COMPUTING RESEARCH NEWS

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Congress Finishes FY2003 Funding, Sets to Work on FY2004

By Peter Harsha

House and Senate appropriators reached agreement in late February on a final FY 2003 appropriations package that provides significant increases in science funding at the National Science Foundation for the current fiscal year, but not quite as generous as the levels originally approved by the respective committees last fall. The long-awaited agreement came nearly five months after the official start of the 2003 fiscal year on October 1, 2002. In the interim, federal agencies had been unable to start new programs or expend new funding.

House and Senate leaders reached agreement with the Administration on a final overall spending number for the 11 unfinished annual appropriations bills (the Defense and Military Construction appropriations bills were passed last fall) and rolled them all into one large bill. The resulting 2003 Omnibus Appropriations bill includes significant increases in science funding overall, as well as some specific increases in computing research for FY 2003.

Among the biggest winners in the appropriations process for FY 2003 was NSF, whose Research and Related Activities account received a 13.5 percent increase, including a 13.1 percent increase in the Computer and Information Science and Engineering directorate. Under the agreement, funding for CISE in FY 2003 increases to $582 million.

Though overall funding for the Department of Energy's Office of Science will decrease in FY 2003 by $48.3 million to $3.26 billion (-1.5 percent over FY 2002), computing research in the office fared much better. Concerned about recent developments by Japan in scientific supercomputing, Congress increased funding to the Advanced Computing Research program at DOE to $167.4 million in FY 2003, an increase of 11.5 percent or $17.2 million over FY 2002.

In most cases, funding levels in the omnibus bill represented a slight reduction from the levels approved by both House and Senate appropriations committees when they considered each of the 11 appropriations bills individually. In order to get under spending limits set by the White House, the House and Senate leadership decided on across-the-board cuts to all approved levels in the bills. As a result, funding for NSF CISE, for which Senate appropriators had approved a 15.8 percent increase, will receive "only" a 13.1 percent increase for FY 2003.

Shortly after Congress finished work on the FY 2003 appropriations bills, debate began on the FY 2004 budget with a marked change in tone. The President's budget request (discussed in the March 2003 *CRN*, vol. 15, no. 2) contained only modest increases in research and development funding overall. The House Budget Committee followed by producing a budget resolution heavily influenced by the understanding that the final cost of the war in Iraq was likely to be significant, but is currently unknown. The "Fiscal Year 2004 Wartime Budget Resolution" drafted and approved by the committee actually calls for a cut in federal science funding of $300 million in FY 2004.

Tracking the effect of the cut is complicated by the way the resolution is structured. The budget sets funding levels for a variety of broadly categorized budget "functions" of the federal government. For FY 2004, the budget resolution calls for spending $22.8 billion in "General Science, Space, and Technology"—budget function 250—an account that includes funding for NSF, the National Aeronautics and Space Administration, and DOE's Office of Science. In the committee report that accompanied the resolution, the Committee explains that it arrived at $22.8 billion ($300 million less than the FY 2003 approved level) by assuming, among other things, a growth rate of just 3.8 percent for NSF in FY 2004.

A number of members of Congress spoke out against this cut to general science funding in hearings that preceded the Committee's action on the resolution. Rep. Vern Ehlers (R-MI), chairman of the House Science Subcommittee on Environment, Technology and Standards, opposed the cut by pointing out that "science forms the foundation" for each of the budget committee's priorities for the budget: funding the ongoing war on terrorism, contemplating a potential war with Iraq, facilitating economic

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Inside CRN

Bajcsy and Rodriguez to Receive CRA Service Awards

CRA is pleased to announce the winners of its 2003 service awards. Ruzena Bajcsy, Director of CITRIS at the University of California, Berkeley, will receive the Distinguished Service Award. Rita Rodriguez, Program Director in CISE at the National Science Foundation, will receive the A. Nico Habermann Award. The presentations will be made on June 7 at the ACM Awards Banquet at the FCRC conference in San Diego.

CRA presents these awards, usually annually, to individuals for outstanding service to the computing research community.

Rita Rodriguez

The Distinguished Service Award recognizes service in the areas of government affairs, professional societies, publications, or conferences, and leadership that has a major impact on computing research. The A. Nico Habermann Award honors the late A. Nico Habermann, former head of NSF's Computer and Information Science and Engineering Directorate. This award is given to an individual who has played a leadership role in aiding members of underrepresented groups within the computing research community. It recognizes work in areas of government affairs, educational programs, professional societies, and public awareness.

CRA Distinguished Service Award

Ruzena Bajcsy has been Director of the Center for Information Technology Research in the Interest of Society (CITRIS) at the UC campuses of Berkeley, Davis, Merced, and Santa Cruz since November 2001.

From December 1998 to September 2001, Dr. Bajcsy served as Assistant Director of NSF's Directorate for Computer and Information Science and Engineering (CISE). During her tenure at NSF, she was instrumental in helping to establish the Foundation's Information Technology Research (ITR) program that funds innovative, high-impact research in information technology. As a result of ITR funding, CISE's research budget grew by about 50 percent, the largest increase in the history of CISE. Dr. Bajcsy was very effective in making the case that the

Ruzena Bajcsy

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Expanding the Pipeline

Are Student Evaluations of Teaching Fair?

By Faith E. Fich

Introduction

Anonymous student evaluations of teaching are widely used at universities throughout North America for tenure and promotion decisions, determination of yearly salary increases, and the choice of teaching award recipients. Their purpose is to fairly evaluate the teaching quality of faculty members and help them improve their teaching. Yet, the perception of many faculty members, including me, is that the use of student evaluations of teaching achieves neither of these goals.

Over the past few years, I have talked to many faculty members in science and engineering about student evaluations, including department chairs, deans, and directors of a number of university teaching centers. I was also a member of a committee set up by the dean of the Faculty of Arts and Science at the University of Toronto to address the issue of bias in evaluation of women science professors' teaching.

It is outside the scope of this article to give a survey of the relevant literature. However, I'll mention some of the evidence that has convinced me of the unfairness of student evaluations of teaching as they are often used. More importantly, I will discuss implications for how the results of student evaluations should be used and present a few general recommendations for evaluating teaching fairly and effectively.

Gender Bias

I want to begin with one carefully controlled experiment that I found very compelling. Sinclair and Kunda [6] administered a test of 10 open-ended questions to approximately 50 male students. Each student was given feedback on his performance, randomly chosen from among four prerecorded videos. There were two evaluators, one male and one female, and two scripts, one praising the student's performance and one criticizing it. After receiving their feedback, each student was asked to rate his evaluator.

The results of this experiment are summarized by the title of their paper, "Motivated Stereotyping of Women: She's Fine if She Praised Me but Incompetent if She Criticized Me." More precisely, among ratings by students who had been given positive feedback, the two evaluators were rated roughly the same. However, among ratings by students who had been given negative feedback, the female evaluator was rated significantly lower than the male evaluator.

To isolate the cause of the difference in ratings, the experiment had a second part. In it, the test answers given by each student and the evaluation he had been given were shown to an observer, another male student who had not taken the test. Each observer was also asked to rate the evaluator. Among the observers, the ratings that evaluators received were not correlated with their gender.

Sinclair and Kunda's interpretation is that when people are criticized, they unconsciously use negative stereotypes about the criticizer to discount the validity of the criticism, as a way of maintaining self-esteem. An implication is that women professors who have high standards or who teach courses that students find difficult may well be victims of bias. They obtained similar results studying racial bias [5].

Another interesting experiment was performed by Kaschak [3]. A set of 25 male students and 25 female students were asked to rate professors, given descriptions of the professors and their teaching methods. Half the professors were listed as female, the other half as male. A second set of 25 male students and 25 female students were given the same descriptions, with the genders of the professors switched. Although the gender of the professor did not affect the ratings by female students, the male students rated the female professors lower.

Other Factors Affecting Student Evaluations

There is a vast body of literature about student evaluations of teaching, containing many conflicting conclusions. The problem is that there are many variables unrelated to the quality of teaching that may affect evaluations and that interact in complex ways. Furthermore, most of this work consists of statistical analyses, where factors that are significant for a small segment of the population, for example, women computer science professors, can be insignificant in the aggregate data.

