on Commerce, Science and Transportation, announced that Bill Frist (R-TN), has been selected to chair the Subcommittee on Science, Technology and Space.

Frist, a first-term senator elected two years ago as part of the Republican takeover, was a nationally known heart transplant surgeon at the time of his election. His views on science policy are not well known. However, as a medical specialist who has published several papers in his field, he has substantial science education and familiarity with research, probably more than anyone else in the Senate.

Jay Rockefeller (D-WV), will return as ranking Democrat on the subcommittee.

It is still an open question what issues the subcommittee will choose to take up in the 105th Congress. The Gramm/Hutchison/Mack bill that would double research funding will undoubtedly be on the agenda (see <http://www.cra.org/policy> for the text of the bill). Kay Bailey Hutchison (R-TX) is a member of the subcommittee.

Another possible issue would be NSF authorization. The Commerce Committee shares jurisdiction over NSF with the Labor and Human Resources Committee, chaired by Jim Jeffords (R-VT). NSF has gone without a reauthorization for several years. The House has occasionally passed bills, but the Senate has been uninterested.

Although an authorization bill is not technically necessary from year to year unless Congress wants to change the agency's course, consideration of a bill offers an opportunity for the subcommittee to publicly examine NSF's activities and priorities. The subcommittee also has jurisdiction over NASA and can be expected to examine the ongoing evolution of the space agency's mission.

NGI initiative workshop in May

Since last October 10, when President Clinton announced in general terms a new Next-Generation Internet (NGI) Initiative, government science agencies have been struggling to fill in the details of the new interagency initiative. Whatever details of its final shape, the program will clearly have a large research component.

To help the planning process, the Computing Research Association will be co-hosting a workshop on the research agenda on May 13-14. The Computer Systems Policy Project and the Cross Industry Working Team will co-host the event.

The workshop, to be held in the Washington, DC, area, will bring together nearly 100 researchers from academia and industry to examine fundamental research questions that need to be addressed to meet the NGI program goals. Attendees will examine such topics as network management, quality of service, middleware, security and NGI applications, and will try to identify the most critical research needs.

CRA will publish a report of the meeting and also produce a videotape report on the event.

Federal funding opportunities

FEDIX Opportunity Alert!!! (FOA) is a free e-mail service funded by the federal government that automatically delivers targeted research and education funding opportunities, including computer engineering opportunities, to researchers, educators and students. In its first year of operation the service has logged more than 30,000 subscribers, who have so far received over 2 million opportunity alerts.

Users can subscribe to FOA by going to <http://www.rams-fie.com/oppalert.htm>, registering and selecting the keywords representing their research interests.

Beginning with the next business day, the system will search all new or updated announcements in the "FEDIX" database of federal opportunities, including the *Commerce Business Daily* and the *NIH Guide*, looking for matches to the keywords. FOA will then automatically e-mail the URL and a short introduction of each announcement that matches the user's research interest profile.

FEDIX is an Internet-based service that provides comprehensive information about federal opportunities to the research and higher-education communities nationwide. With 11 sponsoring federal agencies, 8,000 data files and about 70,000 unique Web sites using it each month, FEDIX has become an important electronic means of bridging the information gap between government and academia with regard to research and education programs.

Researchers and educators can search FEDIX themselves or subscribe to FOA and have targeted opportunities sent to them automatically via FEDIX Opportunity Alert!!!

FEDIX was developed under an Energy Department grant and is sponsored by its participating agencies. The service is free to users. Participating agencies include the departments of Energy, Transportation, Agriculture and Veterans Affairs; NASA; the Air Force Office of Scientific Research; the National Institutes of Health; the Office of Naval Research; the Agency for International Development; the DISA Center for Software; and the Interagency Learning Technology Office.

Human Resources

Labor force from Page 1

degree in either area.

Many colleges and universities encourage high school student interest in computer science and engineering. For example, George Washington University hosts two events for this area: the Junior Engineering Technical Society Tests of Engineering Aptitude, Mathematics and Science; and the National Engineering Design Challenge.

To learn more about current student enrollment and interest, *Computing Research News* spoke with deans at two Washington, DC-area universities. At the University of Maryland at College Park, the number of students pursuing bachelor's degrees in computer science has more than tripled over the past seven years. In 1990, there were 412 declared computer science majors. Today there are 1,400.

"We, at UMCP, are set on increasing by 50% over the next four years the number of graduates in IT-intensive areas," said Richard Herman, dean of the College of Computer, Mathematical and Physical Sciences. "This will affect computer science, electrical engineering and information management systems graduates in the College of Business."

But encouraging more students to enter computer science and related fields is only one part of the problem, ITAA says; there also is a need to ensure that students are learning the right skills. ITAA member companies report a need to develop extensive training programs that essentially compensate for what they believe is not being taught in school.

"The evidence is clear that the problem is both real and serious, leading to at least one overarching conclusion: American schools and universities are not producing a sufficient number of students skilled in information technology to meet the needs of US companies," the report said. "This sets a challenge for those who believe technology and growth can increase prosperity."

