

# COMPUTING RESEARCH NEWS

More than 25 Years of Service to the Computing Research Community

September 1999

Vol. 11/No. 4

## Appropriators Cut FY 2000 Funding For IT<sup>2</sup>

By Lisa Thompson

As Congress prepares to return to business the second week of September, the overall budget picture is still cloudy. Although forecasts suggest that the federal budget surplus will reach \$3 trillion over the next ten years, the White House and Congress disagree about how to use it. Both sides agree that about two-thirds of it should be left in the Social Security Trust Fund. And Congressional Republicans have passed an \$800 billion tax cut bill that would use most of the rest of it.

Although the White House and even many Republicans would like to apply some of the surplus to discretionary spending, neither side is willing to be the first to suggest it openly. So Congress is preparing the FY 2000 federal budget under tight caps on discretionary spending enacted several years ago. While most appropriations panels have written their FY 2000 spending bills, a few are waiting to see if more money becomes available so they can avoid deep cuts in their programs.

As a result of the impasse, the Administration's budget request for the Information Technology for the Twenty-First Century (IT<sup>2</sup>) initiative has been cut by all the panels that have considered it so far (for different reasons though).

million request for development of terascale computing systems was not funded at all. The subcommittee made clear, however, that the cuts were made "without prejudice," that is, because money was not available to provide the requested increases

comprehensive research program in this important field of computing and information technologies."

The report says much the same about the terascale computing program: "The Committee, however, is not prepared at this time to commit resources to the construction of a single site, five teraflop computing facility as requested in the budget submission. The Committee has taken this action, without prejudice, due to budget constraints and other, higher priority pressures on available financial resources. The Committee expects to consider this request in future year budget submissions and would hope to have the benefit of any new IT research that may be available to assist during those forthcoming deliberations."

The Senate appropriations subcommittee will mark up the NSF's budget after the congressional recess.

The Department of Energy's proposed participation in IT<sup>2</sup>, the \$70 million Scientific Simulation Initiative, was not funded by either the House or Senate Energy and Water appropriations subcommittees. The House panel explained that it could not afford to fund the SSI program in addition to DoE's ongoing Accelerated Strategic Computing Initiative:

Appropriators Continued on Page 6

The appropriations process is far from over and there is still a chance of securing additional funds for IT. CRA is asking the computing research community to redouble its efforts to promote Congressional support for the IT research initiative, in particular urging the Senate to work toward a VA-HUD appropriations bill that makes up the NSF's IT funding shortfalls in the House version of the bill. Please see <http://www.cra.org/Policy/advocacy.html> for more information.

The House appropriations subcommittee responsible for NSF provided a \$35 million increase above CISE's current budget to begin funding the IT initiative. This is well below CISE's request for a \$110 million increase. An additional \$36

and not because the subcommittee opposes the idea of expanding support for IT research. The report accompanying the spending bill says:

"Budget constraints make it impossible for the Committee to provide the funding level as provided in ... the full budget request for this new initiative without adversely disrupting funding in all other program areas. Nevertheless, the Committee believes \$35,000,000 is a significant down-payment towards what it expects will be a long-term,

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## 1999 FCRC in Atlanta a Success!

The Third Federated Computing Research Conference (FCRC) was held Friday, April 30 through Thursday, May 6, 1999, at the Atlanta Hilton and Towers, and was by all accounts a success, with some 1,450 people attending the various events, many registering for more than one. Following on successful events in San Diego (FCRC '93) and Philadelphia (FCRC '96), FCRC '99 was composed of fourteen tutorials plus a record number of Symposia and Workshops (sixteen):

CRA Workshop on Academic Careers for Women in Computing Science (CRA-W)

ACM/IEEE International Symposium of Computer Architecture (ISCA)

ACMSIGPLAN Conference on Programming Language Design and Implementation (PLDI)

ACMSIGPLAN Symposium on Principles and Practices of Parallel Programming (PPOP)

ACMSIGMETRICS Symposium on Parallel and Distributed Tools (METRICS)

ACM Workshop on Parallel and Distributed Simulation (PADS)

ACM/IEEE Workshop on I/O in Parallel and Distributed Systems (IOPADS)

ACM Symposium on Theory of Computing (STOC)

IEEE Conference on Computational Complexity (Complexity)

ACM Symposium on Principles of Distributed Computing (PODC)

ACM/UMIACS Workshop on Parallel Algorithms (WOPA)

ACMSIGPLAN Workshop on Computer Support for System Software (WCSS)

ACMSIGPLAN Workshop on Languages, Compilers, and Tools for Embedded Systems (LCTES)

ACMSIGARCH Workshop on Scalable, Shared-Memory Multiprocessors (WSSMM)

ACMSIGMETRICS Workshop on Mathematical Performance Modelling and Analysis (MAMA)

ACMSIGMETRICS Workshop on Internet Server Performance (WISP)

The high number of events was made possible by the flexibility of this year's financial model for FCRC, in which most costs were bundled into an overall "FCRC fee" charged once to each attendee, thus allowing individual events to have relatively small budgets, and making it easy to add one-day workshops to the schedule, even at a late date.

Another highlight of FCRC '99 was the widely-praised lineup of plenary speakers, selected by a committee headed by Rao Kosaraju, Johns Hopkins University. On Sunday, Shafi Goldwasser of MIT and the Weitzmann Institute spoke on "Testing Global Properties Using Random, Local Data: the Paleontologist Approach to Computer Science." On Monday, John Hennessy of Stanford University gave a talk entitled "Back to the Future: Time to Return to Some Long Standing Problems in Computer Systems?" On Tuesday, 1998 Turing Award winner Jim Gray of Microsoft gave his Turing Lecture "What Next? A Few Remaining Problems in Information Technology Problems." On Wednesday, Ken Kennedy of Rice University spoke on "Future Investment in Information Technology Research: Report of the President's Information Technology Advisory Committee." On Thursday, Charles Bennett of IBM Research spoke on "Quantum Information."