Nevertheless, the bulk of the research does show that certain factors unrelated to teaching quality do affect students' evaluations of teaching. Students in higher-level courses tend to rate professors more favorably than students in lower-level courses [1, 4]. The same is true for students taking elective courses as compared with students taking required courses [1, 4]. Both of these outcomes may be related to the students' greater interest in the course material. There is also evidence that small class size [4] and leniency of grading [2, 4] lead to better ratings.

Faculty who penalize students for committing plagiarism may receive unfairly low ratings from those students. In computer science courses, it is relatively easy for students to copy pieces of code from one another and there is sophisticated software to detect plagiarism. Thus, this factor may have a greater effect on our evaluations than in other disciplines.

How to Use Student Evaluations

In light of the many factors unrelated to the quality of teaching that can affect the results, it is important to recognize the limitations of student evaluations of teaching when they are used.

Only compare results from similar courses.

In particular, comparisons of results should only occur for faculty members teaching courses with similar characteristics. These include factors such as class size, course level, difficulty of the material, whether the course is theoretical or applied, and whether the course is required.

Avoid general subjective items.

Bias is more likely to affect general subjective items such as "overall effectiveness of instructor." Therefore, such items should be avoided, especially for tenure, promotion, or salary considerations [1], in spite of the fact that some administrators want a single summary number.

Be careful with new courses.

When a course is taught for the first time or in a significantly different way, students' experiences often do not match their prior expectations. This can cause unfairly negative ratings, and the results must be interpreted with care. In particular, they should not be used to justify an unsuccessful tenure or promotion decision.

Results of student evaluations have low precision.

There are known problems with the precision of the results of student evaluations of teaching. For example, in my department, there are some multi-section courses where there are common assignments graded by the same teaching assistant. Yet, there are often significant differences in the student responses to supposedly objective items such as "assignments are graded fairly" or "returns work promptly," for faculty who are teaching different sections. These results seem to be correlated with the responses to general subjective items. In science, high-precision conclusions require justification. Given the large number of possible sources of error that can arise when students evaluate teaching, it is only reasonable to interpret the results using a very coarse scale: outstanding, good, or poor.

The teaching evaluation forms used by the Faculty of Science at McMaster University in Canada address this problem by giving students a comprehensive list of possible positive and negative characteristics about a course and the people who teach it. Students are asked to choose particularly relevant items from this list, rather than rating a small number of aspects on a scale.

Eliminate inappropriate student comments.

Some students use anonymous student evaluations to make inappropriate, slanderous, or abusive comments. For example, one woman received the comment, "She should wear more provocative clothing." The number of such comments seems to be significantly higher in biology and computer science

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Computer Science, Meet Learning Science

By Randy J. Hinrichs

The opportunities of the digital age have irreversibly disturbed the educational universe. Computer science sees a connected world of rich human-centric interfaces. The National Research Council's prominent study "How People Learn" (2000) tells us how experts learn, and calls for learners to be connected to outside experts, to use visualization and analysis tools, and to create learning opportunities with feedback, reflection, and revision to improve learning. So why do we still have classrooms and lectures as our predominant learning environment? Where is the breathtaking mobile, adaptive learning software that has been promised? Where's the revolution in technology in education? Bringing together the expertise of computer science and learning science research in a partnership with industry, government, and academia may prove to be just what we are looking for to achieve a revolution.

The global call to action has been sounded. The PITAC report calls for using information to *transform the way that we learn,* an upcoming CRA Grand Research Challenge report envisions providing *a teacher for every learner,* and the "Leave No Child Behind" campaign claims assessment and accountability as the vanguard to improving education. Industry too is playing its hand by investing in learning science and technology (LST) research to find the sweet spot for educational networks, tools, and platform design and to nudge the transformation for their information workers. Bottom line: surviving in a highly digitized global environment requires learning at the speed of a neuron firing.

Limitations of the Current Approach

Education and learning R&D are dramatically underfunded, both on an absolute basis and compared with other domains. According to the PCAST, R&D in K-12 education is funded at only 0.03 percent of total K-12 expenditures. The Federation of American Scientists' study of international funding for research in educational technology found that the United States spent only $33 million on non-defense-related education technology R&D in 2000, compared with $95.6 million in Canada (where distance education is a key player) and $65 million in the European Union.

Current funding levels are insufficient to understand how to design and implement technology-education learning. Bloom (1984) suggested that 2-sigma gains could be achieved by providing a 1:1 experience with tutor and student. But we haven't been able to use technology to scale even a 1:1 experience in instruction yet. Preliminary results in looking at effective uses of technology in education vary depending on the evolution of the technology and societal adaptation to the technology. Venezky and Davis (2002) report that technology, especially on the WWW, can be the catalyst for improving and innovating in education; but, where transformative vision and inspiration lead, technology serves only as an additional resource and not as a catalyst. We have so far to go, and our evolving global workforce is looking for a solution.

Setting a Vision for Change

There are attempts to set the vision for an educational transformation. The summit on *The Use of Advanced Technology in Education and Training* convened by Commerce Secretary Don Evans and Education Secretary Rod Paige identified 10 visionaries who explored the potential for technology to enhance education, and highlighted the need for research to get there. Other organizations such as DARPA, the Learning Federation, the National Academy of Sciences, and the IEEE Learning Task Force continue to push a global LST research agenda. Currently, research in LST is all over the place, and it is still quite difficult to find scalable environments grounded in learning science research with a rich set of methods and tools for creating substantive change.

We need a call to action, a grand challenge. We can continue on this path of underfunded, small-scale, poorly coordinated investments in research, or we can create alliances between industry, government, and universities to develop a comprehensive, focused research and management plan. Such a plan can create the partnership needed to reduce redundancy, build significant open architectures and tools for distributed, qualified academic content, and integrate our research into a stream of prototypes and solutions that aim at advancing our noble cause of education and workforce preparedness.

In order to get there, a review of the state of the art in LST research is necessary. Of course many projects and programs exist, but to gain an appreciation for research directions, I looked at a few projects falling into three categories: Access and Navigation, Distributed User Modeling and Assessment, and Networked Simulations. I categorized the research as I see a trend: first, build the infrastructure so people can have easy access to quality educational materials; next, contextualize the content for the user to make it relevant and actionable; and then create immersive, learning environments that accelerate time on task and intrinsic motivation.

Access and Navigation

Much of the research conducted to date has focused on getting content (libraries, lectures, and laboratories) online and making it available to learners. Everyone has their own mom-and-pop solution with some attempts at reining in the chaos of the web. Self-assessment predominates and technology focuses specifically on mobile, data-driven access and navigation of the data. Results include building collective course management environments (OKI), federating databases to turn the web into an instrument (Sloan Digital Sky, iLabs) driving the development of standards for design, communication and data reporting (SCORM), and putting free courseware online (Merlot, NEEDS, OCW). Baker (2002) suggests that moving forward, we need to dynamically generate content and adapt to, and compensate for, limits in users' expertise, interest, or time. Access and navigation is fundamental to building digital education; interactivity based on who you are is evolutionary.

Distributed User Modeling and Assessment

Learning environments with rich interaction and collaboration increase the chances for deep learning. A central claim to creating meaningful, assessed learning environments in *Knowing What Students Know* (2001) is creating a model to observe student behavior, and a method for drawing inferences about student knowledge from their behaviors. Computers can react to these inferences in two ways; they can use AI or Bayesian adaptive models and feed back information to the student based on their answers; or they can use peer-to-peer networks and real-time protocols to enable human-to-human interaction and create dynamic collaboratories that engage learners in working together, both synchronously and asynchronously. One is scalable, the other is not.

AI environments that adjust to the user and provide iterative feedback through problem-solving include Cognitive Tutors, Biologica, Andes, and the Immex Project at UCLA. Findings suggest that in these environments we can observe and augment student problem strategies with embedded assessment over the network. Several prominent peer-to-peer environments include the Learning Experience Project; Learning by Design, which looks at shared understanding with white boarding; Live Notes, which analyzes networked note-taking; and Active Campus, which uses location-based mobile learning to track discussion groups, polling, and voting. Findings suggest that learning increases with both AI and HI feedback models. Understanding the user and the context of the user's learning needs, creating challenging activities that require the user to use the content, and assessing the user's performance *in situ* will advance the effectiveness of digital environments for education.

