COMPUTING RESEARCH NEWS

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1994 budget focuses on information technology

By Juan Antonio Osuna
CRA Staff

The bureaucratic engines best suited for driving the economy along the road to recovery are the Commerce Department and the National Science Foundation (NSF), according to President Clinton's recent budget proposals.

In an effort to spur information infrastructure development, Clinton included generous increases in the fiscal 1994 budget for Commerce and NSF, both of which are major funding sources for the High Performance Computing and Communications (HPCC) program.

In his technology statement announced Feb. 22 in Silicon Valley, Clinton depicted technology, especially information technology, as the key to the country's success.

"Efficient access to information is becoming critical for all parts of the American economy," Clinton said. "Accelerating the introduction of an efficient, high-speed communication system can have the same effect on US economic and social development as public investment in the railroads had in the 19th century."

Clinton's 1994 budget includes generous funding for high technology R&D. Overall, the budget proposes $1 billion to fund HPCC and information infrastructure—a 38% increase over this year.

About a third of the increase—$96 million—will go exclusively to a new component of the HPCC program called Information Infrastructure Technology and Applications.

The major contours of Clinton's budget should come as no surprise, as they are consistent with his technology statement and the stimulus package, both issued in February.

Of any department, Commerce is slated to get the largest overall increase in R&D funds—a 30% increase over fiscal 1993. Commerce oversees the National Telecommunications and Information Administration (NTIA) and the National Institute of Standards and Technology (NIST), both of which play key roles in information technology development.

The proposed budget for NTIA more than doubles its current budget of $40 million in order to launch the National Information Infrastructure (NII) program, which would administer $51 million in grants.

"NTIA will provide matching grants to states, school districts, libraries and other non-profit entities so they can purchase the computers and networking connections needed for distance learning and for hooking into computer networks like the Internet," Clinton said in his technology statement. "These pilot projects will demonstrate the benefits of networking to the educational and library communities."

NIST's budget would jump from $383 million to $535 million, an increase of 39%. The Computer Systems program under NIST would more than triple—increasing from $12 million to $37 million. This money would fund the HPCC program and the development of technical standards for the National Research and Education Network.

Also slated for a generous increase is NSF, which has requested a 16% increase over 1993. The largest boost would go to the Computer and Information Science and Engineering Directorate—its budget would jump 37%, from $215 million to $296 million.

Clinton has planned only modest increases for programs within the Defense Department's Advanced Research Projects Agency (ARPA, formerly DARPA), which also contributes to the HPCC program.

While some of ARPA's programs are being slashed, the Computing Systems and Communications Technology program will increase 6% from $349 million to $369 million.

Overall, ARPA funding will drop from $2.250 billion to $2.182 billion.

Although not all of Clinton's budget proposals differ radically from those of the Bush administration, Clinton's proposals may have more impact on the actual funds Congress decides to appropriate.

Last year, Congress fell somewhat short of the Bush administration's funding requests for NSF. The past administration had asked for a 17% increase, whereas Congress not only failed to appropriate these increases but actually cut NSF's 1993 budget.

This year, things may be different. The political climate may favor giving NSF the funds it wants to help the country get back on its feet economically.

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Who will control networks comprising NII?

By Juan Antonio Osuna
CRA Staff

A flurry of congressional testimony in the last few months has addressed how to build a national information infrastructure (NII) and who should control the networks that will comprise this infrastructure.

At one extreme are industry leaders who urge government to step aside and let industry have almost total autonomy. Such was the view presented by T.J. Rogers, president and CEO of Cypress Semiconductor Corp., during hearings before the House Science, Space and Technology Subcommittee on Technology, Environment and Aviation.

Rogers attacked the Clinton technology program, saying that not everyone in Silicon Valley was cheering when he delivered his technology speech in February. "I am here today in strong opposition to the administration's economic program in general and its technology agenda in particular," Rogers told the subcommittee.

"The men and women of our company do not want handouts," he said. "And if Congress wants to help American high technology, handouts are the wrong way to go—especially if they are funded with tax increases on individuals and corporations."

Rogers said, "Ultimately, the economic battles of the 1990s will be won in America's factories, labs and offices—not in the halls of Congress or the corridors of the White House."

At the other extreme are educators and librarians who fear that leaving NII development to the marketplace will widen the gap between the information "haves" and "have-nots."

"It is important that the information revolution include those least able to afford to take part," said John Masten, chief operating officer of the New York Public Library, during hearings before the House Energy and Commerce Subcommittee on Telecommunications and Finance.

Masten especially praised Clinton's stimulus proposals that would provide matching grants to states, school districts, libraries and industry for buying computers and network connections.

"It is critical to the preservation of democratic access to information and learning that access to the infrastructure is not determined solely by the economic resources of the user," Masten said.

Masten was joined in his testimony by educators who deplored the current technological undernourishment of the school system.

Shelly Weinstein, president and CEO of the National Education Telecommunications Organization and Educational Satellite Corp., said that while the United States spends $20 billion a year on PCs, educators have only spent $2 billion on PCs over the last 10 years.

"Although telecommunications has turned the world into a 'global village,' America's schools for the most part have remained relatively isolated enterprises," Weinstein said. "Within existing commercial market practices, educational institutions are left without low-cost, dependable and equitable access to telecommunication services."

In his testimony before the House technology subcommittee, Vinton G. Cerf, president of the Internet Society, offered several recommendations to government for addressing diverse interests, including:

- invest in precompetitive technologies that encourage industry to develop them into marketable products;
- ensure interoperability when developing technical standards;
- give network access and training to school teachers and children;
- foster shared scientific databases and tools among researchers; and
- build electronic bridges among scientific, research, academic and educational communities.

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Nation will benefit from CS research

By Fred W. Weingarten

The other day, a reader of CRA's occasional E-mail bulletins expressed distress at our description of the administration's request for a supplementary National Science Foundation (NSF) appropriation. In the bulletins, we suggested that members of the computing research community contact their representatives in Congress and express support for the supplement.

"What about the deficit?" our reader asked, suggesting that CRA was behaving like every other special interest group and holding its hand out for funding that would be detrimental to the broader public interest in controlling the budget.

It was a reasonable and fair question. Our political leaders face several extremely difficult problems, including the deficit, and the comment made me think about CRA's role in the political process. I concluded that we are on the right track:

1) We have not only the right, but the duty to participate in the debate.

American society is large and complicated. Despite, or perhaps because of that complexity, we have opted to operate as a democracy. And democratic decision-making is a messy, noisy, unpleasant process that often is not conducted at the level of dispassionate rationality.

However, regardless of how it may seem in the newspapers, many policy makers also want to know the facts and the effects of deciding one way or the other. If people like us, who know and who have a stake in the system, do not inform the process, how can we complain about outcomes?

Organizations such as CRA and scores of other associations are vital to this process. The issues are complex and the constituencies large and diffuse. Our policy role is to inform our members about issues, suggest timing and help organize effective responses by the community. We do this in many ways, including through the pages of *CRN*, in our E-mail bulletins and at conference programs. We generally do not initiate or organize specific political activities—we are not a lobbying organization. We simply inform and advise those members of the research community who wish to express their views.

2) The budget, from our perspective, approximates a zero-sum game. Our message is "priorities."

Nothing anyone in the CRA community does is going to have any influence on the budget deficit. If we rejected all money allocated this year for computing research, the net effect would be to readjust priorities within research toward some other area. Similarly, to the extent we convince Congress to double funding for computing research, the money most likely would come from some other program. We do not have the clout, influence or operating style to have any significant effect on the overall deficit.

When policymakers are deciding how to spend taxpayer money, we want them to be aware that some things are beneficial to the nation. One of those things is research, and one of the most important areas of research is computing.

We are dealing with priorities on three levels:

• The research community as a whole must assert the general importance of research as a federal responsibility.

• The computing research community must assert the importance of its field.

• Members of the computing field need to be seen as setting our own priorities. That is a painful but important task.

3) We have a good story.

The arguments need to be made rationally, based on facts, examples and clearly stated assumptions about technology, the economy and society. We stand on shaky ground when we argue against other priorities, even if we believe they are less important. When we make our case for computing research, physicists argue for a supercollider, astronomers for a radio telescope.

It is the job of participants of the political process to judge these competing claims. Because they cut across disciplines, the broader scientific organizations such as the American Association for the Advancement of Science and the National Academies can help in this larger priority debate. But more specialized organizations such as CRA have more trouble.

To the extent my description of the process is accurate, we have no choice but to participate. If we do not speak up, decision-makers will assume that computing research is not all that important. Or they will make the priority choices for us.