The plenary talks were scheduled just before lunch instead of first thing in the morning as in the past, and this proved a popular choice. This FCRC

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Expanding the Pipeline

FCRC Provides CS Females Forum

The CRA Committee on the Status of Women in Computing Research (CRA-W) held a very successful "Workshop on Research Careers for Women in Computer Science and Engineering" in conjunction with the Federated Computing Research Conference April 30 - May 1 in Atlanta, Georgia. The goal of the workshop was to provide computer science undergraduate and graduate students, professors, and researchers from industry and the national laboratories—especially females—an opportunity to share information critical for achieving success in computer science. A summary of events and talks at the workshop can be found at <http://www.cra.org/Activities/craw>.

CRA-W is participating on the Access and Inclusion team of the Education, Outreach, and Training Partnership for Advanced Computational Infrastructure (EOT-PACI), a joint organization formed to implement the EOT goals of NPACI and the National Computational Science Alliance. CRA-W is dedicated to improving the representation of women in computer science and other computing technology fields. Summaries of CRA-W sponsored or affiliated events are intended to broaden exposure to the content of such workshops, and especially to help young women in the field get valuable information about their chosen profession.

This year's conference was organized as a series of parallel groups, enabling participants to attend panels most pertinent to their current career status and future goals. The panels were targeted to students and pre-tenure faculty, researchers in industry and the national labs, and post-tenure faculty. The pre-tenure group attended panels on topics such as "Getting a Job" and "The Tenure Process." Industry and national lab researchers attended panels such as "Models of Industrial and National Lab Research," "Industry and National Lab Career Options," and "Strategies for Success in Industry and the National Labs." Post-tenure faculty concentrated on topics including "Career Options Beyond Research," "From Associate to Full—Going up the Ladder After You've Reached the First Rung," and "Reinventing Your Research Career." All three groups participated in joint sessions pertinent to all career paths, including "Research as a Career," "Networking and Professional Social Interactions," and "Time Management, Family, and Quality of Life Issues." Panel question-and-answer sessions were held at the end of each discussion.

Apart from panel discussions, participants also attended social events that enabled them and the speakers to exchange information, make professional contacts, and help create an informal professional

network that is critical to success. The seating arrangement for the lunch on May 1 was designed to allow participants with common research interests to interact. Friday night attendees participated in a "Networking Practicum" specifically designed to enable young researchers to interact with senior researchers in their specific fields.

Also at this workshop, CRA presented its annual awards for Outstanding Undergraduates. This is a program that recognizes undergraduate students who have shown outstanding research potential. This year's awards went to April Rasala and Masette Vena, both of Dartmouth College. The runner-up was Pedro Felzenszwalb of Cornell University. A full list of the recipients and honorable mentions can be found on the CRA website.

One of the weekend highlights occurred when Ruzena Bajcsy, assistant director of the Directorate for Computer and Information Science and Engineering at the National Science Foundation, gave the keynote address. Bajcsy focused in part on the potential additional congressional funding that will come in response to the President's Information Technology Advisory Committee (PITAC) Report to the President, which supports basic research. Her message encouraged the academic community to proactively support the recommendations in their interactions with their congressional leaders.

Serving as chair of this year's workshop was University of California at San Diego (UCSD) Professor of Computer Science and Engineering Francine Berman. She is also an SDSC senior fellow and NPACI partner. The workshop's vice chairs were Nancy Leveson of the Massachusetts Institute of Technology, Anne Condon of the University of Washington, and Joann Ordille of Bell Laboratories.

Congratulations go to the following for making the workshop a success:

Francine Berman, UCSD [Conference Chair]

Kim Peaks, CRA [Conference Coordinator]

Nancy Leveson, MIT; Anne Condon, the University of Washington; and Joann Ordille, Bell Laboratories [Program Vice-Chairs]

Bill Aspray [CRA] NSF and SIG Governing Board [Travel support]

Jan Cuny and Leah Jamieson [Co-chairs of CRA-W]

Ann Redelfs, SDSC/NPACI [Publicity and Web support]

Donna Baglio and David Johnson [FCRC]

Ruzena Bajcsy, NSF [Keynote speaker]

All of the Moderators and Panelists

This article appeared in © 1999 Online: News about the NPACI and SDSC Community. <http://www.npaci.edu/online/>, as CRA-W is a partner of NPACI's. ■

Borg Appointed by Clinton

Over the summer, the President named CRA Board of Directors Member Anita Borg to serve as a Member of the Commission on the Advancement of Women and Minorities in Science, Engineering and Technology (CAWMSET). The Commission was established by Congress in October 1998. Elaine M. Mendoza, President & CEO, Conceptual Mindworks, Inc. is chairing the commission.

Dr. Borg's appointment to CAWMSET is a recognition of her long-standing commitment to minority representation in the field of computing. Starting in 1987, she founded Systems, an Internet-based community for technical women. Since 1996, Dr. Borg has worked with the multiracial steering committee for the Access by Design Project of the Center for Children and Technology to encourage the high tech industry to be more receptive to the needs of our entire diverse population. In 1998, she was inducted into the Women in Technology Hall of Fame. She is the Founder and President of the Institute for Women and Technology, which works internationally to increase the impact of women on technology and to increase the

positive impact of technology on the world's women.

CAWMSET's mission statement is to "advance the full and equitable participation of all Americans in SET education; to increase the number of qualified American scientists, engineers, and technicians by expanding the human resources pool of women, members of racial and ethnic minority groups, and persons with disabilities; and to thereby enhance the Nation's economic capacity and technological growth in this era of global competitiveness."

The Commission held its first meeting April 14, 1999 at the National Science Foundation (NSF) in Arlington, VA. The first meeting combined introductions of both individuals and their perspectives on the issue of the underrepresentation of minorities in SET. Those who spoke were representative of academia, industry, and government agencies whose missions encompass human resources issues.