Networked Simulations

Networked simulations make the invisible visible. The intent of this nascent research is to create a sense of being in the learning environment, focusing the student more on interactions, immersed in the content as an environment, role-playing among visual objects, constructing solutions by solving problems and thinking critically with others, while manipulating real-time equipment or scenarios to simulate the real world. The objective is to encourage decision-making based on experimentation, thus amplifying learning. The challenge is enabling scalable and affordable models. Several good examples of the simulations for teaching have been implemented.

The Minimally Invasive Surgery Training System (MIST) teaches minimal laparoscopic surgery. ICT Games Project is building emotional reaction in gaming environments, while MIT's Games to Teach and CMU's BioHazard research are producing models for science and engineering in the university classroom using game-based technology for learning. Cave technologies for immersing students deeply in visual environments, such as the Round Earth work at the University of Illinois, show equal promise. Networked simulations provide the most promise for continuous learning in a rich environment of contextualized content with the ability of adapting to the user at the level of the user's interaction. It also motivates them in ways similar to simulations over the Net, such as X-Box, which already are consuming hours of user attention. Imagine learning environments like this for education extended with digitally instrumented technologies, persistent content, and multi-expert participation, leveled by the user's ability and focused on learning while doing.

Conclusion

If we start with this great base of learning research and couple it with computer science research, we can stimulate a revolution in learning. There is much to be learned from computer science research: human computer interfaces, adaptive behaviors, interoperable geometries, 3D operating systems, and dynamic databases. This partnership in research agendas can help insure quality access to learning, enrichment for teacher and student experience, scalability across interoperable systems, standardization in tool and content development, new forms of meaningful interactivity, and the educational enchantment so hoped for by so many. We do not need to imitate the classroom; we already have good ones. We need to make the device an alternative classroom, and call people into the device and scale the classroom by uniting our knowledge of computers and learning.

At Microsoft Research we are addressing technology-based learning as a distributed lifelong learning challenge. Our efforts look at building

Computer Science
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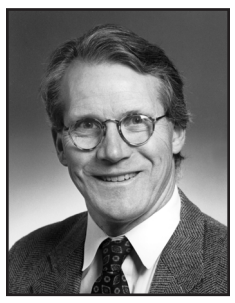
CRA Board Elections

Incumbents



Randal E. Bryant, a graduate of the Massachusetts Institute of Technology with a Ph.D. in computer science, is President's Professor and Head of the Department of Computer Science at Carnegie Mellon University. He is a Member of NAE, a Fellow of both ACM and IEEE, and has received the ACM Kanellakis Award, the IEEE W.R.G. Baker Prize, and the Semiconductor Research Corp.'s Technical Excellence Award. Bryant was a member of the Executive Committee of the ACM/IEEE Design Automation Conference (1994-2000, including technical program co-chair, 1998-99). He was Editor and Associate Editor of *IEEE Transactions on Computer-Aided Design of integrated Circuits and Systems*.

Elected to the board in 2000, he has chaired the Taulbee Survey committee; currently chairs the surveys committee; and is a member of the service awards and the Grand Challenges Conference steering committees.

Janice Cuny, a board member since 2000, is Professor of Computer and Information Science at the University of Oregon. She won an IBM Faculty Development Award and National Science Foundation Faculty Award for Women, and has been an IEEE Distinguished Visitor. Cuny has been a member of CRA's Committee on the Status of Women in Computing Research (CRA-W) since 1993 and was co-chair from 1996-99. She has organized five faculty-mentoring workshops for CRA-W, chaired the selection committee for CRA's Undergraduate Awards, and served as a mentor in CRA-W's Distributed Mentoring Program and as a moderator of a Snowbird workshop.

Cuny is currently Vice Chair of the board, heads a CRA study on Graduate Student Retention and Recruitment, and chairs the communications committee. She has a Ph.D. in computer science from the University of Michigan.

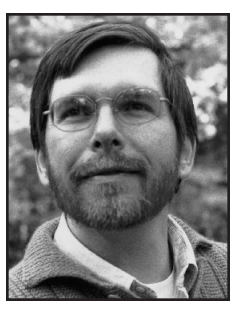
Jeffrey S. Vitter, who received a Ph.D. in computer science from Stanford University, is Dean of Science and Professor of Computer Science at Purdue University. He received the NSF Presidential Young Investigator Award, and was named a John Simon Guggenheim Memorial Foundation Fellow. Vitter is a Fellow of IEEE and ACM. He was vice chair (1991-97) and chair (1997-2001) of the Executive Committee, ACM SIGACT. He won the ACM Recognition of Service Award twice (1997, 2001), and was a Fulbright Scholar in 1998.

Vitter currently serves on several review boards, panels, and editorial boards. Elected to the board in 2000, Vitter currently co-chairs the government affairs committee, where he plays an active role in advocating for the funding of basic research. He also has chaired workshops at Snowbird conferences in 2000 and 2002.

Elaine J. Weyuker, an AT&T Fellow at AT&T Labs – Research, is a Member of NAE and a Fellow of both ACM and IEEE. She served as liaison between the original CRA-W committee and ACM's committee on women and minorities. Weyuker was Professor of Computer Science at the Courant Institute of Mathematical Sciences of NYU; and Director of Graduate Studies and Head of the Graduate Fellowship Selection Committee for the Computer Science Department, NYU. She currently serves on several editorial boards, publishes widely in software engineering, and has authored two books on the theory of computation.

Elected in 2000, Weyuker was a member of the steering committee on CRA's study of faculty recruitment and retention, and currently serves on the industry committee. She received a Ph.D. in computer science from Rutgers University.

Newly Elected

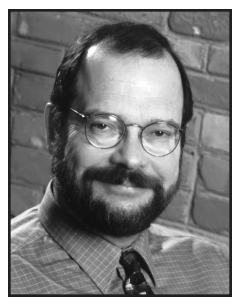


William Aspray, a Professor in the School of Informatics at Indiana University, was CRA's executive director from 1996-2002. A graduate of the University of Wisconsin-Madison with a Ph.D. in the history of science, he has held faculty positions at Williams College, Harvard, Rutgers, University of Pennsylvania, and Virginia Tech. Aspray also held senior positions at the Charles Babbage Institute and the IEEE History Center at Rutgers University. He has published or edited approximately 10 books, 60 articles, and more than 200 oral history interviews.

Aspray is currently involved in research on a variety of topics central to CRA's mission—IT workforce, underrepresentation of women and minorities in computing, research funding, the organization of computing research in academic and industrial organizations, industry-academic relations, IT policy, and the demographics of the CS community.

Carla Ellis, Professor of Computer Science at Duke University, currently co-chairs CRA's Committee on the Status of Women in Computing Research (CRA-W). She was a member of CRA's Committee on Recruitment and Retention, and has frequently served as a mentor in CRA-W's Distributed Mentoring Program. A principal activity has been to encourage more undergraduates, especially women, to pursue graduate degrees in CS&CE. She organized CRA-W's Distinguished Lectures and Graduate Recruiting panels.

Ellis chaired ACM SIGOPS (1995-99) and SIG Governing Board (1998-2000); she served on the ACM Executive Committee and was a Council Member (1998-2000). Ellis was technical chair of the USENIX Annual Technical Conference (2002), and is currently Editor-in-Chief of ACM *Transactions of Computer Systems*. She is a graduate of the University of Washington with a Ph.D. in computer science.



John Leslie King is Professor and Dean in the School of Information at the University of Michigan. His research focuses on improving strategies for the development of high-level requirements for the design of information infrastructure for usability in complex organizational and institutional domains such as freight logistics, common carrier communications, and health care delivery. He serves on the NSF-CISE Advisory Committee, the executive board of the Institute for Social Research, and numerous advisory committees for emerging programs in information and computing in universities in the United States and abroad.

Prior to joining the University of Michigan, King was on the faculty at the University of California at Irvine, and Marvin Bower Fellow at the Harvard Business School. He was Editor-in-Chief of the INFORMS journal Information Systems Research from 1992-98. He holds a Ph.D. in administration from UCI.