Back to our critic. I think CRA is taking appropriate, defensible and responsible positions. The government has a $1.5 trillion budget. Some expenditures are appropriate and some are not; some are frivolous and some are very important. It is our (and everyone's) job to help the political process distinguish between them. In doing so, we rest on two foundations:

• A bipartisan consensus that research support is an appropriate government responsibility is crucial. We may argue about priorities, the balance between basic and applied research or the funding levels, but the core government responsibility is indisputable.

• Computing is a critical technology for the nation to invest in. I believe most of the current rhetoric about the importance of the high-tech economy and the information society (though I also believe we must think about the social implications of those technologies).

The implication of that rhetoric is that computing should have high priority for federal research dollars. Researchers will disagree on priorities or on the appropriate balances within the field, but I cannot imagine that there is much contradiction of the basic point.

It may seem self-serving for us to take such a position, but that is true of most groups that petition the government. The political system expects and knows how to filter for that. No one is treated more warily by politicians than someone who claims to be speaking with pure objectivity for the public interest. We need to be aware of our self-interest and keep it in check and not let it blind us to the fact that politicians have to respond to many sides of an issue.

We also need to be aware of and sensitive to the larger national context. Government research funding competes with important national priorities, and politicians will have a difficult time making choices. In the final analysis, we will win some and lose some debates. But we need to be persistent—it is part of the job.

Fred W. Weingarten is the executive director of the Computing Research Association.

Letters to the Editor

CS should be proud of its accomplishments

Editor:

One of the implications of the National Research Council report, *Computing the Future*, is that somehow computer science has gone wrong and not fulfilled its social contract to provide for the economic good.

I believe we should be proud that we have more than fulfilled our social contract. Starting from nothing in the 1960s, we have developed the finest computer science educational system in the world. Building on the research produced by that system, software had become one of the few technologies in which the United States leads the world. And the information industry is the largest and fastest growing high-tech industry in the United States.

Whatever we did in this so-called "looking inward" phase, we had better continue doing it if we want to keep our technological lead in the world. We have too many examples in other fields where micromanaging has resulted in losing such a lead. We do not want to repeat those mistakes.

The agenda of our field has expanded greatly over the past three decades (look at some 1960s journals) and will continue to do so at an accelerating rate. The dynamics of that expansion and how it has led to the development of new technologies and entire new industries is one of the great success stories of our lifetime. It is too important to tinker with.

Philip M. Lewis, chair of computer science State University of New York, Stony Brook.

Expanding the Pipeline

How can men help expand the CS pipeline?

BY Michael J. Fischer

Past *CRN* columns on expanding the pipeline have focused on a diverse set of problems faced by women pursuing careers in computer science. The CRA Committee on the Status of Women in Computer Science, of which I am a founding member, was established to help women achieve full participation in our field and to identify and address problems faced by women in achieving equality with men.

In this column, I would like to consider the role that men can play in solving these problems. I will argue that better communication is a prerequisite to getting men effectively involved in issues of equality, and that existing communication forums that exclude men have a tendency to inhibit communication between men and women outside the forum as well.

The first question that comes to mind is, "Why should a man care about the problems that professional women face?" It is neither his problem nor his business. I have several answers to that question. There's the moral answer, that all human beings deserve equal opportunity. There's the practical answer, that the field needs the talents and services of people of both genders and that we are all poorer if half of the population is excluded. There's the selfish answer, that many problems commonly identified as "women's" problems affect men, too, such as undue pressure on graduate students, lack of flexibility in career paths and the expectation that career will be placed ahead of family. And finally, there's the ethical answer, that many men are in positions of responsibility and they have an obligation to make themselves aware of the issues concerning women and the effects that their actions have on women.

> *Existing communication forums that exclude men have a tendency to inhibit communication between men and women outside the forum as well.*

Effective problem solving involves several steps:

- The problem must be identified.
- People must be made aware of the problem.
- Open discussion is needed among all parties involved in order to find solutions and compromises that are generally acceptable.
- Actions must be taken that address the problem.

Because many problems affecting women cannot be solved without the cooperation of men, it is essential that men be closely involved in the problem-solving process. A breakdown at any stage of the process may prevent a satisfactory solution from being reached.

Much progress is being made on identifying problems affecting the careers of women in our field. Numerous reports bring home the message loud and clear that women drop out of the pipeline at far greater rates than men for reasons that are many and complex. Once the problems have been identified, the community at large must be made aware of them. This can be an enormously difficult task

Lengthy reports are costly to disseminate and often go unread by those for whom they are intended. Articles in periodicals, such as this column in *CRN*, play a role in heightening general awareness of some issues, but they are not able to engage a large segment of the community in active dialogue.

Electronic communication could permit such dialogue, but there is no major open electronic forum devoted primarily to issues faced by professional women in computer science. I believe that such a forum could have a significant impact on bringing such issues to the attention of the community, in building consensus on how they should be addressed and on influencing people in positions of power

I urge that the community create and participate in such a forum. In fact, an active forum for the discussion of issues of concern to women already exists in the form of Systers and related mailing lists, except that they are closed to men. I know that many will defend the exclusionary policy of closed forums and argue that they play a valuable role for women that would be impossible if they were open to all. On the other hand, an unintended side effect of closed forums is to create a climate that discourages open dialogue between men and women from taking place elsewhere. This happens in three ways:

- Closed forums divert the energies of maintainers and participants away from open forums. Issues aired on closed forums do not reach many of the people who can and must address them. Nevertheless, participants in a discussion may feel that they have made the problem publicly known and thus lose motivation to communicate their concerns further
- Closed forums send men the message that their concern and involvement in issues of equality are not welcome. This is hardly a recipe for increasing the cooperation and sensitivity of men toward these issues.
- Perhaps most pernicious, closed forums tend to polarize the community by legitimizing discrimination based on gender and encouraging gender-based group identity. This runs counter to the aims of many of us who are working to remove gender barriers and ensure that all people are treated as individuals according to their own merits.

It is time to enlist the efforts of the whole computer science research community in addressing problems faced by its members, male and female alike. Means to facilitate communication and discussion of these issues are essential. An electronic forum should be established that is open to everyone with an interest in improving the status of women in computer science. Influential men in particular should be urged to join.

An obvious way to accomplish this would be to open Systers up to everyone. It already exists and apparently is well run. At the very least, its members should be encouraged to support open forums and take discussion of substantive issues there. Only by working together can we make this a more just world.

Michael Fischer is a professor of computer science at Yale University.

Correction

An article in the March issue titled "Deciding the Fate of NSF" should have said, "The message was reinforced by a 2% cut in funding appropriated for research."

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CRA co-hosting symposium for female students in computing

The Computing Research Association and the George Washington University, with expected funding from the National Science Foundation (NSF), will co-host a one day symposium, *Windows of Opportunity: Symposium for Female Students in Computing*, in Washington, DC, May 23. C. Dianne Martin, professor of computer science at George Washington University, is chairing the symposium.

NSF's Directorate for Computer and Information Science and Engineering (CISE) is committed to encouraging and supporting activities that will contribute significantly to increasing the number of women qualified to participate in research and education in computer science, information science and computer engineering. The CISE Directorate has established the goal that by the year 2000, 45% of the graduate students in CISE research disciplines will be female.

To further this goal, 100 graduate and 100 undergraduate female students in the CISE disciplines were selected to attend the symposium. Department chairs and deans from US institutions nominated the students. Senior female researchers from CISE fields will be invited to participate, and professional staff from NSF will play an active role in the symposium. It is anticipated that students will benefit personally and professionally from their participation and act as agents for change at their institutions. Each participant is expected to give a presentation at her home institution after the symposium.

The symposium will feature outstanding female researchers in CISE who will describe exciting research areas, sessions on academic and career path management that focus on issues of special concern to women and information sessions addressing the funding opportunities available for female students in CISE disciplines.

Fiscal 1994 Federal Budget

Table 1. NSF Funding in Fiscal 1993 and 1994 (in millions of dollars)

Directorate	1993 Planned	1993 +Stimulus	Percent Change (93 vs. 93+stimulus)	1994 Request	Percent Change (93+stimulus vs. 94)
Research and Related Activities					
Biological Sciences	271.3	291.5	7%	311.9	7%
Computer and Information Science and Engineering	215.2	262.9	22%	296.0	13%
Engineering	261.1	296.9	14%	323.1	9%
Geosciences	379.8	421.0	11%	448.5	6%
Mathematical and Physical Science	619.9	660.4	7%	718.4	9%
Social, Behavioral & Economic Science	89.5	99.0	11%	106.9	8%
Subtotal for Research and Related Activities	**1,836.9**	**2,031.6**	**11%**	**2,204.8***	**9%**
Education and Human Resources	487.5	487.5	0%	556.1	14%
Academic Research Facilities and Instrumentation	50.0	54.7	9%	55.0	1%
Salaries and Expenses	111.0	115.7	4%	125.8	9%
Other	248.1	250.7	1%	238.5	-5%
Total NSF Budget	**2,733.5**	**2,940.2**	**8%**	**3,180.2**	**8%**

*Subtotals exclude Artic Research funds, which have been moved to a new category (within "Other") beginning in fiscal 1994.