Industry expectations

Is higher education out of sync with what the real world wants? That particular characterization, said Herman, "is a bit strong, but not far off the mark."

Herman illustrated by telling the story of a local employer who is very impressed with Maryland graduates and hires them "by the carload." To ensure the best preparation possible for future graduates, Herman asked the employer what additional skills or experience might be needed. The employer referred to an ability to work on a piece of a long-term project and integrate it with other pieces.

Consequently, Herman said, Maryland is developing a Corporate Scholars Program that will provide

students with internships "more fully woven into the academic experience."

New courses based on private-sector needs are now being developed, and outside expertise is being brought in to work on prototypical problems. But, Herman pointed out, there must be a "liaison from the other side, and the private sector has shown in 'word and deed' considerable enthusiasm for a closer partnership along these lines."

Involving corporations

In a similar manner, Thomas Mazzuchi, interim dean at George Washington University's School of Engineering and Applied Science, encourages the private sector to become more involved in higher education—to help shape curriculum and provide internship opportunities.

Corporations have been "generous" in donating funds, Mazzuchi said, but direct involvement is needed. (In the ITAA survey, 28% of IT company respondents donated money to higher education; 40% of those making donations designated the funds be spent to improve IT curriculum.) "If companies can suggest curriculum structure to meet their needs," he said, "I don't know of any university that would ignore such suggestions." GWU's School of Engineering works with an advisory panel of local industry representatives who provide such guidance.

Undergraduate students at George Washington can participate in a co-op program that enables them to gain real world experience. At the master's level, graduates can opt to take project-oriented courses and work with area companies in lieu of writing a thesis.

"The breakdown in communication between industry and education should be a concern for everyone," Mazzuchi said. When companies have to invest money training workers because of this breakdown, it results in lost productivity to the nation as a whole.

How is future demand likely to shape up? To meet the growing demand for IT skills and expertise, must every declared computer science major seek a Ph.D.? Herman said the importance of master's level graduates is now being recognized. There is also a greater need for bachelor's degrees, he said.

There is "an immediate need for basic infrastructure people (i.e., those who set up and monitor networks)," Mazzuchi said. As those needs are being filled, R&D will continue to grow, and Ph.D.s will continue to be in demand, he said. Mazzuchi plans to use the ITAA report as a recruitment tool for faculty and students.

Electronic copies of the ITAA report are available by sending an e-mail message to acallahan@itaa.org; specify "IT Workforce Study" in the subject field. Or call Shannon Bickford at 703-284-5342.

Commerce requests paper on human resource needs

The Commerce Department recently invited the Computing Research Association to submit a brief policy paper on human resource needs in the area of software production. The context of the request was the continuing discussion over the role of foreign nationals in the US labor market. As we pointed out in our response, computer science and computer engineering departments produce only a fraction of the total work force that goes into software production.

The complete policy paper is available at CRA's Web site (see <http://www.cra.org>; click on Government Affairs). The following is a brief summary of the response.

Background observations

1. The demand for software professionals is growing rapidly. Although the magnitude of supply and demand is hard to quantify even over the short term and very difficult to project into future years with any precision, the entire information sector continues to grow rapidly. The demand for software professionals far outstrips the supply. In particular, there is no reason to believe that foreign nationals are taking industry jobs, academic jobs or educational program slots from qualified Americans. Quite the contrary: Foreign national software experts are contributing to our nation's storehouse of knowledge and to our software production capability.

2. The nature of software jobs and the skills required to hold them are widely varied and changing rapidly. A software production team may include artists, content specialists, specialized programming and database experts, marketing and sales people and customer service representatives. Technological change also creates a rapid change of labor requirements.

Computing departments must produce graduates who can find rewarding jobs that fill the needs of the current market but who are also broadly educated and flexible.

3. Educational institutions need to sustain a stable, long-term response to growth in demand for their graduates. Throughout their brief history as an academic discipline, computing departments have experienced periods of surging enrollments followed by droughts. According to the 1996 CRA Taulbee Survey, undergraduate enrollments are up sharply. CRA's members are trying to strike a balance, sustaining a reasonable growth in the production of graduates at all levels while avoiding the painful consequences of overproduction.

4. The computer science and engineering departments that are members of CRA only produce a small—albeit a critically important—portion of the workers loosely labeled as "information" or "software" professionals. They are deeply trained in such specialties as computer architecture, data communications, systems, data structures, information security, object-oriented programming, artificial intelligence and virtual representations. The complex, advanced applications of today could not be built without the talent and knowledge they possess.

5. Foreign nationals constitute an important and welcome part of the student population and of academic faculty and industrial research staff. In response to the original Commerce query regarding foreign-national employment patterns in computing research, we posed some questions to the CRA Board of Directors.

The results are at best anecdotal. However, our university respondents suggested that nearly 40% of the new hires last year were foreign nationals. Our numbers also suggest a similar proportion of foreign-national researchers work in US industrial labs. Several of those who responded said they expected the proportion of foreign nationals in academia and industry to increase over the next several years.