Marc Snir is Professor and Head of the Department of Computer Science at the University of Illinois at Urbana Champaign. He is a Fellow of the ACM and IEEE, and winner of the IBM Corporate award and the IBM Outstanding award (twice). He has had a varied career spanning industry, academia, significant theoretical and applied research, leading contributions to successful standards and products, and significant public service.

Snir co-chaired a CSTB study on the Future of Supercomputing (2003-04). He was a panel member of the National Research Council review of NASA Pioneering Research Technologies program (2002-03); the Congress Mandated Study on "High Performance Computing for the National Security" (2002); and the External Advisory Committee, NIH Resource for Macromolecular Modeling and Bioinformatics (1999-2001). Snir received a Ph.D. in mathematics from the Hebrew University of Jerusalem.

Alfred Spector is Vice President, Services and Software Research, IBM Corp. He currently serves on the National Science Foundation's CISE Advisory Board. Spector was a presenter at CRA's Conference on Grand Research Challenges in June 2002. He has received the IEEE Computer Society Tsutomu Kanai Award for outstanding contributions in distributed computing systems; and a Department of the Army Certificate of Appreciation for Civilian Patriotic Service.

From 1989-1996 he was Founder, Chairman, and CEO of Transarc Corp., for which he was named a finalist for the Ernst & Young Entrepreneur of the Year in 1992. Prior to assuming his current position, he was General Manager, IBM Software Group. Spector has been an Adjunct Professor of Computer Science at Columbia University; and Associate Professor of Computer Science with tenure, at Carnegie Mellon University. He is a graduate of Stanford University with a Ph.D. in computer science. ▮

Cyberinfrastructure: Challenges for Computer Science and Engineering Research

By Peter A. Freeman and Lawrence L. Landweber, NSF

The NSF vision for the future of cyberinfrastructure will only be achieved if there is continuous progress in basic CS&E research. The opportunity to provide an array of cutting-edge computational and information resources as common infrastructure for all of science and engineering stretches the envelope in many CS&E disciplines. Indeed, cyberinfrastructure will be an important, if not the most important, driver for CS&E research in the next decade.

In our column in the March issue of *CRN*, "Cyberinfrastructure: The Critical Role of Computer Science and Engineering Research," we postulated that the future of cyberinfrastructure (CI) is contingent upon CS&E research. In this column we examine some of the exciting challenges for CS&E researchers.

We define CI to be the cutting-edge, distributed computing and communications environment that can be built at any particular time to support a broad range of scientific and engineering research and education. For the purpose of this article, we target the CI of 2013. This will likely involve large numbers of teraflop computing systems and petabyte data stores, augmented by instruments such as colliders and telescopes and vast collections of sensors. There will also be lots of highly distributed small processors, sensors, and data stores with highly variable network requirements. A high-speed network, carrying petabits per second in its core, will connect these systems, services, and tools. The solution to a particular science problem may involve the distributed use of these resources. This CI environment will be available to the country's science and engineering research community. It is this environment that we hope the CS&E community will keep in mind as we formulate our CS&E research direction for the coming years.

This future CI will encompass many of the sub-disciplinary elements of CS&E. It will pose many very difficult research questions in networking, data management, distributed systems, software systems, and others. In the following, we describe some of the challenges that will be faced by researchers in these broad research categories.

Computer Networks

CI will require networks that allow scientific collaborators to share resources on an unprecedented scale and allow geographically distributed groups to work together effectively. To address these issues, a scientific foundation to advance our understanding of the increasing complexity of large-scale networks is required. Advances must be made to create and sustain the science and technology needed for the effective engineering, control, and management of a ubiquitous network infrastructure designed to provide high-performance mechanisms for discovering and negotiating access to remote resources.

Next-generation networks are likely to exhibit unpredictable and complex behavior and dynamics, giving rise to a new set of exciting and challenging network problems. Research challenges include:

1. Sensor networks for sensors ranging from simple "smart dust" motes to sophisticated, miniaturized, solid-state weather-sensing radars. These sensors will require a self-diagnosing, self-healing, and self-organizing architecture that is radically different from today's Internet.
2. Overlay networks that seek not to replace the current IP infrastructure, but rather to build a rich layer of application-driven functionality to better support specific network applications.
3. Extensible networks aimed at enabling enhanced network services by providing a framework in which new services and applications can be dynamically added to the network substrate.
4. Network management capabilities for self-configuration, self-diagnosis, and threat-response. Network *measurement* will play a key role, since information about network state is crucial in making informed control decisions.
5. A new architecture for the core of the network to accommodate orders-of-magnitude increases in traffic.
6. Security, from network trust models to anonymity and privacy issues, to the social and management issues surrounding information assurance. In addition, the assumptions and requirements that underlie the CI applications of the future require new attention to problems related to scalability, adaptability, level and quality of service, routing and congestion control, reliability, and interoperability.

Database Management Systems

Database management technology provides facilities to enable the efficient location, transformation, replication, combination, and understanding of large, massively distributed data sets. It lets consumers of data focus on what they want to discover from the data, instead of the details of how and where it is stored, accessed, and processed.

Current DBMS are not sufficient for the task ahead. One must first define a relational schema, make the data conform to that schema, and then load it in the system. Once data is in a DBMS it can only be accessed through the DBMS SQL interface (non-SQL apps are out of luck). In addition, existing DBMS are not network aware and have only rudimentary support for distributed data. Lastly, they can be so painful to use that the vast majority of scientists use file systems, accomplishing data management tasks "by hand."

The CI vision requires new DBMS technology that is built with the fundamental assumption that data is massively distributed among autonomous heterogeneous sites.

It should allow "schema later" processing, in which the system need not know a complete rigid schema before managing the data. It should be able to manage data in a format dictated by the scientists rather than by the DBMS. Most importantly, it should be self-tuning and self-configuring so that a scientist can use it without taking courses to become a certified database administrator.

Distributed Computing

The ultimate goal of CI is to achieve a transparent and seamless computation and resource-sharing execution environment for user-centric applications. The challenge from the system designer's viewpoint lies in the development of the theoretical foundation, methodologies and models, and system implementations to facilitate collaboration and cooperation of interacting user applications. Much of current research on pervasive/grid/mobile computing is a step in this direction, but falls short in achieving the goal, mainly due to the complexity of managing the massive scale of heterogeneous computation, communication, and storage resources in the future networked environment.

Innovations and fundamental breakthroughs are critical in the following areas:

- Virtualization of massively large-scale computation and data resources through high-level abstractions.
- Dynamic and adaptive systems.
- Context-aware and user-intention-aware resource management.
- Algorithms and protocols for collaborative and cooperative processing.
- Group management and control of mobility.
- Integration of heterogeneous administrative domains.
- Management/control of distributed environments and connected resources.
- Rapidly deployable, self-organizing, self-configuring, and self-healing systems. In addition, research will be needed to achieve interoperability, usability, scalability, and robustness of future mega-scale autonomous systems.

Software

As with essentially all applications of computing technology, software will ultimately be the element of CI that enables it or causes it to fall short of its envisioned potential. Many of the issues discussed above, to say nothing of hundreds of others, will result in software implementations. The languages, constructs, techniques, and structures that are used will be key, but our current stock of software elements is no doubt insufficient. As a simple example, consider the basic mechanisms we have for describing data in terms that a domain-scientist can easily work with.

Software engineering (SE)—the tools, techniques, and processes for creating complex software systems—is clearly inadequate to the task ahead. Most software is still created by people with little or no knowledge of proven SE approaches, and while the result is often acceptable initially, the lifetime costs of modification and repair are often horrendous and prevent the kind of progress that we should be making. Even if everyone used the very best SE, there is ample evidence that the results would still be much less than appropriate.

In short, we need better software "building blocks" and better software engineering. If you consider other disciplines that ultimately produce engineered or constructed artifacts, you will note that they are based on a body of scientific knowledge and coherent, systemized experience. While we certainly have some aspects of this, by and large software and, more generally, computing-intensive systems, are not built on any such foundation.

Creating a true "science of design," along the lines indicated above, has to be a top priority for CS&E. (Other terms may be better, but some, such as "software science" are either taken or have a certain historical connotation that may not be appropriate here). As with most of the other examples we have cited, this should be a goal of fundamental CS&E research, independent of the need for it in creating CI. Building CI, however, presents a wonderful opportunity for advancing toward a science of design.