Those who spoke included Rita Colwell, Director of NSF who opened the meeting, followed by Arthur Bienenstock of the Office of Science and Technology Policy. ■



# Seed Corn at the Millennium: What Can We Learn from the Taulbee Data?

By Stu Zweben

As we approach the millennium, computer science finds itself in a position that bears great resemblance to that of the early to mid 80s. Enrollment in undergraduate computer science is booming. Many faculty positions in computer science departments reportedly are going unfilled, as are positions in industry (Freeman and Aspray 1999). Faculty are looking seriously at, and being aggressively recruited by, industry as an alternative to their current jobs. There is concern that we cannot keep enough students in our graduate programs to even keep the pipeline at its level of a couple of years ago, much less expand it to accommodate the increased demand for Ph.D. graduates. The forerunner of the CRA, in those days called the Computer Science Board, claimed circa 1980 that we were eating our seed corn by not being able to provide for the next generation of computer scientists in our educational institutions (Denning 1981). Do we have Seed Corn II upon us?

It would be useful to document such a situation as much as possible, so that appropriate actions can be taken to deal with it. In computer science, the best and most current source of data about human resources in our graduate departments comes from CRA's annual Taulbee Survey. What do these data tell us about the seed corn issue?

## The Ph.D. Pipeline

The Taulbee Survey provides snapshots of the Ph.D. pipeline at three important points. The most often quoted figures are those at the end of the pipeline. These are the numbers of Ph.D. graduates. But the survey also gathers information about the number of students passing the Ph.D. qualifying examination, and about the number of new Ph.D. students entering the academic departments.

Figure 1 shows the Taulbee data for each of these junctures since the mid 1980s, as reported by the Ph.D. granting computer science departments in the U.S. and Canada. The increasing number of Ph.D.s produced, as reported in the survey, is evident through 1994-95. This is a bit later than is often reported, and the discrepancy is due mainly to 1) the difference in number of departments reporting each year, and 2) the omission in our analysis of the computer engineering department data. To normalize for this variability in reporting, Figure 2 shows the pipeline data for the same period per department reporting. The number of departments reporting was taken from the Taulbee Survey's salary tables, though it is recognized that the number of departments reporting production, qualifier, and enroll-

ment data may not be identical to the number reporting salary data. Again, the peak production occurs during 1994-95, at about eight per department. The last survey (for the

National Research Council. Prior to 1994-95, Canadian departments' figures were merged in these reports with those of the departments not ranked in the top 36. Also note that

than do lower ranked departments. This figure also indicates that the decrease in Ph.D. production in the past two reporting periods has not been distributed uniformly across departments based on their NRC ranking.

At the Ph.D. qualifying exam level, Figure 2 shows a decreasing trend on a per department basis since the early 90s, with some recovery in 1996-97. Figure 4 shows the breakdown of the qualifier data by ranking. Here the decreasing trend is evident in all categories although, curiously, the collective departments ranked 13-24 seem to have recovered during the latest reporting period to their early 90s levels.

The number of new Ph.D. students per department declined from 1993-95, but for the last three years it has increased considerably, so it is now at its historic high of the late 80s. Figure 5 shows these data by ranking category. As can be seen from Figure 5, the recovery is most striking in the higher ranked departments.

## Analysis

One might be encouraged by the increase in new Ph.D. students during the past three years, and predict that this will result in a significant increase in Ph.D. production in a few years. However, the qualifier data should cause one to be a lot more pessimistic about this. Suppose one assumes that, in general, a student will take the qualifier in the second year of study. This would mean that the qualifier trends should lag those of new Ph.D. students by a year. Figure 2 shows that, while not entirely true, this has been the basic pattern over the years. However, the gap in the two lines widened during the past couple of years. Thus, while the significant rise in new Ph.D. students per department has increased the number of those passing qualifiers per department, the proportions are going down. This is one piece of evidence in support of a seed corn problem; a smaller fraction of students appears to be entering the post-qualifier stage of study for the Ph.D. One cannot determine from these data if a smaller proportion of students are taking the exam, or a smaller proportion of those taking the exam are passing (or both). But the effect is worrisome.

The period between passing the qualifier exam and graduating with the Ph.D. is more variable. However, if the total time to the Ph.D. is about five to six years (the most recent Taulbee Survey showed the average to be just over five years), the lag between the qualifier trend and the Ph.D. production trend should be roughly four years. Figure 2 tends to confirm this hypothesis.