Budget from page 1

Before Congress tackles the 1994 budget, it must contend with the president's 1993 stimulus package, which at press time, still was being debated before Congress.

In its original form introduced by the president, the stimulus package included substantial boosts for NSF and the Commerce Department for fiscal 1993. The package included $188 million for NSF R&D programs and another $19 million earmarked for NSF networking and computing applications. This is a 10% increase over NSF's previous 1993 budget.

NSF also decided to allocate $4.7 million of the stimulus to help pay salaries and operating expenses. Despite efforts from both parties to streamline government and reduce bureaucracy, then-NSF Director Walter Massey insisted that NSF is terribly understaffed. NSF has about the same staffing level now as it did 20 years ago, even though the agency's budget has tripled in the last two decades.

Table 2. CISE Program Funding (in millions of dollars)

	1993 Plan	1993+ Stimulus	1994 Req.
Computer & Computation Research	34.80	41.42	46.07
Info., Robotics & Intelligent Sys.	26.95	35.84	40.62
Microelectronic Info. Processing Sys.	21.49	28.20	32.83
Advanced Scientific Computing	69.53	82.25	91.27
Net. & Commun. Res. & Infrastructure	39.96	48.09	54.94
Cross-Disciplinary Activities	22.49	27.11	30.28
Total CISE Funding	**215.22**	**262.91**	**296.01**

The stimulus boost to NSF was only part of $631 million in overall technology investments, which included other funds for networking and computing applications.

Under the Commerce Department, NTIA was allocated $64 million and NIST was to get another $14 million to help build NII.

"The development of a broadband, interactive telecommunications network linking the nation's schools, libraries, healthcare facilities, governments and other public information producers could pay enormous dividends to the US economy," Clinton wrote in *Vision for Change*, which contained the stimulus proposal.

To help build information infrastructure, another $9 million was allocated for the National Institutes of Health and $6 million for NASA.

In late March, Congress endorsed Clinton's long-term investment proposals through a resolution. This long-term budget allocated $47.5 billion for the four-year Rebuild America fund.

Included in this four-year fund is $2.3 billion for NSF, $275 million for information infrastructure and $784 million for high-performance computing crosscutting many agencies. The fund also gives $1.2 billion to the Federal Coordinating Council for Science, Engineering and Technology

Select programs in the 1994 budget

National Institute of Standards and Technology (Commerce)

• *Advanced Technology Program.* ATP provides cost-shared grants for US companies to develop precompetitive, generic technologies. ATP's budget would increase from $68 million in fiscal 1993 to $199.5 million in 1994. The stimulus package also contains $103 million for ATP.

• *Computer Systems Program.* This program would triple its 1993 budget of $12 million to $37 million in 1994. Overall, the program focuses on developing standards and conformance tests for computers and telecommunications systems. In 1994, NIST will concentrate on security, interoperability and the Integrated Services Digital Network. The funding increases will enable NIST to support the High-Performance Computing and Communications program by developing standards and protocols for the National Research and Education Network.

• *Applied Mathematics and Scientific Computing.* Funding of $7 million in fiscal 1994 would be an increase of only $200,000 over 1993 levels. The program provides NIST with expertise in mathematical modeling, statistics, numerical analysis and scientific computing. NIST also will collaborate with other laboratories on the HPCC program.

• *Research Support Activities.* These activities would get less money. Its 1994 budget of $31 million would mean a $4 million cut. These funds are used for basic research in fast-breaking scientific and technical areas.

National Telecommunications and Information Administration (Commerce)

• *National Information Infrastructure Grant Program.* This new program would distribute $51 million in grants for pilot projects to connect schools, libraries, researchers and healthcare providers to high-speed networks. The program would employ 14 people within NTIA.

Advanced Research Projects Agency (DOD)

• *Computing Systems and Communications Technology.* The 1994 budget of $369 million would constitute a 5% increase over the 1993 budget of $349 million.

• *Manufacturing Technology.* This program would increase 37%—from $219 million in 1993 to $299 million in 1994.

• *Semiconductor Manufacturing Technology.* This program would increase from $95 million in 1993 to $100 million in 1994—a 5% increase.

NSF's mission debated at congressional hearing

By Juan Antonio Osuna
CRA Staff

Rep. Rick Boucher (D-VA), chair of the House Science, Space and Technology Subcommittee on Science, asked witnesses in a March hearing for ways to improve the mission of the National Science Foundation (NSF).

The hearing was the first of a series to examine the future of the NSF and the possibility of amending the NSF Act of 1950, which established the agency and its mission. After holding several more hearings, Congress will consider legislation to reauthorize NSF, probably in May.

Overwhelmingly, panel experts said NSF's primary mission should remain focused on basic or curiosity-driven research and that NSF is capable of adapting to societal changes without new legislation.

"Our committee believed that the missions of the NSF, as spelled out in the enabling legislation, as amended [in 1968], are broad enough to allow for these adjustments," said William Danforth, co-chair of the Commission of the Future of the NSF. "We [the commission] believed further that the traditional focus and the large goals of NSF are as important as ever and are likely to be even more important in the future."

James Duderstadt, chair of the National Science Board (NSB), pointed out that the line between curiosity-driven and nationally strategic research is fuzzy and that evaluating which programs fit into which category often will be subjective.

The implication is that new legislation telling NSF how to divide its money would inevitably be open to interpretation. "Given NSF's current funding level, the mix [of curiosity versus strategic research] is approximately correct," Duderstadt said.

Although panelists did not say much about shifting funds from one program to another, they did emphasize priorities that future appropriations might address.

Brian Rushton, president of the Industrial Research Institute, said NSF should emphasize education and basic research. He said the primary role of universities should be education, not research.

"Industrial R&D depends on American colleges and universities for an unending supply of new knowledge, and an ample supply of well-trained scientists and engineers," Rushton said.

Continued on page 5

Washington Update

Bill Roundup

National Competitiveness Act of 1993 (S 4)

Sen. Ernest Hollings (D-SC), chair of the Senate Commerce, Science and Transportation Committee, introduced a bill in January to increase US economic competitiveness in critical areas of technology such as advanced manufacturing, wind engineering and high-performance computing and networking.

The bill is a reincarnation of three bills introduced during the last session of Congress—the Manufacturing Strategy Act, the Wind Engineering Act and the Information Infrastructure and Technology Act. The new Information Infrastructure and Technology Act authorizes $60 million for fiscal 1993, $120 million for 1994 and $180 million for 1995.

National Network Security Board Act of 1993 (S 237)

Sen. Larry Pressler (R-SD) introduced a bill in January to create a National Network Security Board within the Federal Communications Commission for monitoring and investigating disruptions in long-distance and local telephone systems. The board would conduct on-site investigations to determine the cause of system crashes and recommend policies to prevent network crashes.

Telecommunications Network Security & Reliability Reporting Act of 1993 (S 238)

Pressler introduced another bill in January that would require the FCC to report annually on the security of the nation's telecommunications networks.

Electronic Library Act of 1993 (S 626)

Sen. Bob Kerrey (D-NE) introduced a bill in late March to establish state-based electronic libraries. The National Science Foundation (NSF), in consultation with the Education Department, Commerce Department, Advanced Research Projects Agency and Library of Congress, would issue grants to states for developing electronic libraries. The bill authorizes $10 million for fiscal 1994, $25 million for 1995, and such sums as may be necessary for 1996 and each fiscal year thereafter.

Technology for the Classroom Act of 1993 (S 264)

Sen. Jeff Bingaman (D-NM) introduced a bill in January that would authorize $90 million for fiscal 1994 for implementing new communication technologies in schools.

Half of the money would provide grants directly to schools of all levels so they can implement technologies such as computers, software, databases, films, transparencies, video, audio and telecommunications equipment. The other half of the money would be funneled through state agencies so they can implement programs.

Elementary & Secondary School Library Media Act (S 266)

Sen. Paul Simon (D-IL) introduced a bill in January that establishes a Division of Library Media Services within the Education Department and three programs for infusing school libraries with better technology.

The Elementary and Secondary School Library Media Program authorizes $200 million for fiscal 1994 to implement new technologies in libraries and classrooms linked to library centers.

The School Library Media Specialist and Teacher Partnerships for Instructional Innovation Program authorizes $20 million for fiscal 1994 to train teachers and students how to use information technologies.