These challenges are well within the expected envelope of CS&E research over the next decade, regardless of the specific overarching strategic initiatives at play. The rate of technological change will

Cyberinfrastructure
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Federal Funding Agencies

DOD/Air Force Office of Scientific Research

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http://www.bisti.nih.gov/bistic_funding.cfm

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Research Programs
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Long-Time Members Retire from CRA Board

Pictured above at a recent CRA board meeting are Mary Jane Irwin (Penn State) and Dave Patterson (UC Berkeley) who, along with Nancy Leveson (MIT), will complete four terms as board members in June 2003. All joined the board in 1991, and have made exceptional contributions to the growth of CRA. We are grateful for their service and will miss their wisdom, experience, and good humor.

Change in Taulbee Survey Reporting

The CRA Board of Directors has recently approved a change in CRA's procedures for disseminating the results of the annual Taulbee Survey.

One reason for the change is to reward departments that submit the survey on time by disseminating the preliminary salary data to them in December rather than in January. Another is to provide final survey results to CRA members, as a benefit of their membership, before they are made publicly available.

Previously, CRA preliminary faculty salary results have been published in the January issue of *Computing Research News*, followed by the complete survey results in the March edition of *CRN*.

Beginning with the 2002-03 survey, which will be circulated to chairs of Ph.D.-granting departments in September 2003, only departments that have submitted their surveys by the November deadline will receive the preliminary salary results. These results will be provided to those departments by mid-December; *they will no longer be published in the January CRN*.

In mid-February, final survey results will be provided to departments that participated in the survey, as well as to all CRA members. Once again, this is earlier than in the past. *Final results will no longer appear in the March CRN*; instead, they will be published in the May issue, and will be posted on the CRA website at that time. ▮

CRA Welcomes New Staff Member

CRA is pleased to welcome Carla Romero as Director of Programs, effective April 1.

Most recently Carla has been employed by the University of Texas at Austin managing grant funds for three labs in a national research center and assisting non-profit organizations in the areas of marketing, public relations, and fundraising.

She was previously responsible for designing and implementing educational programs targeted at minority youth in Texas and New Mexico. She has facilitated training sessions to build leadership skills, professional development, and college awareness. Her career includes the direction of scholarship and resource programs for undergraduate/graduate students, management, and legal experience.

Carla has been an advisor to several minority science and engineering student organizations, and has served on committees and boards, including the El Paso Expanding Your Horizons Planning Committee, the American Indian Science and Technology Education Consortium, and the Hispanic Women's Network. She is the recipient of service awards including the 1993 NASA Hero Award.

A native of New Mexico, Carla has lived in Texas for seven years. She received her Bachelor of Arts in English, pre-law at the University of New Mexico, and her Master's of Public Administration at the University of Texas at El Paso.

At CRA Carla will be involved with the broad range of programs focusing on human resources, on community-building, and on connecting CRA with the other organizations advancing science and engineering. ▮

INVITATION FOR PARTICIPATION

CRA-W Distinguished Lecture Program
and Graduate School Recruiting Panels

Applications now being accepted to host recruitment events designed to attract female students to graduate school

See: http://www.cra.org/distinguished.lecture/

Contact Program Coordinator:
Renée J. Miller (miller@cs.toronto.edu)

CRA Welcomes New Members

Labs/Centers

Accenture Technology Labs
Lawrence Berkeley National Laboratory
Los Alamos National Laboratory

Academic Departments

Boston College (CS)
Bowdoin College (CS)
Emory University (MCS)
Johns Hopkins University, Information Security Institute

Transitions and Awards

Francine Berman has been appointed the first holder of the Endowed Chair in High Performance Computing by the Jacobs School of Engineering at UC San Diego. Berman is a professor of computer science and engineering and directs the San Diego Supercomputer Center (SDSC) at UCSD.

Avi Silberschatz received the 2002 IEEE Taylor Booth Education Award at the IEEE annual meeting in San Diego on February 28. Dr. Silberschatz, currently Vice President of the Information Sciences Research Center at Bell Laboratories, Murray Hill, New Jersey, will join Yale University as Professor of Computer Science, effective July 1, 2003.

Stu Zweben, chair of the Department of Computer and Information Science at Ohio State and a CRA board member, has recently received the Outstanding Educator Advancing Technology Award from the Columbus Technology Council, an economic development group in Central Ohio. ▮

FY2003 Funding from Page 1

stimulus, and maintaining fiscal responsibility while preserving domestic spending responsibilities. Ehlers also cited NITRD as an example of a program that through "[p]roductivity improvement and technological breakthroughs [has] spurred the longest period of economic expansion in our nation's history, and holds the key for stimulating our economy now."

The House Science Committee, in its "Views and Estimates" of the President's budget request, also endorsed more significant levels of support for research and development funding. Twenty-five members of the committee signed the "V&Es," which adopt a tone similar to the Ehlers testimony, noting "science and technology are the keystones of our economic prosperity and national security." The committee was especially disappointed in the budget document for failing to provide NSF with the significant increases in funding authorized by the NSF Doubling Act, passed overwhelmingly by Congress and signed by the President last December. The Act authorized an increase of 15 percent for NSF in FY 2004, significantly more than the 3.8 percent the budget resolution assumes.

Despite the support, the House budget resolution was approved by the committee as written, including the $300 million reduction to function 250. The full House approved the measure in late March. At press time, the Senate was considering its own budget resolution containing a $500 million increase to the function 250 account over FY 2003. Though the budget resolution is in some respects a symbolic document—especially if both chambers fail to agree on funding levels—it does play a role is setting the funding allocations that the appropriations committees will work within during the appropriations process later this year. If the chambers disagree on funding levels and fail to produce a joint budget resolution, as happened last year, the appropriations process can become more complicated, with both House and Senate appropriators working from different funding baseline numbers. These differences will have to be worked out in negotiations between the chambers before any final appropriations bill can be passed.

The next step in the budget process is the beginning of the work of the appropriations committees in taking testimony concerning the 13 annual appropriations bills that are necessary to fund government activities for FY 2004. By June, the first draft bills should be under consideration by the committees, and should provide a clearer view of the prospects for science funding in the coming year.

CRA government affairs activities are posted at: http://www.cra.org/govaffairs. ▮

Service Awards from Page 1

bulk of this money, especially in the first year, go to researchers in computer science and engineering.

Ruzena Bajcsy has a record of more than 30 years of contributions to the computing field as a scientist and administrator. She is a pioneering researcher in machine perception, robotics, and artificial intelligence. Bajcsy is currently a professor in both the CIS Department and the Mechanical Engineering and Applied Mechanics department at Berkeley; she also directs the University of Pennsylvania's General Robotics and Active Sensory Perception Laboratory, which she founded in 1978.

Prior to her service as Assistant Director at NSF, Dr. Bajcsy spent nearly 20 years at the University of Pennsylvania, including five years (1985-1990) as the chair of the Computer and Information Sciences Department. During her career, Dr. Bajcsy has also been active on the editorial boards of many major journals, and served as chair or member of scores of major conferences and workshops.

Among many honors received, Bajcsy is a member of both the National Academy of Sciences' Institute of Medicine and the National Academy of Engineering, and she is a Fellow of the AAAI, IEEE, and ACM. She received the ACM A. Newell Award in 2001.

CRA A. Nico Habermann Award

Rita Rodriguez is recognized for her impact on minority students, faculty, and institutions throughout the country by constantly striving to improve the quality of programs at minority institutions. Her energy and devotion in helping the members of underrepresented groups in the computing science community is well known.

Dr. Rodriguez is a Program Director in the Division of Experimental and Integrative Activities (EIA) in the CISE directorate at NSF. She began her NSF career in 1995 in the CISE Office of Cross-Disciplinary Activities. She immediately took over the direction of the Minority Institution Infrastructure (MII) Program and CISE's international involvement—including the NSF-CONACyT Program for collaborative research with Mexico.