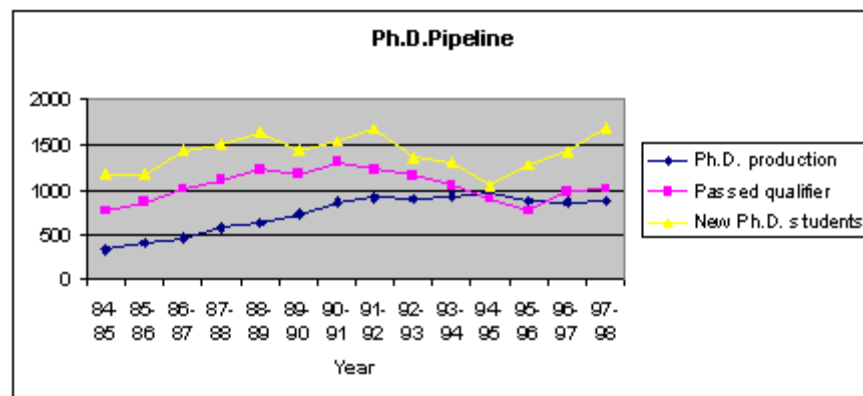


Figure 1

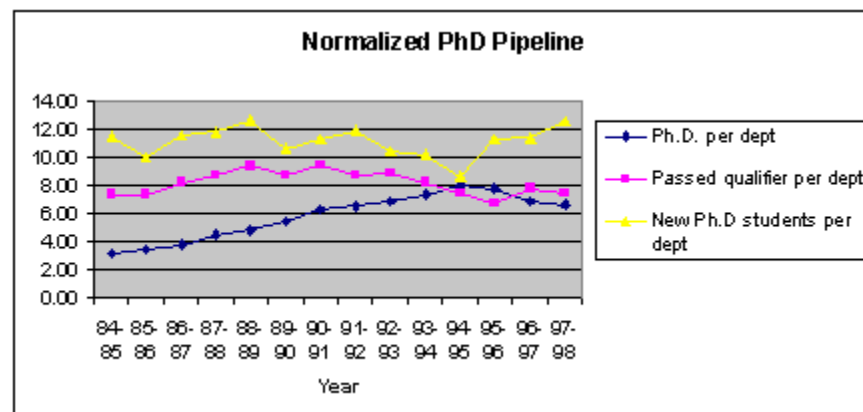


Figure 2

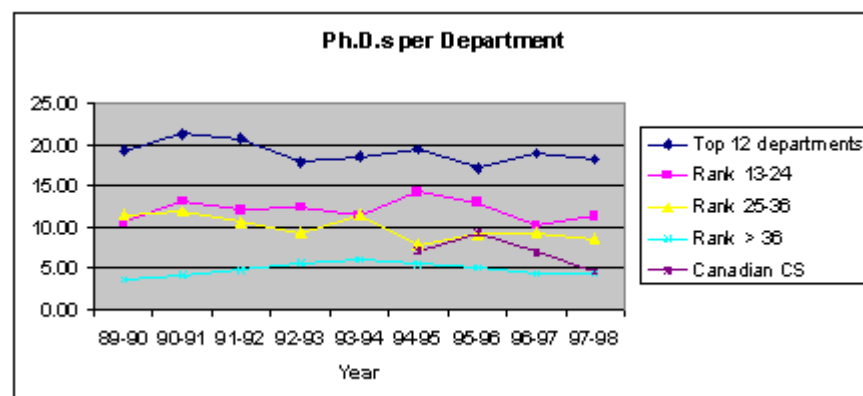


Figure 3

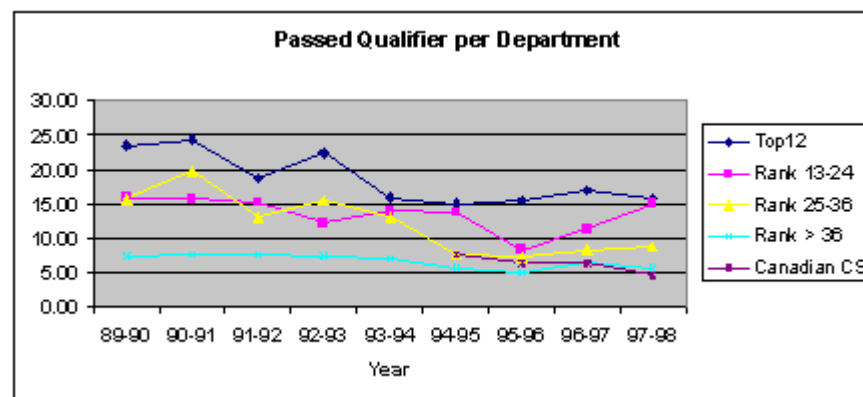


Figure 4

1998 graduating class) showed a value of 6.6 per department, a decrease of more than 15percent from the peak.

Figure 3 shows the differences in Ph.D. production based on departmental ranking. The Taulbee Survey categorizes the departments based on the ranking from the

in 1995, the most recent NRC rankings were published, and this means that the actual departments included in each of the categories changed beginning with the 1994-95 survey.

From Figure 3, one can see that higher ranked departments produce on average considerably more Ph.D.s

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Seed Corn from Page 3

Figure 6 shows the data from Figure 2 transformed so that the qualifier data is lagged one year from the new students data and the Ph.D. production data is lagged four years from the qualifier data.

The general decrease between 1990-91 and 1995-96 in the number per department passing the qualifier exam suggests that Ph.D. production per department will continue to show decline for the next couple of years, unless the proportion of those passing qualifiers who complete the degree increases from its historic levels. Of course, an argument can be made that the proportion of those passing qualifiers who go on to complete the degree is decreasing rather than increasing. Anecdotal evidence abounds of Ph.D. students leaving after passing the qualifying exam. It would be illuminating to see data at an intermediate point between the qualifier exam and the granting of the Ph.D. It is common for departments (or their institutions) to require a second intermediate hurdle, variously called by names such as the Candidacy or Preliminary Examination stage. Unfortunately, the Taulbee Survey doesn't collect data about this milestone, but such data may provide more conclusive evidence about the status of the Ph.D. pipeline.

The number of students graduating with the Ph.D. should not exceed the number passing the qualifier, unless there is a back door into the Ph.D. Figures 2 and 6 suggest, therefore, that the number of Ph.D.s produced per department will not rebound to its 1994-95 high in the foreseeable future.

Faculty Data

Production of new Ph.D.s is only one part of the seed corn issue. In order to educate the next generation of computing professionals, we need to currently attract and retain these persons within academic computing departments.

The number of advertisements for faculty positions is growing (CRN had to increase the size of its January issue to cope with the increased demand for advertising). If fewer new Ph.D.s are going into the academy, there will be a greater tendency for these faculty positions to go unfilled. If existing faculty are departing the academy with increasing frequency, this will damage our ability to not only teach new students but also perform vital research in the discipline and mentor the new faculty.

The Taulbee Survey collects data on the first jobs taken by new Ph.D.s, and on faculty departures. Last year, the survey also attempted to obtain information about the extent to which open positions are being filled, but the question was not worded satisfactorily. We are trying to improve our ability to collect this vacancy data.

Figure 7 shows, for new Ph.D. graduates whose first post-Ph.D.

employment was known to be in the U.S. and Canada, the proportions of

effect of this trend contributes to the seed corn problem.