The Uses of Technology in the Classroom Program authorizes $40 million for fiscal 1994 to expand the use of computers in schools and to allow library media centers access to databases.

DOE National Competitiveness Technology Partnership Act of 1993 (S 473)

Sen. J. Bennett Johnston (D-LA), chair of the Senate Energy and Natural Resources Committee, introduced a bill in March to link Energy Department laboratories with those of the private sector. The bill also would implement a National Information Infrastructure program by amending the High-Performance Computing Act of 1991. It would create a coordinated inter-agency program that would develop partnerships, deploy information technologies and educate people on how to use them. DOE also would address technical standards and regulatory issues involved with development of a national information infrastructure. To implement the program, the legislation authorizes $50 million for fiscal 1994, $100 million for 1995 and $150 million for 1996.

Government Printing Office Electronic Information Access Enhancement Act of 1993 (HR 1328, S 564):

Rep. Charlie Rose (D-NC) and Sen. Wendell Ford (D-KY) introduced two identical bills March 11 to provide the public with on-line access to government information. The bill has passed the Senate and is pending a full vote in the House.

Continued on page 7

House bill amends HPCC

By Juan Antonio Osuna
CRA Staff

After weeks of anticipation, Rep. Rick Boucher (D-VA), chair of the House Science, Space and Technology Subcommittee on Science, was expected to introduce in late April a bill to expand the High-Performance Computing and Communications (HPCC) program to benefit a wider cross-section of society.

The bill amends the HPCC Act of 1991, adding a new title that broadens the program to bring libraries, local governments, schools and healthcare providers onto national computer networks and to develop the underlying technology base to support those applications.

"The program is required to focus on applications accessible and usable by all citizens," a committee staffer's analysis of the bill said.

Title III amends the current HPCC Act, sponsored in 1991 by then-Sen. Al Gore, allowing the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) to direct an interagency program, involving NASA, the National Science Foundation (NSF) and the departments of Commerce, Energy, Defense and Health and Human Services.

FCCSET would create a five-year plan with detailed funding levels and responsibilities for these agencies. Also, FCCSET would periodically report to Congress on the program's progress and recommend possible legislative action.

NSF is charged with leading other federal agencies to assist schools, libraries and local governments in connecting to the National Research and Education Network.

The program would fund basic and applied R&D, with special attention to user-friendly interfaces and security and privacy problems.

Testbed projects would connect hospitals, doctors and researchers to information systems that would allow them to share patient records and medical research. The bill specifically asks that computerized systems not compromise patient privacy.

Also, the program would increase public dissemination of health information as well as federal and local government information. Mechanisms also would be established for disseminating scientific and technical information to the research community.

Panel listens to HPCC experts

By Juan Antonio Osuna
CRA Staff

In preparation for a report to be released in May, a National Science Foundation (NSF) panel met March 11-12 to hear experts project the future of high-performance computing.

Attending the meeting were representatives of Cray Research Inc., Silicon Graphics Inc., Thinking Machines Corp., Intel Corp., IBM Corp. and Convex Computer Corp., as well as the research directors of several state and national supercomputing centers.

The meeting was the second of three before the May report is released. The report is intended to guide the National Science Board in setting NSF policy.

As was noted many times during the meeting, the panel convenes at a time when the political climate is favorable for high-tech R&D. "We have good friends now" in the Office of Management and Budget and the Office of Science and Technology Policy, said Nico Habermann, assistant director of the NSF Computer and Information Science and Engineering Directorate. OMB and OSTP play critical roles in funding NSF.

Panel chair Lewis Branscomb said the report should spell out the social benefits of high-performance computing technology. "We just cannot say more science is good," he said.

Stephen L. Squires, director of the Advanced Research Projects Agency's Computing Systems Technology Office, said a new ARPA program called the National Information Enterprise is under way to promote systems that will serve all of society, not just scientists.

"The federal role ought to go beyond just the grand challenges to something we call the national challenges," he said, adding that high-performance computers should emphasize functionality more than teraflop speeds.

"The nature of the program is to move the entire technology base up a few notches. That means the whole technology base, including the people, including K-12," Squires said. "If you do not move the whole society ahead with the technology, then it is not worth it."

Some industry experts urged NSF to take bold initiatives in promoting certain technologies. Quoting from Alan Kay, Justin Ratner of Intel said, "'It is easier to invent the future than to predict it.'"

Ratner went on to predict the future anyway, saying that by 1996:

- microprocessor speeds will reach 200 MHz with 800 million instructions per second and 800 million floating point operations per second,
- static RAM caches will reach 4 megabits and main dynamic RAM will reach 64 megabits,
- disk drives will be reduced to 2.5 inches or smaller and transfer data at 5 megabytes/sec, and
- interconnect communications will achieve speeds of 1 gigabyte/sec.

Mission from page 4

Boucher asked panelists about expanding NSB's role. He said the NSF Act of 1950 broadly assigns NSB with the responsibility to "…recommend and encourage the pursuit of national policies for the promotion of research and education in science and engineering."

Science and technology (S&T) policy now is a part of many federal agencies. Boucher asked panelists who should take the lead in developing this policy—NSB or the Office of Science and Technology Policy.

Duderstadt said the board should increase its role in developing national S&T policy but expressed doubts as to whether it could adequately lead other agencies without more funding.

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Bills from page 5

A sequel to HR 5983 introduced in the last Congress, these bills ensure the public electronic access to the *Federal Register*, *Congressional Record*, other publications distributed by the superintendent of documents, a directory of government electronic information and information that other federal agencies specifically request to be made electronically available.

Although GPO would grant federal depository libraries free access to these resources, they would charge the public enough to recuperate costs.

Individual Privacy Protection Act of 1993 (HR 135)

Rep. Cardis Collins (D-IL), chair of the House Commerce Subcommittee on Commerce, Consumer Protection and Competitiveness, introduced a bill in January to establish the Individual Privacy Protection Board.

The bill calls for a five-member board appointed by the president and approved by the Senate to study computerized information systems maintained by government and private industry. The board would recommend legislative or administrative action for protecting individual privacy rights.

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Research News

CSTB releases new report

BY Marjory S. Blumenthal

The National Research Council's Computer Science and Telecommunications Board (CSTB) recently released the report *Computing Professionals: Changing Needs for the 1990s*. Recognizing that CRA and others strive to measure the supply of computing professionals, the study sought to provide a broader picture of the computing professional labor market, addressing both supply and demand aspects.

The report builds on discussions held at a workshop developed by the Steering Committee on Human Resources in Computer Science and Technology.

The committee was chaired by Leslie L. Vadasz, an Intel Corp. senior vice president, and included Eileen Collins of the National Science Foundation, Nancy Leveson of the University of Washington, Shelby Stewman of Carnegie Mellon University, James Tennison of IBM Corp., Maxine Trentham of CTA Inc. and Paul Young of the University of Washington.

Three broad groups of professionals were considered: researchers in computer science and engineering; developers of commercial applications and systems; and professionals involved in deploying applications and systems.

Both the steering committee and the workshop participants were interdisciplinary. Also brought in for this project were managers from organizations that produce and use computing technology and analysts of scientific and engineering labor markets.

Below are excerpts from the report's executive summary:

Skilled professionals…are responsible for developing and implementing computer-based technology and for its diffusion throughout our society. These highly skilled professionals are often treated as part of a large occupational group, a group that can be referred to as computing professionals. But that label masks an unusually wide range of occupations, including researchers in computer science and computer engineering, developers of commercial applications and systems and individuals involved in deploying applications and systems. Adding to the confusion over the identity and number of computing professionals is the growing use of computing in other vocations.

Maintaining US excellence in the creation and use of computing systems requires access to a sufficient supply of the best talent. Because employers, educators and public policy-makers know so little about the size of the labor pool and the skill requirements and responsibilities of the individuals shaping the computer revolution, human resources planning and policy making are more haphazard than they should be.

The steering committee found reasonable consensus among workshop participants about the following:

Demand is fluid and skill requirements are growing

Demand for computing professionals is subject to strong cross-currents that are masked by statistical averaging. Based on their discussion of these trends, the steering committee and workshop participants concluded that demand for computing professionals is expected to grow overall, although more slowly than in the 1980s.

The overall level of skill required in computing professional occupations appears to be growing. As skill requirements grow, employers may increase their demand for individuals with formal education in computer science and engineering.

Demand for individuals in specific jobs and occupations appears to shift relatively frequently. So do the responsibilities and skill sets that define specific jobs, occupations and the mix of occupations that characterize computing professional work.

Workshop participants observed that demand for computing professionals to engage in research appears to be softening due to constraints on funding for academic research and the decline of large central industrial research laboratories.