Under the direction of Dr. Rodriguez, the MII Program clearly emphasized depth rather than breadth in its considerations, and this became clear to applicants and reviewers alike. The program sought to strengthen research and academics in these predominantly minority institutions by creating true models that improved "the pipeline" from undergraduate to Ph.D. over the long term. The guidance Rodriguez has provided to institutions emphasized investments with potential for significant long-term impact. She collaborated with program directors of different divisions and directorates to multiply the available financial support for these institutions, improving minority opportunities and fostering wider research interactions in CISE activities. Through collaboration with other NSF divisions and directorates, Dr. Rodriguez brought many millions of dollars into the CISE women and minorities computing communities in joint support.

Since returning to EIA in 2001, Dr. Rodriguez has once again been on the forefront of the NSF programs dealing with women and minorities. She has put in extra effort to promote these programs, to encourage PIs, and to assure that funding reaches as many well-qualified members of the CISE community as possible. ■

Computer Science from Page 3

real-time collaborative environments and web services for education as a platform for conducting research in education. We are using a shared source model for collaborations and partnering with universities worldwide in an invited RFP process. We are working with our government and private partners to define and develop a detailed learning science and technology roadmap to describe a research plan, along with a research management plan for implementing the roadmap. Our goal is to rally industry, government, and educators to use information to transform the way we learn, to provide a teacher for every learner, and to bring together learning science and computer science to serve the educational needs of our emerging digital workforce and lifelong learners.

The Computing Research Association can play a key role to enable this fundamental transformation in education and training by focusing their intellectual laser beam onto the partnerships needed to build momentum for a national program in learning science and technology R&D, and unite the discoveries of computer science and learning science and to align missions.

Randy J. Hinrichs (randyh@microsoft.com) is a Group Research Manager for Learning Science and Technology at Microsoft Research. He has been working as an educational technologist researcher for 25 years, and is one of the pioneers of the Learning Federation, a consortium of industry, government, and universities focused on an international research agenda for LST.

References and sources of information related to this article are available in the Web version at: http://www.cra.org/CRN/online.html ■

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continue at the exceptional speed at which it has progressed over past decades. These changes will drive and be driven by the research questions that are of utmost interest to our community. For the most part, these questions will be indistinguishable from those that cyberinfrastructure demands. Certainly research with no direct application to CI will occur, and we must be careful to seek out and support work on important questions that may fall outside the current demands of CI. Unstructured, investigator-driven research will always be the bedrock of future advances.

The application of leading-edge research to create integrated cyber resources began years ago, and the increased focus on CI need not change the research agenda. To achieve the goals of CI we undertake a journey without a specified end-point, nor a single path. It will be defined by the research that the CS&E community undertakes and by the needs of the domain scientists and engineers. It will test the capabilities of our advanced CS&E researchers, while providing focused goals and funding for our research. We are confident, colleagues, that you are equal to this test.

Peter A. Freeman is Assistant Director and Lawrence L. Landweber is a Senior Advisor in the Computer and Information Science and Engineering directorate at the National Science Foundation. ■

CSTB Releases *Who Goes There?*

Who Goes There? Authentication Through the Lens of Privacy explores authentication technologies (including biometrics, PKI, passwords, etc) and their implications for the privacy of the individuals being authenticated.

This recent report by NRC's Computer Science and Telecommunications Board examines numerous concepts, including authentication, authorization, identification, privacy, and security, and provides a framework to guide thinking about these issues when deciding whether to use authentication in a particular context. The report also explains how privacy is affected by system design decisions.

Who Goes There describes government's unique role and what this means for government use of authentication that seeks to minimize invasions of privacy. Usability and security considerations are also covered and a primer on privacy law and policy is included.

More information about this report is available on CSTB's website at http://ww.cstb.org/ ■

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Student Evaluations from Page 2

departments, where there are many students who are not motivated by interest in learning or the subject matter in their courses, but rather by hopes of admission to medical school or high-paying jobs in IT.

University staff administering the evaluations should remove forms containing biased or offensive comments and not include their ratings in any compilations. However, the number of forms containing such comments should be reported as possible evidence of bias. A better way to discourage inappropriate comments is to partly remove students' anonymity: Enable staff to identify the student evaluations, but don't allow any faculty members (including department chairs) to access this information. Texas A&M University has used this approach for many years. Electronic evaluations are a good way to implement partial anonymity. In addition, they have the advantage of giving students ample time to express their views, and they do not necessarily exclude students who missed class on a particular day.

General Recommendations

Use multiple forms of evaluation.

Most teaching experts agree that multiple forms of evaluation are needed to properly evaluate teaching. One reason is that many aspects of teaching cannot be addressed by students. Alternative methods of evaluation are especially important for professors who receive (possibly unjustified) low ratings from students or when there is a perception of possible bias (such as high standard deviation in student ratings, inconsistent ratings in different classes, or inappropriate comments, anonymous notes, or newsgroup postings).

Other ways to evaluate teaching include observation of lectures and examination of course material by trained peers or teaching experts (e.g., from a university's teaching center), the use of teaching portfolios, giving exit interviews or questionnaires to graduating students, requesting letters from former students, having student discussion facilitated by trained faculty or staff, obtaining feedback from teaching assistants, and comparing the performance of students on common, jointly-graded exams in multi-section courses taught by different professors. Peer and expert evaluation can be particularly valuable in helping professors improve their teaching because the criticism is likely to be constructive and objective. Furthermore, professors are generally more receptive to their feedback.

More detailed assessment should be done periodically.

Because it is more expensive, detailed assessment of teaching might not be done every year. However, it should be done periodically, say once every five years and more frequently prior to tenure. Courses, themselves, should also be evaluated. The curriculum may require a course to cover too much material, or the background, ability, or motivation of students enrolling in the course may have changed. In such situations, it is unfair to penalize a teacher who is attempting to meet unrealistic requirements.

Have a transparent teaching evaluation process.

It is important that detailed written information be provided to faculty outlining explicit expectations for good teaching and explaining how teaching evaluations affect salary, tenure, and promotion decisions. This should include what information is considered, what criteria are used, whether comparisons are being made, and, if so, with whom and why. When there is a possibility of bias in some of the information, this fact and how it is dealt with should be mentioned. If improvement in teaching is needed, specific objectives and ways of achieving those objectives should be discussed with that faculty member.

Why should departments care about improving their teaching evaluation process? If it has been done the same way for a long time and there haven't been major problems, why should it change? One reason is that even a slightly biased process can, over time, lead to substantial inequities in salary. Another reason is that when faculty members have the perception that they are being unfairly evaluated, they feel unappreciated. This can affect their morale, the effort they are willing to put towards teaching, and their desire to stay in their department. Thus, improving the teaching evaluation process might improve retention as well as teaching.

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[6] Lisa Sinclair and Ziva Kunda, *Motivated Stereotyping of Women: She's Fine if She Praised Me but Incompetent if She Criticized Me*, Personality and Social Psychology Bulletin, 25(11), 2000, pp. 1329-1342.

Remembering Anita Borg—A Legacy of Achievement

CRA joins the many friends and colleagues of Anita Borg who celebrate her life and mourn her passing on April 6, 2003.

A graduate of the Courant Institute of Mathematical Sciences, New York University, with a Ph.D. in computer science, Anita was a research computer scientist in the area of fault-tolerant operating systems and microprocessor memory systems. She spent 11 years working in research at Digital Equipment Corp.

Anita was an active member of the CRA board of Directors from 1994 to 2000. In September 2000, she was awarded the CRA A. Nico Habermann Award for her dedication and contributions to aiding members of underrepresented groups within the computing research community.

Among the comments made by her nominators at that time included: "Anita has done more than any other individual to attract, encourage, and retain women in computing research"; "I cannot think of anyone more worthy of the A. Nico Habermann Award"; and "Anita Borg has encouraged more women to pursue and advance in computing careers than any other person..." The nomination also included the names of 100 other women from nine countries who lent their support.

Anita worked tirelessly to create a community of women in CS. She encouraged women to make connections, give and receive advice, exchange information, develop their own strengths, and reduce their sense of isolation.

The Systers mailing list, started by Anita Borg in 1987 for women in systems, has grown into an international Internet community with more than 2,500 members from 38 countries. It has spawned more focused lists such as Systers-students and Systers-academia. Anita was the Keeper of Systers for 10 years, moderating its discussions, developing web-based information and communication technology to support it, and nurturing its community.