Another problem is the enormous administrative burden of qualifying a foreign national to be hired. In the words of one respondent, "The [high] success rate of attempts to hire these people through the federal approval process is not a valid measure of how tough it is to hire foreign nationals. [Newspapers sometimes cite the high success rate as an indication that the process is too easy.] In fact, the legal and financial barriers are so high that only rock-solid cases are brought to this level."

To repeat our point above, foreign nation software experts make an important contribution to the national's technical strength, and there is no evidence that American experts are displaced.

Policy recommendations

Our specific recommendations are as follows:

- Do no harm when undertaking immigration reform and, if and when possible, remove unnecessary burdens.
- Invest in research that improves the effectiveness, quality and ease of production of software.
- Federal policy needs to encourage steady and consistent growth.
- Federal programs that reach out to encourage women and under-represented minorities to enter the computing fields are a sensible and desirable response to the growth needs of the field.

It is in the self-interest of the field and of the nation that we try to address this issue. CRA has been quite active in its work. But there is also a major role for the science agencies to play.

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Research News

DARPA's IPTO had formidable reputation

By Arthur L. Norberg

One of the prime agencies for computer R&D funding in the post-1950 period was the Defense Advanced Research Projects Agency. DARPA, through its Information Processing Techniques Office (IPTO), which operated from 1962 to 1986, selected a series of specific programs in computing to solve bottlenecks in command and control systems.

IPTO's emphasis on ambitious technical objectives and its years of nurturing the institutional framework for R&D in information processing resulted in some remarkable technical achievements. As a result, the office gained a formidable reputation among its associates and many outside observers. A recent history of IPTO describes and evaluates the management practices used in IPTO that gave rise to these achievements and uses this study of management to examine the programs and accomplishments of IPTO. The history, *Transforming Computer Technology: Information Processing for the Pentagon*, ends with an evaluation of the influence of IPTO programs for the computing enterprise.

As one of its prime practices, IPTO promoted an array of high-risk R&D projects to expand the frontiers of computer science and engineering (CS&E) for both civilian and Defense Department needs. High-risk projects often require long-term support. Because of its place in DOD, IPTO had significant budgets to expend and, thus, could sustain these projects. IPTO employed an amalgam of approaches used by other military agencies in the 1950s and some new ones designed for the special circumstances in DARPA.

Among these approaches were fast turnaround times for project approval and extensive personal initiative on the part of program personnel. Indeed, it was the program directors and managers who conceptualized, designed, organized, funded and monitored projects and who played a major role in the diffusion of results.

IPTO succeeded largely because it recruited capable and technically able members of the research community and allowed these people—within the context of DARPA's mission—an unusual amount of freedom to promote research as they saw fit, seek advice as they felt the need and manage the office as they thought the program required.

Focus on specifics

The IPTO programs were designed to focus on specific objectives, not to support general R&D in computing, but they still had a remarkable impact on computing. The academic and corporate researchers funded by IPTO sought a more flexible, capable and interactive computer. These machines set the stage for the transformation of computers from the large, alphanumeric-based machine of the 1960s to the colorful desktop

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computers of today.

Subsequent to the 1960s, four remarkably striking new features were added to computers:

- The interactive nature of computer use (online activities).
- The connectivity of computer systems and users (networking).
- The visual capabilities of input/output systems (graphics).
- The increased sophistication of systems (intelligent systems).

IPTO programs and contractors developed many of these new areas, including networking. Occasionally, as in the case of graphics, IPTO projects in the 1960s and 1970s laid the fundamentals for exploitation by industry in the 1980s. A few times, as in the case of time-sharing, IPTO-sponsored researchers joined in a development and stimulated rapid change. And research in artificial intelligence virtually owes its progress to IPTO support and leadership.

Emphasis on time-sharing

IPTO's first major venture in computing was to ensure greater use of time-sharing, increase its effectiveness in R&D and encourage other groups to adopt the idea. Time-sharing demonstrated the benefits of locally shared resources using identical computers. After advancing the state of the art in time-sharing and encouraging the use of the new time-sharing systems, IPTO turned to consideration of how to increase the sharing of resources among different computer systems. IPTO took technological leadership in the development of packet-switching technology and networks, especially the ARPAnet and, later, the Internet, today's driving engine of computer communications.

Officially, IPTO's networking project was the implementation of a specific tool to solve resource-sharing problems that the office encountered in administering and guiding its programs. IPTO's direct management involvement was the key that allowed the network to succeed. ARPAnet, a large-scale experiment, started to solve the problem of resource sharing between computers and among researchers. The goal was to connect computing systems and—through the systems—the researchers. Then research could be accumulated and duplication of effort avoided through the sharing of resources and improved communication. Through the use of packet switching to connect computers—and, later, computer networks—distributed computer resources could be economically shared, and access to the resources and the people using them could be

improved. ARPAnet was designed inside IPTO to achieve these ends.

Introducing the Internet

IPTO made even greater contributions with the design and implementation of the Internet. The Internet grew out of DOD's need to interconnect its various research networks. The solution to the problem was a new protocol and architecture, designed by Vinton Cerf and Robert Kahn in IPTO and published in 1974. The development of internet-work protocols and their acceptance and use within DOD and the university communities made flexible, worldwide interconnection of computer users commonplace.