Equality of opportunity and the increasingly global talent pool are among supply challenges.

In general, given the current economic environment, the total supply of computing professionals is adequate for today's needs. Given that bachelor's degree production is declining in science and engineering, especially in computer science, continuing attention will be needed to assure an adequate flow of talent into computing professional occupations. At issue are both the quantity and the quality of entrants.

In particular, more effort should be made to encourage and support the interests of women and non-Asian minorities, groups that are underrepresented in the field. Underrepresented populations offer new sources of talent and new perspectives that can enrich the computing professions.

Dynamic occupations require continuous learning

Continuing education and training are important for computing professionals because of the dynamism of computing technologies and markets. The education of new entrants to computing occupations must provide a foundation for future training and retraining.

Better planning requires more and better data.

Better data are needed on the supply and demand for computing professionals. The dynamism of computing professional occupations makes it difficult to ensure that federal statistics about them remain accurate and sufficiently precise.

A first step is to improve the taxonomies under which data are collected and analyzed, an effort that requires greater understanding of skill requirements and trends. At the same time, there is a need for a robust high-level taxonomy with both a few broad occupational groupings and a clear explanation of associated portfolios of skills.

Better data on education and degree production for computing professionals are needed to guide employers, students, educators and policy-makers.

Marjory S. Blumenthal is director of the Computer Science and Telecommunications Board.

CRA sponsoring workshop for industry at Snowbird

The Computing Research Association is sponsoring the CRA Industrial Research Workshop at Snowbird for technical managers of industrial computing research. The goal of the workshop is to increase the effectiveness of industrial computing research by promoting the communication of common concerns and solutions.

The workshop is at the Snowbird resort near Salt Lake City. It begins the evening of Sunday, July 11, and ends at noon on Tuesday, July 13. The registration fee, which includes meals, is $350. Hotel costs are extra. Attendance is limited.

The workshop is modeled after the extremely successful biannual CRA Snowbird Conference for academic department chairs, government officials and industrial computing research managers. The workshop will feature panel discussions, invited speakers and plenty of time to get to know one another.

Attendance is limited to managers of industrial computing research organizations in North America who are at a level roughly equivalent to academic department chairs. The focus will be on managing strategically oriented, precompetitive research, a substantial fraction of which is published in the open scientific literature. If a large number of people want to attend the workshop, CRA and the workshop organizers will select the attendees.

The keynote speaker will be John Seely Brown, who is vice president of advanced research for Xerox, head of Xerox's Palo Alto Research Center and the Xerox chief scientist. Brown is the author of the controversial article, "How Research Reshapes the Corporation," published recently in *Harvard Business Review*.

Topics planned for the panel discussions include managing the relationship with the company; the social contract for industrial fundamental research; joint research with universities and with other companies; handling successes and disasters; research metrics and quality management; managing intellectual property; and the balance between research freedom and research management.

For more information about the workshop, contact Mark Weiser, the workshop organizer, at Xerox PARC, 3333 Coyote Hill Road, Palo Alto, CA 94304. E-mail to weiser@xerox.com is preferred. For more information about registering, contact Kimberly Paks at tel. 202-234-2111 or E-mail: kimberly@cs.umd.edu.

NAE elects 73 new members

The National Academy of Engineering recently elected 73 new members and eight foreign associates. This brings total US membership to 1,684 and the number of foreign associates to 142.

NAE membership is among the highest professional distinctions and is given to those who have made "important contributions to engineering theory and practice" and who have demonstrated "unusual accomplishment in new and developing fields of technology," according to NAE. Newly elected NAE engineers in computer science and related fields are:

Robert K. Brayton, professor of electrical engineering and computer science, University of California, Berkeley. For contributions to the theory and practice of computer-aided analysis and the design of electrical and logical circuits and systems.

Carl R. De Boor, professor of mathematics and computer science, University of Wisconsin, Madison. For contributions to numerical analysis and methods, especially numerical tools used in computer-aided design.

Susan L. Graham, professor of computer science, University of California, Berkeley. For contributions to the theory and practice of compiler construction and for leadership in the computer science community.

H. T. Kung, Gordon McKay professor of electrical engineering and computer science, Harvard University. For introducing the idea of systolic computation, for contributions to parallel computing and for applying complexity analysis to very large-scale integrated computation.

Richard C. Larson, professor of electrical engineering and computer science and co-director of the Operations Research Center, MIT. For developing and applying operations research methodologies in public and private service industries.

David A. Patterson, professor and associate chair of the Computer Science Division, University of California, Berkeley. For technical and educational contributions and leadership in the development of computational systems.

Deborah J. Seifert, manager of operations support, Allied Signal Aerospace Co. For contributions to the expanding field of computer-integrated manufacturing as an instrument of industrial competitiveness.

Robert J. Spinrad, vice president of technology analysis and development, Xerox Corp., Palo Alto, CA. For contributions in the application of computers to data acquisition, analysis and control for scientific experiments.

Niklaus Wirth, head of the Department of Computer Science, Swiss Federal Institute of Technology in Switzerland. For developing computer languages and systems having pedagogical and pragmatic impact.

Jack. K. Wolf, professor of electrical engineering, University of California, San Diego. For contributions to information theory, communication theory, magnetic recording and engineering education.

William A. Wulf, AT&T professor of engineering and applied science, University of Virginia, Charlottesville. For professional leadership and contributions to programming systems and computer architecture.

Research News

Understanding planet Earth: challenges for CS/CE

By Helen M. Wood

Over the next decade, the US government, working with academia and industry, will develop and interconnect vast computing and communications systems hosting previously unimaginable amounts of environmental data. These data and systems will provide essential support to the US Global Change Research Program (USGCRP), established to help develop sound national and international policies related to global environmental issues, particularly global climate change.

The National Research Council report, *Computing the Future: A Broader Agenda for Computer Science and Engineering*, cited global change research as an example of an application domain that presents intellectually substantive and challenging computer science and engineering (CS&E) problems. Some of the problems are inherent in the mind-boggling volumes of data involved. Others derive from the nature of the data and the multidisciplinary uses to which the data will be applied. To get a sense of the types of CS&E problems presented by this area of work, it helps to learn a bit more about the program and some of the data management efforts under way.

USGCRP's central goal is to help establish the scientific understanding and the basis for national and international policy-making related to natural and human-induced changes in the global Earth system. To accomplish this goal, USGCRP addresses three parallel but interconnected streams of activity:

- documenting global change (observations) through the establishment of an integrated, comprehensive, long-term program of documenting the Earth system on a global scale;
- enhancing understanding of key processes (process research) through a program of focused studies to improve our understanding of the physical, geological, chemical, biological and social processes that influence Earth system processes; and
- predicting global and regional environmental change (integrated modeling and prediction) through the development of integrated conceptual and predictive Earth system models.

The program is designed explicitly to address scientific uncertainties in such areas as climate change, ozone depletion, changes in terrestrial and marine productivity, global water and energy cycles, sea level changes, the impact of global changes on human health and activities and the impact of anthropogenic activities on the Earth system. The highest priority near-term scientific and policy-related issue for USGCRP is to examine the extent to which human activities are changing, or will change, the global climate system. The program has seven prioritized science elements:

1) climate and hydrologic systems
2) biogeochemical dynamics
3) ecological systems and dynamics
4) Earth system history
5) human interactions
6) solid Earth processes
7) solar influences

A better predictive understanding of the Earth system requires improved answers to a number of questions. These questions fall into three major classes: 1) What global changes have occurred in the past and are occurring now? 2) What physical, geological, chemical biological and social processes are involved in global change? 3) How well can global change be predicted?

> *Global change research presents intellectually substantive and challenging computer science and engineering problems.*

While success requires progress in all seven scientific elements, program leaders also recognize the need for the development of data and information management systems to provide ready access to and support for the analysis of integrated datasets. For fiscal 1993, the program has planned about $1.4 billion for its focused programs, with about 20% identified for data and information management.

USGCRP requires massive quantities of highly diverse data to improve our understanding of global change processes and to monitor global change. The large-scale and long-term nature of global change processes requires that continuous observations from many national and worldwide sources be used in conjunction with existing data to achieve scientific understanding and to ultimately develop predictive capability. All of this requires careful arrangements for managing the wide range and enormous volumes of data that will result from the space- and ground-based observational programs. Because of the critical importance of data and information management in achieving the scientific objectives, this aspect of USGCRP has been emphasized strongly throughout the entire program life cycle.

The US Global Change Data and Information Management Program Plan commits participating agencies to work with each other, with academia and with the international community to make it as easy as possible for researchers and others to access and use global change data. In support of this goal, the agencies are organizing a Global Change Data and Information System (GCDIS) that takes advantage of the mission resources and responsibilities of each agency.