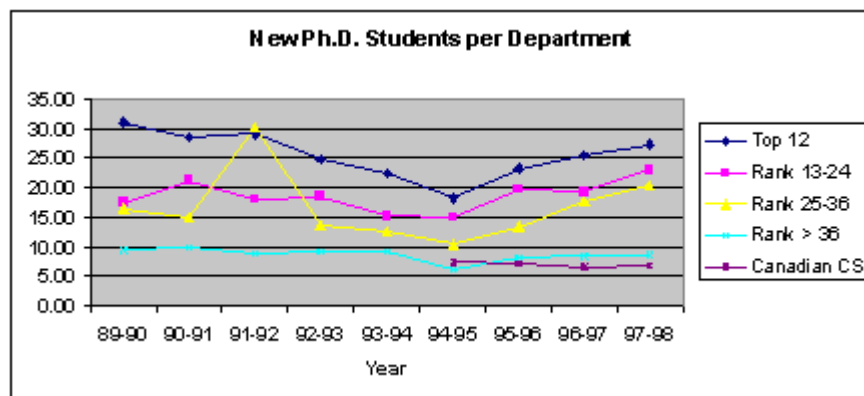


Figure 5

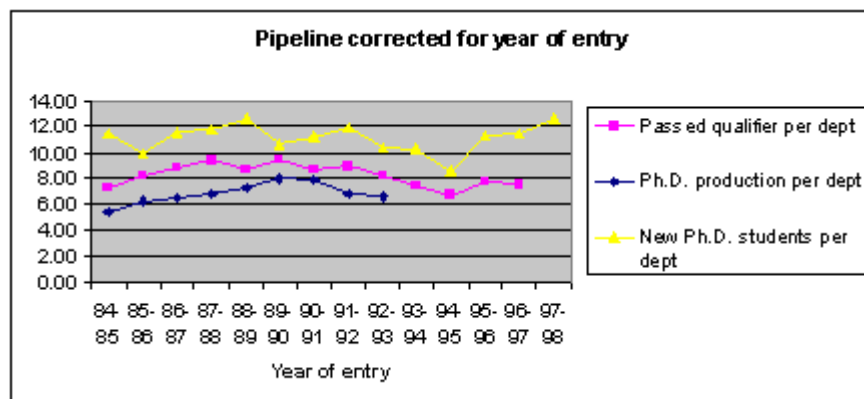


Figure 6

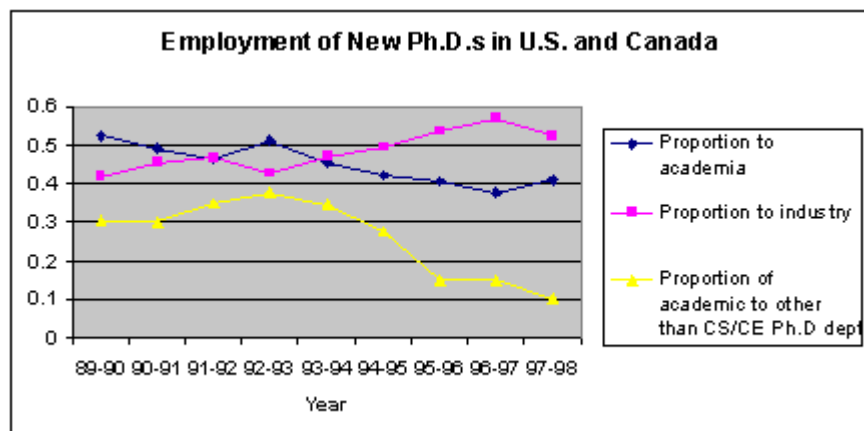


Figure 7

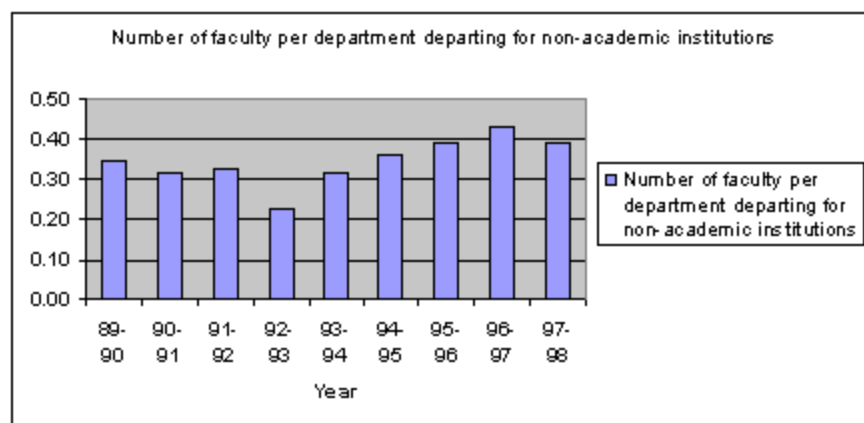


Figure 8

these graduates who went to industry and academia. Note that, within the "industry" category, the Taulbee data do not distinguish among positions in industry research, startups, development, etc. These data compare with NSF data that indicate, of new Ph.D.s in 1994 with plans for U.S. employment, 43% planned to go to industry and 49% to academia, while in 1996 these respective percentages were 50% and 44%. The data in Figure 7 illustrate the recent tendency for new Ph.D.s to go to industry with greater frequency than they do to academia. While industry employment is not to be discouraged, the

Of those new Ph.D.s who go into academia, the vast majority go to other Ph.D. granting computing departments. Figure 7 also illustrates this, and in fact shows a decreasing proportion who go to other than Ph.D. granting CS/CE departments. While in the early 90s there were about one-third going to such departments, now there are only around 10%. This does not bode well for these departments, which also are facing increasing enrollments and increasing demands for instructional personnel.

The Taulbee data on faculty departures is shown in Figure 8. On

a per-department basis, the recent trend seems upward after some decline in the early 90s. The numbers are small enough so that it does not seem as if one can sound an alarm, though the trend is in a direction consistent with a seed corn problem.

Conclusion

The Taulbee Survey provides some evidence that there may be a seed corn problem, though the evidence to date is weak. There is a trend of a decreasing number of students per Ph.D. granting department who are continuing past the qualifying exam level, despite a recent upsurge in the number of new Ph.D. students per department. This likely will mean that the number of Ph.D.s per department over the next several years will remain below its historic high of just four years ago. There also are considerably more new Ph.D.s going to industry than to academia, and somewhat of an increase in the number of faculty per department who leave for non-academic positions.

Many persons intuitively feel that the seed corn problem is far greater than this. Additional data about the Ph.D. pipeline, such as at an intermediate point in the Ph.D. study, and data about vacancies and their ability to be filled, can improve our understanding of this problem. While we may not be able to collect this data in time to properly analyze the current situation, it should prove valuable for the future.