In 1994, Anita co-founded the Grace Hopper Celebration of Women in Computing series (with Dr. Telle Whitney) to highlight the research of women, build community, and provide career development opportunities. The conference, held every other year, is now the largest meeting of women in computing in the world.

Anita then expanded her focus to include women in all aspects of technology by creating the Institute for Women and Technology (IWT). This non-profit institution has two visionary goals: to increase the participation of women in all aspects of technology and to increase the positive impact of technology on the lives of women. It assumed responsibility for Systers and the Hopper Celebration and launched a new initiative, called Virtual Development Centers, in which ideas generated in exploration and innovation events are realized in prototypes by faculty, students, and professionals.

In addition, Anita served on a variety of boards and committees, including the Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology; the National Academy of Engineering Celebration of Women in Engineering Steering Committee; the National Research Council Committee on Women in Science and Engineering; and CRA-W. She was a Fellow of ACM, and in 2002 received the Heinz Award for Technology, the Economy, and Employment.

Anita Borg (l) was presented the CRA Habermann Award by Jan Cuny (r) at the Hopper Conference in 2000.

Anita Borg will be greatly missed. CRA's condolences go out to her husband, family, and friends.

Additional information, including details of a memorial fund set up in Anita Borg's memory, can be found on the Web at: http://www.iwt.org/news/anitaborg/inmemory.htm.

2003 Federated Computing Research Conference

June 7–14, 2003

San Diego, California

http://www.acm.org/sigs/conferences/fcrc/

Note to Department Chairs

CRA has recently announced a new program to send Welcome Packages to graduate students of member institutions as they pass their qualifying exams (or the last major hurdle before their Ph.D. thesis). The package will welcome the students into the research community and provide information on the services that CRA provides for them. It will include a bookmark, recent copies of *Computing Research News* and the CRA Bulletin, and a snazzy new CRA t-shirt. If your department is a member of CRA and is not already participating but would like to, please contact Carla Romero (carla@cra.org). ▮

Professional Opportunities

CRN Advertising Policy

See http://www.cra.org/main/cra.jobshow.html

Indiana University
Computer Science Department
Faculty Positions

The Indiana University Computer Science Department anticipates filling several tenure-track faculty positions beginning 2003-2004. Areas of interest are databases, embedded systems, networking and programming languages. In addition our new, privately endowed, pervasive technology labs will be hiring several senior positions in the areas of graphics, human computer interaction, embedded systems, data mining and security.

The CS department, which is part of the College of Arts and Sciences, is working cooperatively with our new School of Informatics, which offers a B.S. degree focusing on the application of information technology to various disciplines and has M.S. programs in Human Computer Interaction, and Bio and Chemical Informatics. Cross-appointments with Informatics are possible in computer science related areas such as data mining and search technologies.

A Ph.D. in Computer Science is required for all CS faculty positions. Applicants must have demonstrated potential for excellence and productivity in research. In addition, a strong contribution to the educational mission of the department is expected.

The department occupies a spacious limestone building with extensive state-of-the-art computing facilities. The attractive wooded campus of Indiana University is located in Bloomington, chosen as one of the most cultural and livable small cities in the US, and only one hour from the Indianapolis airport. To learn more about the department please visit our web site at www.cs.indiana.edu.

Please send a detailed CV and a list of references to:

Faculty Search
Computer Science Department
Indiana University
Lindley Hall 215
Bloomington, IN 47405-7104
email: search@cs.indiana.edu

Indiana University is an Equal Opportunity/Affirmative Action Employer. The Computer Science Department strongly encourages applications from women and minorities.

Massachusetts Institute of Technology
Department of Earth, Atmospheric and Planetary Sciences
Scientific and Technical Software Engineer Position

MIT's 'Climate Modeling Initiative' is looking for an enthusiastic, self-motivated and technically adept scientific programmer to be responsible for release engineering and quality assurance of software used to simulate the atmosphere, ocean and climate (see http://mitgcm.org). The person would join a small group of model developers and help maintain an evolving suite of user-friendly demonstration codes that can be deployed easily on hardware platforms ranging from local computer clusters, desktop systems and major facilities. Much work will be done in delivery of a quality model accessible through web technologies.

Application and systems programming skills with some or all of, scripting tools such as Perl and Python, shell programming, UNIX and Linux and Fortran and C programming, familiarity with parallel programming libraries such as MPI and shmem and experience with analysis tools such as Matlab will all be useful for this position.

To apply, send a CV and the names, addresses, email addresses and phone numbers of three references to:

Prof John Marshall and Chris Hill
MIT Room 54-1526
77 Massachusetts Ave
Cambridge, MA 02139, USA
(marshall@gulf.mit.edu; cnh@gulf.mit.edu, phone: 617 253-9615)

MIT is an equal opportunity, affirmative action employer, and a non-smoking environment.

Palo Alto Research Center (PARC)
Member of Research Staff

Formerly part of Xerox, PARC offers a multidisciplinary environment for pursuing both basic and applied research. Ideas developed at PARC include personal computing, laser printing, graphical user interfaces, and ubiquitous computing. Our funding comes from both corporate sources and government agencies, as well as from licensing revenue.

We invite applications for several open positions. A PhD is required. Please send your CV, statement of research interests, three letters of recommendation, and URLs of relevant publications to the appropriate email address listed below. PARC is an Equal Employment Opportunity company committed to workforce diversity.

Embedded Model-based Computing Group

We are interested in intelligent planning and control for complex distributed systems. The ideal candidate would have demonstrated research interests in artificial intelligence, distributed systems, operations research, and intelligent control. For more information, see www.parc.com/ldc. Please send applications to spljobs@parc.com (subject: MBC Position Application).

User Interface Research Area

We have openings for candidates with expertise in 1) cognitive modeling, cognitive psychology, and cognitive task analysis; or 2) designing and building user interfaces and information visualizations. For more information, see www.parc.com/employment. Please send applications to card@parc.com.

University of California, Davis
Department of Computer Science
Faculty Positions

The Program in Technocultural Studies and the Departments of Computer Science and Electrical and Computer Engineering at the University of California, Davis, invite applications for a joint tenure-track faculty position at the level of Assistant Professor. We are interested in the general areas of data/information mapping, representation, and especially visualization, streaming media and enabling technologies, concerned with "mining" massive data collections and flows. This position requires the technical expertise of computer science/computer engineering combined with the creative and critical sophistication of the contemporary arts.

We welcome applications from candidates that emphasize novel and emerging applications in areas that bridge Technocultural Studies and Computer Science and Engineering. We invite applications at the Assistant level from candidates with demonstrated research excellence and a commitment to excellence in teaching. The appointee will teach courses in both Computer Science/Computer Engineering and Technocultural Studies and, thus, must be capable of creatively engaging a wide range of artistic, technical, mathematical and programming proficiencies and interests.

The UC Davis campus is the third largest in the University of California system. UC Davis ranks among the nation's top 20 universities in research funding. Davis is a pleasant, family-oriented community in a college town setting with excellent public schools and a mild climate. Davis is ideally located for many professional, cultural, and recreational activities. It is just 15 miles from California's capital city of Sacramento and is within easy driving distance of the Silicon Valley, Berkeley, San Francisco, the Sierra Nevada Mountains, and the Pacific Coast areas.

This position requires a Ph.D. or equivalent and is open until filled. For complete application instructions, please consult our webpage at http://www.cs.ucdavis.edu/department/employ/

UC Davis is responsive to the concerns of dual career couples and offers a Partner Opportunity Program. UC Davis is an affirmative action/equal opportunity employer.

University of Delaware
Computer and Information Sciences Department
USDA Postdoctoral Fellow in Bioinformatics

Empirical machine learning project to predict the genes making agriculturally important proteins. Seek a creative, quick learning computer science Ph.D. either in machine learning or other practical or theoretical specialties.

Especially attractive to those wanting to retool for later permanent employment in the hot area of bioinformatics. Initial position for 12 months @ $50K with extension possible.

Inquire of, apply to, and have your references sent to:
Prof. John Case (case@cis.udel.edu).