The history of IPTO's involvement with computer graphics illustrates the growth of a vital professional community and the importance of support for the exchange of ideas for R&D. The fundamental concepts behind the remarkable computer graphic images we encounter every day emerged primarily from research projects funded by IPTO. These projects defined the problems regarding I/O devices, the visual characteristics of computer graphic images, and the theory and techniques needed to produce aesthetically pleasing and seductive computer images. Through the commercial exploitation of these developments, graphic systems became available to everyone with access to a computer.

IPTO-supported projects produced results that could be used in any computing system for many purposes, regardless of the nature of the organization. A list of the technical leaps produced by IPTO and the research community that it supported during its 25-year history goes beyond time-sharing, wide area networking and connections across networks. The list includes interactive graphics, distributed computing, very-large-scale integrated circuit design systems, natural language communication systems for use with computers, and expert systems. The R&D programs produced broadly relevant results that found their way into both military and civilian systems.

Many of the people associated with these IPTO projects eventually started other innovative projects, such as the Alto project at the Xerox Palo Alto Research Center; Alto was the grandfather of all subsequent microcomputers. The graphics on this machine, which developed from the results of earlier IPTO projects, found their way into Apple Computer Inc. computers and Atari's game

machines. In the 1980s, industry's exploitation of expert systems, local area networks, applications software packages, flexible and sophisticated chip designs, graphics, and the use of AI in design and operation of computer systems—in other words, the world of computing in the 1990s—became possible because of the deliberate efforts of IPTO to produce more capable, flexible, intelligent and interactive computer systems.

IPTO sponsored the ILLIAC IV, designed at the University of Illinois at Urbana-Champaign and built by the Burroughs Corp. ILLIAC IV was the world's first large-scale array computer and a new development in parallel processing architecture. With the advent of DARPA's Strategic Computing program in the 1980s, IPTO returned to the problem of massively parallel computers. First, there was the development of more powerful workstations. Based on government-supported work at the University of California at Berkeley and Stanford University, Sun Microsystems Inc. and Silicon Graphics Inc. developed—with further help from the government—advanced workstations using the reduced instruction-set computer architecture. RISC, proposed by IBM Corp., was brought to practice by these companies and the two universities.

IPTO's influence

While there are many challenges for computing in the 1990s, some of which (i.e., security issues and network management) have been introduced by the online and interconnected computing environment, there is no question that computing in the 1990s has overcome many of the limitations of the 1960s environment. This is in large part due to the emphasis IPTO placed on the interaction between humans and computers and on making the computing environment more responsive to human needs.

IPTO's programs achieved these results because the office focused on a four-pronged approach to computing system development: resource sharing, system development, integration of results and test beds for implementation. In addition to influencing changes in the computing environment, IPTO also stimulated the creation of closer ties among members of the CS&E community, affected military systems through the introduction of new computing techniques and systems, and had a substantial effect on the computing education community.

For more information, see Norberg's book, *Transforming Computer Technology: Information Processing for the Pentagon*. Johns Hopkins University Press, 1996.

Norberg is a professor of computer science at the University of Minnesota. His interests include the history of science and technology.

Professional Opportunities

CRN Advertising Policy

Send copy and payment for Professional Opportunities advertisements to Advertising Coordinator, *Computing Research News*, 1875 Connecticut Ave. NW, Suite 718, Washington, DC 20009-5728. Tel. 202-234-2111; fax: 202-667-1066; e-mail: crn@cra.org. E-mail submissions are preferred.

The format of an ad must conform to the following: 1) the first line must contain the name of the university or organization, 2) the second line must contain the name of the department or unit, and 3) the body of the ad should be in paragraph form. The words in the first two lines are included in the total word count for the ad. You may request in writing that some text be set in bold; a bold word in the body of the ad counts as two words.

The rate is \$2.25 (US) per word. Purchase orders, money orders and checks are acceptable (*please do not send cash*). All CRA members receive at least 200 free words per dues year. CRA's standard advertising package consists of printing an ad in *CRN* and distributing it electronically to CRA's jobs listserv and Web page (where it remains for two months). As an alternative to this package, advertisers may request that their Professional Opportunities ads just be published in *CRN* or just distributed electronically. The cost of the ad is the same whether the standard or the alternative package is selected.

Professional Opportunities display ads cost \$60 (US) per column inch, with a two-inch minimum. Ads must be submitted in camera-ready, offset (positives or negatives) or mechanical form. If your ad is larger than three inches, please request our Advertising Rate Card.

Computing Research News is published five times per year: in January, March, May, September and November. Professional Opportunities ads with application deadlines falling within the month of publication of *CRN* will not be accepted for publication in *CRN* unless the ad says applications will be accepted until the position is filled. If the closing date of a Professional Opportunities ad does not correspond with the publication of an issue of *CRN*, advertisers can choose the alternative advertising package and only have the ad distributed electronically. Advertising copy that is to appear in *CRN* must be received at least one month before publication. The deadline for the September issue is August 1. Ads for electronic distribution only may be submitted at any time.