The primary users of GCDIS are global change researchers in agencies, academia and the international community who conduct process studies and integrated modeling investigations; researchers, policy makers and educators who assess the state of global change and global change research to provide information for policy decisions; and the public. Thus users will be worldwide and multidisciplinary and possess varying levels of scientific and computing knowledge and skill. GCDIS data also should be of value to industry.

The program plan provides a framework for sharing data and information resources among agencies so they can make wise decisions that accommodate the broad needs of the user community. Under this program plan, participating federal agencies commit to several specific activities including:

- documenting and preserving long-term and in situ remotely sensed and derived digital and nondigital global change data, so comparative analyses can be conducted over decades or centuries;
- building on existing digital and nondigital data resources to improve access to high-quality global change data by integrating appropriate activities of agency data centers, archives, libraries and other information-disseminating organizations, and by providing products in appropriate media, depending on a user's needs;
- using appropriate national, international and de facto standards to make it easier to archive and exchange data, describe the quality of data, improve the compatibility of media as they change over time, access the data by networking, develop accurate documentation and help with the consistency of data products and procedures across agencies.

Although some elements of GCDIS will be developed expressly for the purpose of supporting USGCRP, GCDIS also will incorporate many other data management systems that are designed and developed for other purposes, operational on a variety of hardware and software and managed by or for various government agencies.

The primary sources for global change data are national and international agency programs. Information targeted for GCDIS includes raw data from observation systems, value-added data from data assembly activities and derived data from models and other investigations.

The largest datasets of interest to the USGCRP are obtained from Earth remote sensing satellites. While a number of satellite programs are planned for the future, the polar-orbiting and geostationary operational environmental satellites of the National Oceanic and Atmospheric Administration (NOAA) and the Defense Meteorological Satellite Program currently are providing valuable, real-time information about changes in the world's weather and climate. The basic purpose of these operational satellites is to support weather forecasting. However, they also yield information on key climate variables including surface temperatures, wind velocities and land cover. These data form a record of baseline information—with some datasets dating from 1978—against which global change can be measured.

In order for the data to be of use to global change researchers, a number of fundamental problems first must be addressed. Solving these problems will provide useful insights into dealing with the challenges expected in the years ahead when data will pour in from environmental research satellites and other sources at rates surpassing 2 terabytes a day.

To get a handle on the problems inherent in managing large, environmental datasets, NOAA and NASA formed the Pathfinder Project in 1990. Pathfinder datasets are long time-series, global or regional datasets from which higher level geophysical products can be derived that are applicable to the study of global change questions.

The Pathfinder process typically involves transferring data to a more accessible medium, defining a mature community consensus algorithm, consistently processing the entire dataset and creating data services required by global change research users.

The problem of gaining workable access to enormous datasets is well-illustrated by the task of migrating a subset of the Advanced Very-High Resolution Radiometer (AVHRR) dataset from magnetic tapes to optical platters. This dataset resided on about 17,000 magnetic tapes, in both computer-compatible tape and cartridge formats. After transcription, the data resided on 366 12-inch optical platters, with each disk holding 6.5 billion bytes of data, or 10 days worth of orbital data from one spacecraft. It has taken from six weeks to three months to transcribe a year of AVHRR data to optical platters, using two transcription sites.

The problems addressed thus far by the Pathfinder Project center around the migration of these enormous datasets to a more manageable working medium. Once that occurs, the emphasis will shift to processing the full datasets against community-consensus algorithms. But it is not that simple. Adjustments must first be made to the data to account for variations in the satellite sensors and other factors. Over the lifetime of a satellite, the sensors are subjected to environmental stress, interference from adjacent instruments, solar interference and routine instrument degradation. In addition, improved versions of the sensors may be flown on subsequent spacecraft, resulting in improved support for weather forecasting, but creating additional problems for those involved in climate and global change research. Before attempts are made to identify changes in measured climate parameters, "noise" in the data record first must be removed. This overall process is termed "calibration."

Processing can begin only after data are moved to more convenient media and cleaned up for cross-comparisons and trends analysis and scientists have agreed upon the algorithms to be used. As the processing results are passed to the science teams, it is inevitable that improvements in the algorithms will be developed and problems with the data calibration may be revealed—then the process will begin again.

All of the above discussion focused

Continued on page 11

Policy News

SPI building folklore database

BY Bernard A. Galler

We at the Software Patent Institute (SPI) are asking the software community to help us build our folklore database. You can do this by sharing the concepts and techniques that you find so familiar, but which the Patent and Trademark Office (PTO) generally cannot identify as prior art. The database will help PTO do its job better, so that patents are not granted for techniques that have already been invented but are lost in the folklore. This folklore exists in old off-line journals, user manuals, conference proceedings, course handouts and other materials, but it is not yet readily searchable by PTO. The SPI database will be available to PTO and the public for searching, not only in connection with software-related patents, but also for historical and other research.

SPI is rigorously neutral on the desirability of software-related patents. We believe the existence of this database will be of use to the community, regardless of one's position about such patents.

SPI mission

SPI is a nonprofit institution dedicated to providing information to the public. SPI also assists PTO by providing technical support in the form of educational and training programs and providing access to information and retrieval resources. SPI's primary goal is to provide PTO and the public the best available information on prior art in the software field. In addition, SPI is providing an educational resource from which PTO and the public may obtain an enhanced understanding of the nature of software, software engineering and the history of the discipline and its relationship to the patent process.

SPI is asking people in the software industry, government and academia to contribute descriptions of software techniques and processes to the Software Patent database. (Note that SPI is not building a collection of the techniques and processes themselves, in source code, object code or any other form.) These descriptions form the content of the database and will be made available for computer-aided searching to PTO, SPI members and the public. SPI expects PTO and others involved in the patent process to search the database for patent-related reasons. However, software developers, historians and computer scientists also will find the database useful.

SPI is interested in documenting what industry, academia and government have been doing. Descriptions of techniques or processes that were first described or used in the past are its first priority, especially the "tricks" that everybody knows but are unsure of how they found out about. The information could come from a chapter in a standard reference work, a conference or course, some publication that is not available on-line or some other source.

Accessing the database

The database resides at the Industrial Technology Institute of Ann Arbor, MI, which is the home of SPI. During the development and testing phase, access is limited to those helping to conduct the tests (primarily PTO and SPI members). SPI is hoping to have dial-up (and possibly Internet) access by mid-1993.

Once linked, searchers can use all the standard techniques available in commercial-grade text-searching software, including individual keywords, Boolean operations among keywords and proximity searches. The techniques are similar to those used in other text-based services such as WestLaw, Lexis, Orbit and Dialog. Individual records will be available for on-line examination and downloading, subject to standard charges.

Over time, SPI will add value to the database by adding keywords and other search aids to those that come with each original submission. SPI has developed a relational database that will contain such added value and has been linked to the free-text database containing the submissions themselves. For now, the process starts with submissions to the free-text database, and we are hoping the software community will agree to help us in this way.

Submission guidelines

Each record in the SPI database consists of a free-form, textual description of a software technique or process and some additional, structured information. If you have the legal authority to give us something that is more complete but less structured than individual submissions, such as the complete text of conference or course proceedings, we are happy to accept such material if it can be provided in electronic form.

SPI has a template that you can copy and fill out as you prepare electronic submissions. Send submissions in electronic form (via e-mail or on an MS-DOS or Macintosh disk) and the license agreement in paper form.

To obtain the full text of the submission guidelines including the template, send your request by e-mail: spi@iti.org; fax: 313-769-4064; or postal mail: Software Patent Institute, 2901 Hubbard, PO Box 1485, Ann Arbor, MI 48106-1485.

Bernard A. Galler is chair of the Software Patent Institute.

CRA plans research policy seminar

CRA plans to sponsor the *Congressional Computing Research Policy Seminar on High-Speed Data Networks* this summer. The seminar is tentatively scheduled for July 30 in Washington, DC. CRA's occasional series of seminars informs key policy-makers about the challenges and opportunities presented by computing research. The speaker will be Leonard Kleinrock, professor and chair of the Computer Science Department at the University of California, Los Angeles.

Bills from page 7

Commission on the Advancement of Women in the Science and Engineering Work Forces Act (HR 467)

Rep. Constance Morella (R-MD) introduced a bill in January to establish a commission to help overcome the low representation of women in the sciences.

The 17-member commission (five appointed by the president, one by the director of the Office of Science and Technology Policy and the rest by key members of Congress) would track representation of women in the science work forces, study policies and practices of government and industry and recommend changes.

Technology Education Assistance Act of 1993 (HR 89)

Rep. Dale E. Kildee (D-MI), chair of the House Education Subcommittee on Elementary, Secondary and Vocational Education, introduced a bill in January to improve the use of technology in schools.