The vacancy problem goes well beyond those departments surveyed through Taulbee, since most of the undergraduate and masters computer science students are taught in departments that do not grant Ph.D.s. The decline in the number of new Ph.D.s who take positions in these departments is quite alarming.

Acknowledgments

My thanks to Bill Aspray and Stacy Cholewinski for their assistance in compiling these data and helping me understand how they were collected and how they might be interpreted. However, any errors in the arguments or their associated data should be attributable to me.

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Stu Zweben is Professor and Chair in the Department of Computer and Information Science at Ohio State University. He is currently the chair of the Computing Research Association Surveys Committee. He is past Co-chair of the CRA Taulbee Survey Committee. He can be reached for comments at zweben@cis.ohio-state.edu. ■

## Association News

## Outstanding Undergraduate Awards Deadline October 25

### Nomination Information

The Computing Research Association is pleased to announce the sixth annual CRA Undergraduate Award Program, recognizing undergraduate students who show outstanding research potential in an area of computing research.

A cash prize of \$1,000 will be awarded to each of two undergraduate student winners, one female and one male, who are majoring in computer science, computer engineering, or an equivalent program. A number of other outstanding candidates will be recognized with Honorable Mention. The awards will be presented at one of the major computing research conferences sponsored by CRA, ACM, the IEEE Computer Society, SIAM, AAAI, or USENIX. The two first-prize winners will receive financial assistance toward their travel to the conference. CRA encourages home departments to provide similar assistance to other students who are recognized.

Please make this award widely known in your department. CRA hopes that your strongest undergraduates will be nominated. The award is a terrific way to recognize your best students and your department.

This year's awards program is made possible by the generous support of the Mitsubishi Electric Research Lab.

### Nomination Procedure

A nomination package consists of the following items:

1. Nomination form
2. Nominee's resume (two-page maximum)
3. Nominee's transcript of academic record
4. Verification statement signed by department chair\*
5. Letters of support from two other supporting nominators (two-page maximum)
6. One-page description highlighting one or two of the student's research or other achievements. This statement should be prepared by the student and it should describe the significance of the work as well as the student's specific contributions.

\*The verification statement signed by the department chair should simply state that the student is in good standing and eligible for the award.

A department may nominate more than one candidate. While it is preferable for nominations to be submitted by the candidate's department chair, it is also possible for them to come from individual faculty members. Nominees must attend a university or college located in the United States or Canada.

Nomination forms and other information are available on the CRA website at: <http://www.cra.org/Activities/awards/undergrad/home.html>

The nomination must reach CRA no later than October 25, 1999. Four copies of the complete nomination package are required (one transcript must be an original).

Address:

CRA Undergraduate Award Competition  
 Computing Research Association  
 1100 Seventeenth Street NW, Suite 507  
 Washington, DC 20036-4632  
 Tel. 202-234-2111  
 Fax: 202-667-1066  
 E-mail: [awards@cra.org](mailto:awards@cra.org)

### Criteria for Selection of Winners

1. Evidence of unusual talent in some area of computing research as demonstrated by one or more of the following:
  - a. Significant research contributions, individually or as a member of a team.
  - b. Creation of highly innovative software or hardware design.
  - c. Demonstration of exceptional leadership or vision in a field of computing research.
  - d. Other evidence of extraordinary interest, excellence, or commitment to computer science and engineering, including industrial experience, participation in special programs, and mentoring or tutoring of other students.
2. Outstanding academic record.

Questions and inquiries involving this year's Outstanding Undergraduate Awards should be directed to Jean Smith at [awards@cra.org](mailto:awards@cra.org). The award winners will be announced by December 1, 1999. ■

## Executive Fellowship

By Victor Rosenberg

Around 1997 the Computing Research Association concluded that the federal government could benefit from the services of academic computer professionals. I am not sure why they came to this conclusion, but I think they were right and I am grateful they decided to establish a fellowship for senior faculty in information technology to spend a year or two in Washington. As the first recipient of the CRA fellowship, my goal for the year in Washington was to help where I could, but more importantly to learn as much as I could about the government's policies in the area of electronic commerce. Little did I know that I would be involved in the creation of the policies.

I chose to be placed in the Department of Commerce, because it is one of the agencies that deal with business, universities, and local governments. This is the intersection where I believe e-commerce will be most important.

I came to two major conclusions about electronic commerce policy. I concluded that electronic commerce is not just buying and selling on the Internet, it is a much more profound restructuring of business so that it can function effectively in a global, networked environment. More and more companies are coming to recognize this and are wrestling with the consequences. Government officials must understand the phenomenon and deal with the issues that are raised. My second conclusion is that government must help technologically and economically challenged businesses and individuals participate in the new wired world.

The major question that government officials are grappling with is just what is the proper role for government in this new technological environment. Government must help the smaller and the disadvantaged businesses to participate in the technology; and second it must develop policies to make e-commerce safe and effective. The latter includes the development of standards where

appropriate and making sure that consumers can trust the system. They must be confident that they will not be defrauded and they must be confident that the system will be reliable. This is especially true of business-to-business e-commerce which is currently about four fifths of all electronic commerce.

As part of my work I participated in the writing of the Department's 2001 budget request. If the budget is funded (a big if) there should be room for a program that will target small- and medium-sized business for assistance in getting into the world of electronic commerce.

### The Fellowship Year

The fellowship year began with an excellent ten-day orientation presented by the American Association for the Advancement of Science (AAAS). In cooperation with many scientific professional societies, AAAS sponsors about seventy fellowships each year and places scientists in Congress and in executive branch agencies. This orientation, along with a continuing series of seminars throughout the year, gave me an especially useful insight into science policy and how it is made in Washington.

Washington is a strange place for a Midwesterner to land. It has a unique life of its own and is especially strange for a former entrepreneur who is used to getting things done quickly and efficiently. JFK used to joke that Washington is a town of northern charm and southern efficiency. I arrived in Washington at a very interesting time with the culmination of the impeachment trial. It will be difficult to get much done in the last two years of the Clinton Administration, but e-commerce will not wait, even for politicians.