The University of Montana
Department of Computer Science
Position Description:

The Department of Computer Science at The University of Montana invites applications for a tenure-track position in bioinformatics. More detail on Computer Science staff, research programs, and facilities can be obtained at: http://www.cs.umt.edu. We are seeking a computational scientist whose research interests include developing new approaches to the analysis of large biomedical and biochemical data sets, especially those generated by proteomics and micro-array analysis. This position is offered in collaboration with the Center for Environmental and Health Sciences.

The University of Montana has expanding research programs in proteomics and micro-array analysis. See http://www.umt.edu/cehs and http://biology.dbs.umt.edu/ for more information. The candidate should have the interest and background to be able to collaborate effectively with the biological sciences community. The candidate should also have the computer science background to participate as an active faculty member in a department of computer science.

For more details, see http://www.cs.umt.edu/positions/.

The University of Montana is an equal opportunity/affirmative action employer and encourages applications from women, minorities, Vietnam era veterans, and persons with disabilities. This position is eligible for veteran's preference in accordance with State law, and this announcement can be made available in alternative formats upon request.

University of Nebraska – Lincoln
Computer Science and Engineering Department and NCITE - National Center for Information Technology in Education

The UNL CSE Department and NCITE are seeking a non-tenure track research professor to develop technology to aid in teaching and learning. A primary goal is to investigate the development of learning objects and the role of applicable standards such as SCORM to create effective tools for teaching and learning. The appointee will help lead the "reinvention" of computer science education through the development of learning objects, a learning repository, and ancillary support material. The appointee will be expected to collaborate with Teachers college researchers and others in developing a rigorous understanding of the impact of educational technology on learning and teaching. The appointee will also develop funding proposals in response to solicitation from major funding agencies to further the work undertaken.

Applicants are required to have a PhD in computer science, software engineering, or related fields. Five years teaching experience is required. A successful background in grant writing is preferred. A record of successful publication in research journals is preferred.

UNL is a comprehensive research university with Carnegie I standing and membership in the elite Association of American Universities. The CSE Department offers BS, MS, and PhD degree programs in both computer science and computer engineering and will begin a PhD program in information technology, Fall 2003. Also see http://www.cse.unl.edu and http://www.ncite.org. Lincoln, the capital of Nebraska, is a prosperous, medium-sized city that ranks high in quality-of-life.

Contact by email search@cse.unl.edu, phone (402) 472-2401, and fax (402) 472-7767. For more information about the UNL CSE Department, visit http://cse.unl.edu.

The University of Nebraska is committed to a pluralistic campus community through affirmative action and equal opportunity and is responsive to the needs of dual-career couples. We assure reasonable accommodation under the Americans with Disabilities Act; contact Richard Sincovec at (402) 472-2401 or Art Zygielbaum at (402) 472-3124 for assistance.

CRA-W Career Mentoring Workshop at FCRC 2003

Saturday, June 7 and Sunday, June 8

Details at:
http://www.cra.org/career.workshop/

Professional Opportunities

University of Southern California
Computer Science

Applications are invited for full-time and part-time teaching faculty positions. Responsibilities include student advising, minor assistance with administration of the undergraduate program, and teaching fundamental undergraduate and entry level graduate courses. A Ph.D. is preferred but not required. Applicants must have significant teaching experience. The position is non-tenure-track but renewable. Salary is based upon qualifications.

Applicants should send their resume and three letters of reference to:

Edith Ross
Computer Science Department
University of Southern California
Los Angeles, CA 90089-0781
(edith@pollux.usc.edu)

Please go to http://www.cs.usc.edu/ for more information about our department. USC is an Equal Opportunity / Affirmative Action Employer.

Virginia Tech
Department of Computer Science
Human-Computer Interaction

The Department of Computer Science seeks one tenure-track faculty member starting in August 2003 to complement departmental research, participate in innovative teaching practices, and improve faculty diversity. Applicants should have a PhD in computer science or a related discipline. Additional information is at http://www.cs.vt.edu.

We wish to strengthen our established human-computer interaction focus in organizational informatics, knowledge management, community computing, and related areas. Our HCI group includes 6 tenure-track faculty, 8 research faculty, and over 30 graduate students. Current projects address collaborative systems, community and educational computing, user interface software and tools, 3-D input devices, notification systems, virtual environments, visualization, usability engineering, and design. Our work emphasizes multidisciplinary cooperation throughout the university and beyond.

Virginia Tech is located in Blacksburg, a scenic, lively, All-American Award winning town in southwest Virginia with affordable housing. Nearby is the white water of the New River and 1.7M mountainous acres of national forest.

Applicants should send a curriculum vitae, a 1-2 page research statement, a 1-2 page teaching statement, and have at least three letters of reference sent to:

HCI Faculty Search
Dept. of Computer Science
660 McBryde Hall
Virginia Tech
Blacksburg, VA 24061

Review of candidates will begin March 1, 2003, and continue until the position is filled. EO/AA

Wright State University
Department of Computer Science & Engineering
Chair

Applications and nominations are invited for the position of Chair, Department of Computer Science and Engineering at Wright State University in Dayton, Ohio. The position, which includes an appointment as NCR Distinguished Professor, begins Summer 2003 or Fall 2003.

The candidate for this appointment is required to have an earned Ph.D. in computer science or computer engineering or closely related discipline preferably with administrative skills. The candidate should have a commitment to excellence in teaching, research, and service and have an established scholarly record appropriate to a tenured faculty member at the rank of Full Professor. The primary role of the chair is to provide leadership to the Department of Computer Science and Engineering in both teaching and research. The successful candidate will be expected to develop a vision for further enhancing the Department's educational and research programs, and to develop a plan for implementing that vision, in the framework of collegiality that is required to effectively lead an academic department.

The Department of Computer Science and Engineering is one of four departments in the College of Engineering and Computer Science. The Department has 20 tenured and tenure-track faculty, 7 non-tenure track faculty, full-time staff support of 5, and offers undergraduate and master's degrees in both computer science and computer engineering, as well as the Ph.D. in computer science and engineering. Current enrollment is over 550 undergraduate students and about 180 graduate students including 40 doctoral students. The Department is housed in an attractive engineering building with a fully networked Unix environment and excellent laboratories with access to a Teradata machine, several other cluster computing machines and the Ohio supercomputer network. The department maintains an active research sponsored program with approximate funding of $3M per year mainly from NSF, AFRL, State of Ohio and Industry.

WSU, an institution of 16,000 students, is located in a rapidly growing high-technology suburban community, and is surrounded by commercial and government research and development facilities, including Wright Patterson Air Force Base, where the Air Force Research Laboratory is headquartered. The Department has strong ties to several Information Technology companies in the Miami Valley including NCR, Reynolds and Reynolds & LexisNexis. The University is proactively committed to industrial and government partnerships for research and development ventures. The CSE department faculty are actively involved in research in several areas including algorithms and databases, bioinformatics, data mining, programming languages, computer hardware, operating systems, networking, distributed computing, information and systems security, human computer interaction, software methodology and tools, computer vision, artificial intelligence, computer graphics and visualization, intelligent and evolutionary systems and robotics. The Department is closely associated with the College's Information Technology Research Institute, whose goal is to foster R&D efforts and industrial collaboration related to the doctoral program in computer science and engineering. Additional information on the CSE Department can be found at http://www.cs.wright.edu/cse.

Review of candidates begins May 1, 2003 and continues each month until the position is filled. Applicants should provide a brief statement of their capabilities and qualifications, vision for this position, complete vitae, and the names, addresses, telephone numbers, and e-mail addresses of five references. Electronic submission in word or pdf format is preferred. The salary is competitive. Inquiries and applications should be directed to:

Prof. S. Narayanan, Ph.D., P.E.
CSE Chair Search Committee
207 Russ Engineering Center
Wright State University
Dayton, OH 45435
Telephone: (937) 775-5044
Fax: (937) 775-7364
E-mail: snarayan@cs.wright.edu

Wright State University is an equal opportunity/affirmative action employer.

2004 DATES TO NOTE

For new faculty and advanced graduate students

CRA Academic Careers & Effective Teaching Workshop

February 22-24, 2004
Washington, DC

For department chairs

CRA Conference at Snowbird

July 11-13, 2004