The bill authorizes $500 million in fiscal 1993 for elementary and secondary schools to improve the use of computer, video and telecommunications technologies. One-quarter of the money would go to colleges and universities with programs for training school teachers to use these technologies.

Technology Transfer Improvements Act of 1993 (HR 523)

Rep. Constance Morella (R-MD) introduced a bill in January that would allow the federal government to copyright software in certain cases where it developed software, at least in part, under a cooperative R&D agreement specified by the Stevenson-Wydler Technology Innovation Act of 1980.

The bill also allows the federal government to grant copyrights to private businesses that "publicly perform or display computer software throughout the world by or on behalf of the government."

Copyright Reform Act of 1993 (HR 897)

Rep. William Hughes (D-NJ), chair of the House Judiciary Subcommittee on Intellectual Property and Judicial Administration, introduced a bill in February to change copyright law. Current law requires plaintiffs to have registered works with the US Copyright Office before they can sue for statutory damages and attorneys fees. The bill seeks to repeal this law so that owners who have failed to register works can still sue for damages.

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The rate is $2 per word (US currency). A check or money order (*please do not send cash*) must accompany the ad copy. Purchase orders are acceptable. All CRA members receive at least 200 free words per dues year.

Professional Opportunity display ads cost $30 per column inch. The ad must be submitted in camera ready, offset (positives or negatives) or mechanical form. Please call for information on placing display ads for products or services.

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 will not be accepted. (An ad published in the September issue must show an application deadline of Oct. 1 or later.) Advertising copy must be received at least one month before publication. (The deadline for the September issue is Aug. 1.)

New Mexico Institute of Mining and Technology

Computer Science Department

New Mexico Institute Of Mining and Technology seeks applicants for two tenure track positions in computer science. Applicants for the position of department chair must be qualified for appointment at the associate or full professor rank and have demonstrated achievements in teaching, research and academic leadership. The other position will be at the assistant professor level, depending on the availability of funding.

Candidates must have a Ph.D. in computer science or computer engineering at the time of appointment and demonstrate potential for excellence. The ability to teach graduate-level courses and do research in one or more areas of computer science is essential. Ideal candidates also will be able to teach undergraduate courses in computer architecture and operating systems. Lecturing ability in English is required. Duties include teaching, research, thesis supervision and service.

New Mexico Tech is a scientific and technical institute with 1,400 students. The Computer Science Department has 120 students and offers bachelor's, master's and Ph.D. degrees. There are excellent facilities for research and teaching, and excellent opportunities to interact with nearby institutions, including the National Radio Astronomy Observatory, Los Alamos and Sandia National Laboratories. New Mexico Tech is located in the Rio Grande valley with fabulous weather and endless outdoor recreational opportunities.

Send applications, the names of at least three references and a two- to three-page description of research interests to New Mexico Institute of Mining and Technology, Human Resources, Weis Hall, Box C-021, Socorro, NM 87801. Screening will begin May 15 and continue until the positions are filled.

New Mexico Tech is an affirmative action, equal opportunity employer.

University of Chicago

Department of Computer Science

Junior and senior positions are available in the Department of Computer Science. Our preference is for candidates with expertise in one of the areas of experimental computer science, such as programming languages or distributed systems, but we will consider exceptionally strong applicants from all areas.

Send curriculum vitae and three letters of reference to Professor Janos Simon, Chair, Department of Computer Science, University of Chicago, 1100 E. 58th St., Chicago, IL 60637. Inquiries can be directed to chair@cs.uchicago.edu.

The University of Chicago is an equal opportunity, affirmative action employer.

University of Manitoba

Department of Computer Science

Applications are invited for two positions—one tenure-track and one term—at the assistant professor or lecturer level. The minimum qualification for an assistant professor is a doctorate in computer science or allied discipline. Areas of particular interest are operating systems and theory though excellent candidates in other areas may be considered.

The department has 23 tenure-track faculty and several term appointments, and offers a range of undergraduate and graduate programs, including cooperative programs. The department has more than 50 graduate students. The department provides good technical support for teaching and research. Facilities include many interconnected Unix-based RISC workstations, MicroVAXes, X Window terminals and a parallel machine.

Send curriculum vitae and the names of three referees to Peter R. King, Head, Department of Computer Science, University of Manitoba, Winnipeg, Manitoba Canada R3T 2N2. Tel. 204-474-8313; fax: 204-269-9178; E-mail: prking@cs.UManitoba.ca.

The university encourages applications from qualified women and men, including visible minorities, aboriginal people and persons with disabilities. The university has a smoke-free work environment. In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

Syracuse University

School of Computer and Information Science

The Syracuse University School of Computer and Information Science (CIS) offers comprehensive programs in computer science and information science. CIS is strongly interdisciplinary, reflecting the fact that information and computation are integral parts of many disciplines. Degree programs are offered at the bachelor's, master's and doctoral levels. CIS also offers an undergraduate concentration in computational science as well as master's and doctoral level certificates in computational science.

The research interests of the faculty lie in the areas of theory of computation, programming languages, parallel programming, artificial intelligence, computer architecture for symbolic computation, parallel computing, neural networks, computational science, logic programming and coding theory and combinatorics. CIS's independent research centers maintained by Syracuse University—the Northeast Parallel Architectures Center and the Center for Computer Applications and Software Engineering—provide computing and research opportunities for all students. Syracuse University has a growing stature in the sciences and maintains outstanding traditions in music, art, drama and public affairs.

For application and financial aid information, contact Barbara Rivers, School of Computer and Information Science, Suite 4-116, Center for Science and Technology, Syracuse University, Syracuse, NY 13244-4100. Tel. 315-443-2368; fax: 315-443-1122.

Earth from page 9

on the data preparation process. Most of the challenges centered around the logistics involved in managing large volumes of data. As relatively mundane as these problems may seem, they have effectively impeded the study of global change by making the data too difficult for most researchers to acquire and manage.

As we make substantial progress in removing this barrier to data access, we are confronted with the lack of tools for accessing, managing, distributing and visualizing global change data. The multi-agency GCDIS effort mentioned above is intended to provide a basic set of services and features for these needs including:

- an ability to search for global change data products across heterogeneous systems and to order data products through a simplified "one-stop shopping" procedure;
- global change data directory information using a common agency-independent user interface;
- guide or text information about the data to assist the researcher in assessing data availability and suitability; and
- a variety of distribution options, including summary, reduced-resolution browse products and full-resolution data products in standards formats.

As work progresses in this area, it will become increasingly obvious that a number of areas in computer science and engineering can play a major role in helping to make these datasets more useful. Today's database management systems and tools are not adequate for global change research in that they do not support large, scientific (image) database management.

Data objects of 100 megabytes or more are common when dealing with satellite data. For example, one full disk image of the Earth obtained from NOAA's geostationary satellite occupies 384 megabytes. Data types may include raster data, vectors, textual data and more conventional numerical data. Handling and searching such large data volumes inevitably will require the application of improved lossless and selected lossy data compression techniques.

The dataset from NOAA's geostationary operational satellites, currently over 115 terabytes, presents a still greater challenge.

Significant advances are needed in geographic information systems to be able to routinely accommodate remote sensing and other data of the magnitude and nature anticipated for the USGCRP. Tools are needed for querying and browsing these complex datasets. Virtually no tools exist today for automatically searching these databases and locating phenomena of interest. Even a search as relatively simple as "locate images of all cloud-free days over a region encompassing Kansas and Nebraska in January of each year from 1978 through 1985" today requires the development of extensive special-purpose code. And cost-effective processing and reprocessing of these large volume datasets will benefit from the development of highly efficient processing algorithms.

Predictions of weather, climate and global change are included among the grand challenges targeted by the High-Performance Computing and Communications program. Access to environmental databases is a key element of HPCC. Thus, progress in the HPCC program should support advances needed for USGCRP.

Outside of the US government, private industry and academia also are addressing USGCRP data management needs. The Sequoia 2000 project, funded by Digital Equipment Corp., has investigators from computer science and Earth science departments on five campuses of the University of California. Its main objective is to develop an improved data and information system for global change researchers that fosters synergistic interactions between observations and models and enables and encourages interdisciplinary research.

Recognizing that advances in computer science and engineering were required for the success of Mission to Planet Earth—NASA's contribution to the USGCRP—the Center for Excellence in Space Data and Information Systems (CESDIS) was established at the University of Maryland and funded by NASA's Goddard Space Flight Center. CESDIS currently is supporting projects in the management of very large scientific databases, data compression, high-bandwidth computer networking and other areas of direct applicability to global change research. This program is relatively small and unknown.