University of Michigan Division of Computer Science and Engineering

Applications are solicited for several faculty positions in the Computer Science and Engineering (CSE) Division at all ranks. Qualifications include an outstanding academic record, a doctorate or equivalent in computer engineering or computer science, and a strong commitment to teaching and research. Particular areas of interest include multimedia, computer networks, software for distributed computing (including OS), databases, object-oriented programming, graphics and programming languages.

Please send resume and names of five references to Professor Toby J. Teorey, Chair of the Faculty Search Committee, CSE Division, Department of Electrical Engineering and Computer Science, The University of Michigan, 1301 Beal Ave., Room 3401, Ann Arbor, MI 48109-2122.

A nondiscriminatory, affirmative action employer.

University of Utah Department of Computer Science

Computer Administrator: Bachelor's degree in computer science or computer engineering plus three years related experience or equivalency required. Experience running a computer facility to include demonstrated knowledge in managing Unix and PC systems required. Coordinates with the department chairman and faculty to provide an outstanding research and educational environment in the computer science facility with an approximately \$800,000 annual budget and 400 Unix/PC systems. Supervises a hardware, software and operations staff. Duties include planning, specifying, procuring, replacing and installing computer facilities, systems and networks. Manages the College of Engineering CADE Laboratory.

To apply, submit resume, plus names, addresses and telephone numbers of three references, to Shawn Darby, Administrative Manager II, Department of Computer Science, 3190 MEB, University of Utah, Salt Lake City, UT 84112. Fax: 801-581-5843; e-mail: darby@cs.utah.edu.

We are an equal opportunity employer and attempt to provide accommodation for all disabilities.

University of Houston Department of Computer Science

The Department of Computer Science at the University of Houston seeks applicants for two or more tenure-track faculty at any rank. Successful candidates are expected to participate in teaching at any level, to carry out independent research and to participate in building a strong graduate program in the systems, communications and computational sciences areas. Other areas may be considered as well.

Applicants should have a Ph.D. in a relevant field and have a strong interest in both teaching and innovative research. Successful candidates will have the opportunity to participate in research in the Texas Institute for Computational and Information

Sciences, the Virtual Environment Technology Laboratory, the Texas Center for Advanced Molecular Computation, the Institute for Molecular Design and the Institute for Theoretical and Engineering Science. Together, these institutes have at their disposal a 64-node IBM SP-2 with mass-storage facilities, a NEC Cenju, a Cray YMP-EL, a MassPar, several Silicon Graphics machines and a 3-D CAVE. A campus ATM network is connecting the science and engineering buildings with the computational and visualization resources of the Institute for Computational and Information Sciences. The institute will in the near future be connected to the Baylor College of Medicine, Rice University and the vBNS network connecting the NSF Supercomputer Centers through an OC-3 network.

The University of Houston is an affirmative action, equal opportunity employer and especially welcomes applications from women and minority group members.

Applications, including a resume, a list of publications and the names of at least three references, should be sent to Professor Lennart Johnsson, Chair, Department of Computer Science, University of Houston, Houston, TX 77204-3475. Tel. 713-743-3374; fax: 713-743-3335; e-mail: johnsson@cs.uh.edu; URL: <http://www.cs.uh.edu>.

University of Western Ontario Department of Computer Science and Department of Electrical and Computer Engineering

Software Engineering/Computer Networks. As part of a major initiative by the university, the Department of Electrical and Computer Engineering and the Department of Computer Science invite applications for two full-time probationary (tenure-track) faculty appointments at the rank of assistant professor. These positions are joint appointments between the two departments. Candidates should have a Ph.D. in computer science, computer engineering, electrical engineering or related discipline, and show evidence of strong research potential and excellence in teaching. We are especially interested in candidates whose research is in software engineering or computer networks. Eligibility for registration as a professional engineer in Ontario would be an asset.

Each department currently offers degrees at the bachelor's, master's and doctoral level. We plan to

introduce a specialization in software engineering in both Electrical Engineering and the Honors Computer Science undergraduate programs. The successful candidate will bring enthusiasm, academic strength and the ability to work collaboratively to help build these new programs.

We offer state-of-the-art instructional computing environments and research facilities for graphics and imaging, parallel computing, distributed computing, multimedia, text processing, artificial intelligence and vision, simulation and computational methods and computing facilities for the handicapped. Additionally, a recently formed Advanced Communications Engineering Centre has facilities for research in high-speed computer communications and applications.

The University of Western Ontario is a major Canadian university with approximately 25,000 full-time equivalent students and 1,400 faculty members. Located in London, Ontario, it offers a very attractive campus with many and varied activities. London itself has many of the amenities found in larger cities as well as convenient access to the metropolitan areas of Toronto and Windsor/Detroit.

Processing of applications will begin on May 30, 1997, and continue until the positions are filled. A starting date of Sept. 1, 1997, is envisaged but this is negotiable. Applications including a curriculum vitae and the names and addresses of three referees should be sent to either: Dr. Sylvia Osborn, Acting Chair, Department of Computer Science, Middlesex College, The University of Western Ontario, London, Ontario, N6A 5B7 Canada. Or Dr. Alan R. Webster, Chair, Department of Electrical and Computer Engineering, The University of Western Ontario, London, Ontario N6A 5B9 Canada.