One of the highlights of the year in Washington was observing the impeachment close up. I went to a session of the Senate trial and was amused by the conversation of a family behind me in the Senate

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## COMPUTING RESEARCH NEWS

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Policy News

# Early History of U.S. Policy on IT Workers

By William Aspray

The supply of information technology workers in the United States has become a major policy issue over the past several years, involving visa legislation, tax credits for corporate training programs, regional training programs, and major investments in education and research. To provide some perspective on these recent events, this article and a follow-up that will appear in the November issue of *CRN* will trace the history of U.S. policy concerning information technology workers.

Generally, the federal government has not established direct labor policy for information technology workers. Instead, it has been embedded in policies for science, education, public welfare, economics, and business. In the period covered here (up through the late 1970s), IT labor policy was closely related to science and education policy—especially as it applied to the National Science Foundation (NSF)—and to one failed effort connected to social welfare policy.

In the decade following the end of the World War II, the computer was largely conceived as a scientific instrument. Only near the end of that period did people begin to recognize its potential for use in data processing. This change brought with it a demand for many more computers and IT workers, as well as the formation of a computer manufacturing industry.

The first conference on the training of workers for the computing field was held at the end of this era, in 1954, at Wayne State University in Detroit. It was clear at this time that mathematicians were in demand to fill most computer jobs, even in data-processing environments. The vast majority of practicing mathematicians had been trained before the computer was invented, and some uneasiness was expressed about a shortage of mathematicians to fill these positions. While research-related agencies, such as the Office of Naval Research and the National Science Foundation, participated in

this conference, there was no government action at the time, other than to monitor numbers of practitioners and students in mathematics. No one at the time had a good sense of the number of computer workers that would be needed.

The period from 1956 to 1962 was marked by rapid growth in computing use and the number of computing machines, and by an equally rapid expansion of the computer manufacturing industry. This growth was driven in part by Cold War needs. For example, System Development Corporation (SDC), which was formed in 1956 to carry out the programming for the computers in the SAGE missile defense system, trained 7,000 programmers in its first five years. Because of the rapid turnover of employees at SDC, many U.S. programmers received their first programming training there. Very few universities provided formal training in computer science at this time. It soon became clear that there would not be an adequate supply of mathematicians to fill computing positions, and also that it was probably not necessary for mathematicians to fill most programming jobs. SDC and other organizations thus began using standardized aptitude and personality tests to identify people who were analytical and meticulous to train for programming careers, rather than looking for mathematicians.

This era was also marked by the responses to the launching of the Soviet artificial satellite, Sputnik. The National Defense Education Act was passed, providing fellowship support for many people who became computer scientists. NSF's budget was expanded, and increasing numbers of grants were made for teacher training and curriculum development across the sciences, including computer science. Most important, however, was the computer facilities program established by NSF, which ran from 1957 through 1973 and helped some 500

U.S. colleges and universities acquire their first computers.

Throughout the 1950s, computer science education was provided on campus mainly through computer centers, and at a few schools through programs in established departments—most often electrical engineering or mathematics. Computer science programs were developed very rapidly throughout the 1960s, and half of the doctoral programs that exist in the United States today were formed between 1962 and 1972. Training began at the doctoral level, moved to the master's level and finally reached the bachelor's level.

This transition was rapid, and by 1970 more students were graduating in computer science with bachelor's degrees than with doctorates. Curriculum development grants, research grants, and fellowships from the federal government were essential to this growth.

The period between 1962 and 1967 was one in which the federal government began to understand the national importance of computers. In 1962 the Information Technology Processing Office of the Defense Advanced Research Agency was

History Continued on Page 13

There continues to be active interest in the IT worker situation at both the regional and the national level across the United States. Here is a small sample of the recent activities, which is by no means complete:

The National Research Council has recently launched a study of Workforce Needs in Information Technology and Other High Technology Fields. They are sponsoring open hearings around the country, the first on September 24 in Santa Clara, California. For more information about the project, see <http://www4.nationalacademies.org/cpsma/itwpublic2.nsf>.

Joint Venture: Silicon Valley Network, which is a civic action nonprofit located in San Jose, has recently released *Joint Venture's Workforce Study: An Analysis of the Workforce Gap in Silicon Valley*. You can reach them for a copy at 408 271-7213 (or 800 573 JVS outside 408 area code) or by email at [jvsvooffice@aol.com](mailto:jvsvooffice@aol.com). Other interesting information is available on their website, <http://www.jointventure.org>.

Computing Research Association has distributed more than 4,000 copies of its report, Peter Freeman and William Aspray, *The Supply of Information Technology Workers in the United States*. Single copies are still available free of charge from CRA, or the report can be viewed and downloaded from the CRA website <http://www.cra.org>.

The Information Technology Association of America has a variety of on-going programs and projects associated with increasing the supply of information technology workers in the United States. They are undertaking a study of IT skills used in the workplace, scheduled for completion in October 1999. Other projects include engaging IT employers in school-to-work programs, helping women in transition achieve economic self-sufficiency through IT job training, and IT training and placement programs for persons with disabilities, as well as other studies, partnerships, and conferences. For more information, see <http://www.ita.org/workforce/>.

FCRC from Page 1

also seems to have been more successful in encouraging attendees to sample the programs of events other than their own. At FCRC, although attendees register for particular events, they are allowed to attend events at other conferences and workshops running on the same days as theirs, and one of the original goals of FCRC was to encourage this. This year, the layout of the hotel and the arrangement of conference rooms made this easier than in the past. In addition, for the first time the organizing committee was able to prepare a "Timeline Schedule" which allowed participants to quickly identify all the talks and sessions going on at any given time.

Conference management and registration services were provided by ACM, under the supervision of Donna Baglio of the ACM staff, who put in long hours on behalf of the conference and is one of the main reasons for its success. The other chief organizer was David Johnson of AT&T Labs and the Computing Research Association Board.