However, the role of such a program should be considered as a model in terms of presenting opportunities for computer scientists and engineers to become exposed to the scientific and technical problems presented by the diverse area of global change research.

Helen M. Wood is director of the National Oceanic and Atmospheric Administration's Office of Satellite Data Processing and Distribution, a member of the CRA Editorial Board and former president of the IEEE Computer Society.

This article is a contribution of the US government and is not subject to copyright.

FCRC '93

Achievements and challenges in VLSI processor design

BY Maurice V. Wilkes

The following is an unedited summary of Maurice V. Wilkes' keynote address at the Federated Computing Research Conference May 14-22 in San Diego.

A workstation stands on a user's desk and is used personally by that user. What is essentially the same product, but endowed with more peripherals, can be used to give a time-sharing service to a few users, or as a server on a network. When used in this role, I like to call it a *non-personal* workstation. It performs the same functions as the old-fashioned minicomputer and may be more powerful, but it costs a lot less. This can cause misunderstandings. I have heard that one customer was indignant when he discovered that what he was being offered as an upgrade for his database computer had a garden-variety workstation card inside it.

We owe the great advances of the last few years to the development of CMOS process technology. I would like to understand exactly what happened around 1987 that made it possible for semiconductor process engineers to get their act together and move forward with great confidence. The 1-micron barrier has long been broached, and the apparently daunting problem of putting several layers of metal on the uneven surface presented by the underlying layers of logic has been solved.

There have been parallel developments in computer architecture, compiler technology and simulation techniques for performance estimation. There also has been the emergence of Unix as a machine-independent operating system. The latter was of particular importance in that it led to the deposing of the processor instruction set from the dominant role it had hitherto played. The vehicle for the transport of Unix was the language C. Once a C compiler was available for a processor with a non-standard instruction set, Unix could be run on it, and that processor could take its place in the workstation world. A number of companies took advantage of this to introduce workstations with reduced instruction set computer (RISC) processors. Whether or not this relaxation of the compatibility restraint was a temporary phenomenon will emerge as time goes on.

In the middle of 1990, the MIPS R2000/R3000 showed that it was possible to put on the same chip the whole of the integer *RISC core*, consisting of register file, ALU, memory management unit with its associated TLB and control circuits for data and instruction caches. The fact that a RISC integer core occupied only half the space that a conventional processor would have occupied was important at this time, because it enabled modern workstation development to take place two years sooner than it otherwise would have done. The effects—good or bad—that this had on the industry may be debated.

Obviously it was only a matter of time before other units, in particular data and instruction caches and the floating point unit, could be put on the same chip. It took longer than expected to achieve this, and in the meantime Hewlett-Packard and IBM did very well with systems in which these units were on separate chips. There were, in fact, short-term business advantages in a system comprising several chips. Those have had to split the integer RISC core between several chips would have been fatal, but with the clock rates then prevalent, careful pipelining enabled transmission delays to and from the caches and floating point unit to be accommodated. The period during which these considerations were relevant for high-performance CMOS processors has passed, but similar circumstances could well recur in other contexts.

The time taken to send signals from one chip to another is made up almost entirely of the time taken to charge the capacitance associated with the pad. With properly designed and terminated transmission lines, the signals pass between the chips at the speed of light, adjusted to allow for the presence of dialectric material in the interconnect. The speed at which the driving circuits can charge the pad is determined by the amount of power available. The time taken to send a signal from one side of a large chip to another also depends on the power available. As chips get denser and larger, transmission of signals across a chip will require careful attention.

Workstations already have occupied the territory formerly occupied by minicomputers, and there is a tendency to assume that they have all but occupied that of the large mainframe. In fact, this point is still some little distance off. Mainframes are still being bought, although in smaller numbers, and there is severe price competition between vendors.

There is no difficulty in seeing VLSI processors outperform mainframes and traditional supercomputers as regards speed. However, they also will have to match them as regards memory bandwidth and I/O bandwidth. There are challenges here for the industry. They will no doubt be successfully met, but it must not be assumed that they will be met overnight.

Many people believe that the future of VLSI lies entirely with CMOS, and this may be true. However, emitter-coupled logic (ECL) processes are closely tracking CMOS processes and achieve similar feature sizes. ECL is intrinsically faster than CMOS and it works with smaller voltage swings. For these reasons it is capable of greater speed. Workers at Digital Equipment Corp.'s Western Research Laboratory have demonstrated that a VLSI processor using ECL technology is by no means an idle dream.

There has been a surprising growth of interest in BiCMOS, a process in which CMOS and ECL transistors are formed on the same chip. This process is also of interest for analog circuits. Most people are interested in forms of the process in which the ECL transistors are of relatively poor quality, but adequate for driving interconnect. DEC's Western Research Laboratory is exploring the use of a process that provides higher quality transistors that can be used for the computing circuits and the registers, leaving CMOS to be used for storage.

I am aware that many people see no future in high-density ECL chips. However, it would be strange if a process that has for so long dominated higher performance computers were to play no part in the future world of VLSI. Gallium arsenide is coming on fast and may be a competitor, but I do not feel competent to express an opinion on it.

Maurice V. Wilkes was for many years head of the Computer Laboratory of the University of Cambridge. Since 1980 he has worked in industry. His present affiliation is with Olivetti Research. He received the ACM Turing award in 1967 and is the author of Memoirs of a Computer Pioneer, MIT Press, 1985. He was recipient of the 1992 Kyoto Prize for Advanced Technology. He is a Distinguished Fellow of the British Computer Society, a Fellow of the Royal Academy of Engineering and a Fellow of the Royal Society.

Participating FCRC '93 research meetings

• 25th Annual ACM Symposium on the Theory of Computing (STOC)
Sponsor: ACM Special Interest Group on Algorithms and Computation Theory

• Ninth Annual ACM Symposium on Computational Geometry
Sponsors: ACM SIGACT and ACM Special Interest Group on Graphics (SIGGRAPH)

• Fourth ACM Symposium on Principles and Practices of Parallel Programming (PPOPP)
Sponsor: ACM Special Interest Group on Programming Languages (SIGPLAN)

• Eighth Annual Conference on Structure in Complexity Theory
Sponsor: IEEE Technical Committee on Mathematical Foundations of Computing

• Workshop on Parallel Algorithms (WOPA '93)
Sponsor: University of Maryland Institute for Advanced Computer Studies (UMIACS) and the Advanced Research Projects Agency

• 20th Annual International Symposium on Computer Architecture
Sponsors: ACM Special Interest Group on Computer Architecture, IEEE Computer Society and the IEEE-CS Technical Committee on Computer Architecture (TCCA)

• Seventh Workshop on Parallel and Distributed Simulation (PADS)
Sponsors: ACM Special Interest Group on Simulation (SIGSIM), IEEE Computer Society IEEE-CS Technical Committee on Simulation (TCOS) and the Society for Computer Simulation (SCS)

• ACM/ONR Workshop on Parallel and Distributed Debugging
Sponsors: Office of Naval Research, ACM SIGPLAN and the ACM Special Interest Group on Operating Systems

• CRA Workshop on Academic Careers for Women
Sponsor: CRA's Committee on the Status of Women

CRA sponsors FCRC workshop

The Computing Research Association is sponsoring a one-day *CRA Workshop on Academic Careers for Women in Computer Science* in conjunction with the Federated Computing Research Conference in San Diego. The May 15 workshop is supported by a grant from the National Science Foundation (NSF).

The need for a mentoring program to assist young female computer scientists has long been recognized by computing research professionals. The workshop will respond to this need by bringing together women who are just starting their careers and women already in the field. Established professionals will share their experiences and provide the practical information, advice and support their younger colleagues will need if they are to succeed. The program is designed for women who will be at research universities where a substantial research program is critical to success.

The workshop will bring together recent postdoctoral students, graduate students in computer science and professional computer scientists. A program committee of computer scientists, chaired by Cynthia Brown of Northeastern University in Boston, used a competitive application process to select 10 postdoctoral and 10 graduate student participants. Awardees also will receive support to register for one of the research meetings at FCRC '93.

The sessions are "The Tenure Decision," "Getting the Job and Getting Established," "Building your Research Program," "Obtaining External Funding," "Teaching," "Making Connections" and "Time Management." Each session will be chaired by a member of the program committee, and several panelists will help lead discussions.

The Program Committee members are Cynthia Brown (Chair), Northeastern University; Ed Weingarten, CRA; Fran Berman, University of California at San Diego; Jan Cuny, University of Massachusetts at Amherst; Susan Eggers, University of Washington; Joan Francioni, University of Southwestern Louisiana; Judy Goldsmith, University of Manitoba; Maria Klawe, University of British Columbia; and Nancy Leveson, University of California at Irvine.