Positions are subject to budget approval. The University of Western Ontario is committed to employment equity, welcomes diversity in the workplace and encourages applications from all qualified individuals including women, members of visible minorities, aboriginal persons and persons with disabilities.

University of Western Ontario Department of Computer Science

The Department of Computer Science and the Faculty of Communications and Open Learning invite applications for a full-time probationary (tenure-track) faculty appointment at the rank of assistant professor. This position is a joint appointment between the two units. Candidates should have a Ph.D. in computer science, information science or related discipline, and show evidence of strong research potential and excellence in teaching.

The successful candidate will bring enthusiasm, academic strength and the ability to work collaboratively to help build the new Faculty of Communications and Open Learning, one which takes as its scholarly domain the role and impact of information, media and communications in the lives of individuals and in society. At the same time, the successful candidate will strengthen the area of multimedia systems or human-computer interaction within the Department of Computer Science.

Teaching duties will include the development and delivery of courses in multimedia, human-computer interaction or intelligent information systems, both for the Computer Science Program and for the new multidisciplinary program in Media, Information and Technoculture in the Faculty of Communications and Open Learning. Since some classes will include students with varying levels of computer science expertise, the ideal candidate will have the ability to relate to students who may or may not have a technical background.

The Computer Science Department comprises 17 regular faculty and offers B.Sc., M.Sc. and Ph.D. degrees in computer science. Its in-house state-of-the-art computing environment consists of 200 workstations and research facilities for graphics and imaging, parallel computing, distributed computing, multimedia, text processing, AI and vision, and computing facilities for the handicapped. The Faculty of Communications and Open Learning comprises 24 regular faculty members and offers B.A., M.A., MLIS and Ph.D. degrees.

The University of Western Ontario, located in London, Ontario, offers an attractive campus with many activities. London offers a reasonable cost of living coupled with many of the amenities found in larger cities as well as convenient access to the metropolitan areas of Toronto and Windsor/Detroit.

Applications should be sent as soon as possible, and no later than May 30, 1997. The effective date of appointment is Sept. 1, 1997, or whenever the position is filled. Applications including a curriculum vitae and the names and addresses of three referees should be sent to Dr. Sylvia Osborn, Acting Chair, Department of Computer Science, The University of Western Ontario, Middlesex College, London, Ontario N6A 5B7 Canada.

Positions are subject to budget approval. In

accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents of Canada. The University of Western Ontario is committed to employment equity, welcomes diversity in the workplace and encourages applications from all qualified individuals including women, members of visible minorities, aboriginal persons and persons with disabilities.

Kansas State University Computing and Network Services

Director of Computing and Network Services at Kansas State University. Information is available at <http://www.ksu.edu/vpast/cnsdir.html>. AA/EEO employer.

University of California, Los Angeles Department of Electrical Engineering

The University of California, Los Angeles, Department of Electrical Engineering invites applications for several open tenured and tenure-track faculty positions in the field of computer engineering. The department is interested in all areas of computer engineering, including, but not limited to, computer architecture, operating systems, compilers and languages, real-time systems, multimedia systems and distributed systems.

Applicants should have a Ph.D. and an outstanding research record in their area of expertise. Industrial and/or academic experience is preferred. Rank and salary are commensurate with the record of successful candidate.

Letters of application should be mailed to Professor T. Itoh, Recruiting Committee Chair, Electrical Engineering Department, UCLA, 405 Hilgard Ave., Los Angeles, CA 90095-1594.

UCLA is an equal opportunity, affirmative action employer.

University of Delaware Department of Computer and Information Sciences

The University of Delaware, centrally located on the East Coast, invites applications for between one and three visiting/limited-term faculty positions in the Department of Computer and Information Sciences beginning Sept. 1, 1997. A Ph.D. degree or its equivalent, and excellence in research and teaching are required. Candidates are sought in all areas of computer science. The department offers bachelor's, master's and doctoral degrees and has 15 tenure-track faculty, three visiting faculty and five research faculty, along with about 100 graduate students, a majority of whom are pursuing the Ph.D.

Candidates should send a curriculum vitae to Dr. Sandra Carberry, Chair, Faculty Search Committee, Department of Computer and Information Sciences, University of Delaware, Newark, DE 19716. In addition, candidates should have three confidential letters of reference sent directly to the above address or by e-mail to csfacsch@cis.udel.edu. All applications received by May 22, 1997, will be considered.

The University of Delaware is an equal opportunity employer that encourages applications from minority group members and women.

Drexel University Department of Mathematics and Computer Science

Tenure-track positions, salary and rank commensurate with qualifications. Ph.D. in computer science or equivalent and demonstrated excellence in teaching and research required. Department has undergraduate and graduate programs in mathematics and computer science. Areas of particular interest: software engineering, parallel processing, scientific computation, databases, programming languages, computer networks.

Letter, curriculum vitae, list of references to: CS Search Committee, Department of Mathematics and Computer Science, Drexel University, Philadelphia, PA 19104. E-mail: cs_search@mcs.drexel.edu; WWW: http://www.mcs.drexel.edu/cs_pos.

Applicant review begins immediately, continuing until position filled. Drexel University is an affirmative action, equal opportunity employer.

Oregon Graduate Institute of Science and Technology Department of Computer Science and Engineering

The department is seeking applicants for a newly created faculty position (at any rank) with the responsibility for launching a major expansion of our educational program in Software Engineering. The successful candidate will have experience and demonstrated accomplishments in software engineering education, program and curriculum development, and classroom teaching. Applicants need not fit the traditional profile for a faculty position at a research university.

OGI is located in the Portland metropolitan area, with a high quality of life and a quickly growing "forest" of high-technology companies. We are a private graduate school with no undergraduate programs. Providing education and research results to the region is an important part of our mission, and the quality of our teaching and research is valued highly. The department currently has 20 full-time faculty and 45 doctoral students, and external research funding exceeding \$6 million annually. More information can be found at <http://www.cse.ogi.edu>.

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Professional Opportunities ads available on Web

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Professional Opportunities

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The appointment is available immediately; the initial tasks will be to leverage and expand industry contacts, assess demand and develop a plan for software engineering education that both meets the needs of regional industry and is financially viable. OGI is collaborating with the CSE departments of the Oregon State System of Higher Education to design and offer a new master of software engineering degree, and the appointee will be expected to coordinate with and participate in this effort.

The successful candidate will also be encouraged to teach short courses through the Center for Professional Development and to set up and participate in research collaborations. Initial appointment is for one year with renewal based on performance and the success of the Software Engineering program.

To apply, send a brief description of experience in software engineering and education, research interests, the names of at least three references and a resume and publication list to Recruiting Committee, Department of Computer Science and Engineering, Oregon Graduate Institute, PO Box 91000, Portland, OR 97291-1000. E-mail: csedept@cse.ogi.edu.

OGI is an equal opportunity employer and particularly welcomes applications from women and minority candidates. Appointment is subject to the availability of funding.

University of Rochester Department of Computer Science

The Computer Science Department at the University of Rochester invites applications for a tenure-track position in the systems area at the rank of assistant professor. Candidates must have received, or be about to receive, a doctorate in computer science or a related discipline, and must demonstrate exceptional potential for both research and teaching.

Our department is small (12 faculty), with a strong record of research publication and external funding. We offer an outstanding research environment, with excellent students and facilities, and an unusually close-knit and collegial atmosphere. Current research interests include artificial intelligence (vision/robotics/virtual reality, natural language/knowledge representation), parallel systems (compilers, operating systems and run-time environments, performance analysis and prediction), and theory of computation. Total enrollment in the Ph.D. program is approximately 40 students. The undergraduate program has about 15 students per year.

Applicants should send a curriculum vitae, copies of relevant papers, and the names and addresses of at least three references to Faculty Recruiting Committee, Department of Computer Science, University of Rochester, Rochester, NY 14627-0226.

The University of Rochester is an equal opportunity, affirmative action employer; women and members of minority groups are strongly encouraged to apply.

Indiana University Department of Computer Science

The Indiana University Computer Science Department seeks candidates for a two-year visiting assistant professorship, with possibly an extension.

We are looking for a vigorous computer scientist with interest in teaching, developing and administering undergraduate courses.

Candidates must have a Ph.D. in computer science or a related area. Research interest in computer science pedagogy is an advantage. Remuneration will be at the range of \$40,000-\$52,000 (US), depending on background and qualifications. Indiana University has a generous benefits program.

The department occupies a recently renovated spacious limestone building, and has extensive state-of-the-art computing facilities. The attractive wooded campus of Indiana University is located in Bloomington, voted one of the most cultural and livable small cities in the United States, and a short drive from the Indianapolis airport.

Applications will be considered through June 15 until the position is filled.

Please send a detailed CV and a list of references to Educational Director Search, Computer Science Department, Indiana University, Bloomington, IN 47405. Internet: director-search@cs.indiana.edu.

Indiana University is an equal opportunity, affirmative action employer.

Indiana University Department of Computer Science

The Indiana University Computer Science Department seeks candidates for director of Educational Development, a senior special-faculty position, permanent in nature but not tenured.

We are looking for an outstanding computer scientist with a long-term interest in developing and administering innovative programs in computer science, programming and computer literacy undergraduate education. The director will direct the administration of the department's undergraduate programs, develop and teach courses, and represent the department in coordinating and promoting campus-wide instruction on computer applications.

Candidates must have a Ph.D. in computer science or a related area, and a demonstrable long-

term interest and commitment to dynamic development of educational programs and technologies. Research interest in computer science pedagogy is desirable. Remuneration commensurate with experience and qualifications, and expected to be at the senior faculty level when appropriate.

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Indiana University is an equal opportunity, affirmative action employer.

Rochester Institute of Technology Department of Information Technology

Applications are invited for tenure-track graduate and undergraduate teaching positions, beginning September 1997.

The 17-member department offers B.S. and M.S. degrees in information technology (IT), the M.S. degree in software development and management, and a certificate in interactive multimedia development. Offerings include technical and nontechnical dimensions of IT.

The ideal candidate has a vision of how information is changing our culture and has strengths in one or more of the following areas:

- Web front-ending to enterprisewide solutions.
- Content-based application development.
- Instructional technology.
- Computer-based training.
- System and network administration and Webmastering.
- Computer-mediated communication.
- Human-computer interaction.
- Wide-area database access.
- Visual applications development.

The successful candidate will fit into the department's interdisciplinary nature, be able to work with colleagues with different perspectives and diverse backgrounds, have an interest in IT as an emerging discipline and be concerned with technology in instructional delivery.

Minimum of M.S. and two years teaching experience required. Applications accepted until positions filled. Submit cover letter and resume to Ms. Martha Yates, Department of Information Technology, RIT, 102 Lomb Memorial Drive, Rochester, NY 14623-5608. Tel. 716-475-6179. Inquire by electronic mail to: itsearch@firstclass.rit.edu. Information is available via <http://www.it.rit.edu>.

RIT is an equal opportunity, affirmative action employer and specifically invites and encourages applications from women and minorities.

Stanford University Department of Computer Science

Scientific programmer position available in the Knowledge Systems Lab of the CSD at Stanford University. Programmer will work with research team investigating advanced methods of knowledge representation, knowledge acquisition, and human-machine interfaces. Knowledge to be represented covers a broad range, from fundamentals of physics and engineering to rationale for the design of specific devices. Programmer will be responsible for developing new programming techniques to support solution of complex problems—designing and implementing user interface for augmenting or editing a complex knowledge base; will be involved in design and implementation of the software system, in performing experiments to test prototypes, and in evaluating experimental results; will consult on programming details and supervise students on associated research projects; coordinate with external organizations on development of large, shared-knowledge base and documentation of work in user manuals and technical reports.

Ideal candidate will have master's in CS and four years programming experience. Equivalent combinations of relevant education and/or experience will be considered. Must have exceptional Lisp programming skills, preferably on Sun SparcStations. Prior experience in developing large-scale systems, designing and implementing graphics-based HCI on the Web. Java experience is highly desirable. Candidates must have strong background in AI concepts and programming techniques and ability to independently design and implement complex software systems.

Cover letter and resume to rse@stanford.edu. Or to Dr. R. Englemore, Gates Computer Science Bldg., 2A, Stanford University, Stanford, CA 94305. Stanford is an equal opportunity and affirmative action employer and especially encourages applications from minorities and women.

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knowledge, experience and expertise. In addition, nearly 2,000 videotaped technical lectures were distributed, and conference booklets were sent free of charge to students throughout the United States and Canada. To date, supporters of the 1997 conference include Digital Equipment, IBM Corp., Hewlett-Packard Co., Informix, Texas Instruments Inc., Autodesk Inc., BBN, USWest, Xerox Corp., the American Association for Artificial Intelligence, Kronos Inc., Macromedia Inc., Mitsubishi Electric Research Labs, the NEC Research Institute and the National Institute of Standards and Technology.

The 1997 Grace Hopper Celebration is seeking contributions of about \$500,000 to enable the production of a high-quality conference with a low registration fee to ensure a broader and more diverse attendance. Contributions from supporters will help offset the general conference costs, the costs associated with student scholarships and travel grants, and the cost of producing and distributing the full-color celebration booklet and video.

The opportunity is still available to support the world's only technical forum featuring the ongoing contributions that women are making to the rapidly changing computer field. Supporting the 1997 Grace Hopper Celebration is an opportunity for sponsors to make a visible contribution to the recognition and advancement of women in the computing field. In exchange, contributors will be listed in extensive e-mail and Web

publicity, in a first-class celebration program booklet that will be sent to all female computer science and computer engineering graduate students, and in the conference video series. For more information on contributing to the 1997 conference, contact Anita Borg, Grace Hopper Conference '97 fund raising chair. Tel. 415-853-2217; e-mail: borg@pa.dec.com.

Honoring Adm. Hopper

Hopper was a pioneer in the field of computing and an inspiration to women and scientists everywhere. Receiving her degree in 1934, Hopper was one of only four women in the doctoral program, and her doctorate in mathematics was a rare accomplishment in its day.

Hopper was a remarkable woman who faced the challenges of programming the first computers undaunted. Her work spanned programming languages, software development concepts, compiler verification and data processing, yet in true testimony to her vision and her intentness upon the future, Hopper felt her greatest contribution to society to be "all the young people I've trained."

Additional information

For more information on the 1997 Grace Hopper Celebration, connect to <http://www.systems.org:80/hopper>. For information on the submission of technical papers or on speakers, contact Telle Whitney. Tel. 408-522-4360; e-mail: telle@actel.com. To register to attend the conference, contact Ruth Stergiou. Tel. 415-548-2424; e-mail: regdesk@netcom.com.