As in the past, about one third of the attendees at FCRC '99 were

students. This year their attendance fees were kept low in part by generous subsidies from IBM Research - Almaden, AT&T Labs - Research, Lucent Bell Laboratories, and Telcordia Technologies (formerly Bellcore). In addition, the ACM Special Interest Groups SIGPLAN, SIGACT, SIGARCH, and SIGMETRICS provided "lines-of-credit" that could be used to underwrite the student subsidy if needed, but in the end these appear to have been unnecessary. Preliminary financial reports indicate that the FCRC umbrella organization will run a slight surplus, as opposed to the significant deficits of the first two FCRCs that had to be underwritten by the SIGs.

The surplus resulted from tight financial controls, the replacement of the glossy advance program provided for the first two FCRCs by a postcard and a website, and the decision to have conference management and registration done in-house by ACM. There were some complaints about the web-based advance registration process introduced this year, but this was the first time ACM had tried something of this complexity, and

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"The budget justification for SSI failed to justify the need to establish a second supercomputing program in the Department of Energy. The Congress has been supportive of the ASCI program which the Department claimed would have benefits in addition to the defense purposes for which it was originally created. The proposed SSI program has a goal of building and operating a separate, yet similar, program dedicated exclusively to domestic purposes.

At this time, the Committee cannot support this massively parallel proposal to manage and fund two separate supercomputing programs."

At the Department of Defense, DARPA's \$70 million request for IT<sup>2</sup> was cut down to \$30 million by the

House and \$45 million by the Senate. Both of the Defense appropriations subcommittees considered the new program to be a low priority even within a growing DoD R&D budget.

When Congress returns it will continue work on the appropriations bill and set about reconciling the differences between the House and Senate versions. The President will most assuredly veto the Republican tax-cut legislation. This, and the possible veto of one or more appropriations bills, could lead either to negotiations on a compromise package of tax cuts and spending increases, or to a continuation of the impasse. As always, the outcome will reflect political calculations made by both sides as they position themselves for the 2000 Presidential election. ■

## Policy News

## NIH Focus on Biomedical Computing

A National Institutes of Health (NIH) panel has called on the agency to establish a Biomedical Information Science and Technology Initiative to expand research in biomedical computing and train a new generation of researchers. Formed last year by NIH Director Harold Varmus, the Working Group on Biomedical Computing found that the growing convergences in biomedicine and computation necessitate increased attention by the agency.

The NIH initiative will likely become part of the broader Information Technology for the Twenty-First Century initiative. The FY 2000 budget proposal for the initiative includes only \$6 million for NIH, which many criticized as being too low. The Administration described the figure as merely a placeholder, anticipating an increase after the NIH had a chance to consider the Working Group's report.

The report offers four recommendations:

1. The NIH should establish between five and twenty National Programs of Excellence in Biomedical

Computing devoted to all facets of this emerging discipline, from the basic research to the tools to do the work. It is the expectation that those National Programs will play a major role in educating biomedical-computation researchers.

2. To make the growing body of biological data available in a form suitable for study and use, the NIH should establish a new program directed toward the principles and practice of information storage, curation, analysis, and retrieval (ISCAR).

3. The NIH should provide additional resources and incentives for basic research (through R01 grants) to provide adequate support for those who are inventing, refining, and applying the tools of biomedical computing. [R01 grants are the standard individual investigator awards at NIH.]

4. The NIH should foster a scalable national computer infrastructure. To assure that biomedical researchers can gain access to the computing resources they need beyond their desktops, the NIH

should provide financial resources to increase computing capacity, both local and remote. The purpose of this recommendation is to establish a balanced infrastructure for all computational needs.

Some of the research areas identified by the initiative include surgery, neurobiology, medical genetics, rational drug design at the cellular level, cell biology, software development, algorithms, and databases.

The NIH has long been Congress's pet research agency, the recipient of substantial funding increases in recent years and subject of legislative attempts to double its budget over the next five years. In FY 2000, the agency could see as much as \$2 billion added to its currently \$15.6 billion budget, enough, one would think, to begin supporting a reasonable biomedical computing program.

The working group's report on the Biomedical Information Science and Technology Initiative can be found on the NIH website at: <http://www.nih.gov/welcome/director/060399.htm>. ■

## Extending FOIA to Research Data

The Office of Management and Budget recently issued the latest draft of revised rules that would expand public access to federally funded research data. The rules stem from a provision, inserted by Senator Richard Shelby (R-Alabama) in a 1999 appropriations bill, that charges OMB to extend the Freedom of Information Act (FOIA) to cover research data collected under federal grants and contracts to nonprofit organizations. FOIA currently requires federal agencies to provide any non-exempt data to anyone who requests it. (Exemptions from the requirement have been established to protect individual privacy and proprietary interests, among other things.) The revised rules and OMB's request for comment can be found at [http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=1999\\_register&docid=99-20683-filed](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=1999_register&docid=99-20683-filed)

The university community has been working both to soften the rules and to get the Shelby provision repealed. It is feared that the new data requirements will impose onerous and unfamiliar administrative burdens on universities; will be a disincentive in attracting volunteers for health research studies and clinical trials; will have a chilling effect on university-industry cooperation; and could lead to harassment of researchers in controversial areas.

Earlier this year, the late Representative George Brown (D-California) introduced a bill (H.R. 88) that would repeal the Shelby provision. (CRA has endorsed H.R. 88.) A recent hearing on the bill, held by the House Subcommittee on Government Management, Information, and Technology, provoked a lively debate (<http://www.house.gov/reform/gmit/hearings/testimony/990715h.htm>). On another front, an amendment to postpone implementation of the new regulations for one year was recently defeated by the House Appropriations Committee.

Proponents of the Shelby provision argue that the public has a right to see research data that it pays for. They are particularly concerned about research used in developing federal regulations. There have been a number of high-profile incidents in which the Environmental Protection Agency justified expensive regulations on the basis of research conducted under contract and then claimed it was not required to release the data, even to outside reviewers, because it belonged to the contractor.

Opponents of the bill have a formidable challenge in the face of strong anti-regulatory sentiment in Congress. The OMB intends to complete the rule-making process by the end of September. ■

## IT Workforce Still Concern For Congress

High-tech companies having trouble finding qualified job applicants have once again asked Congress to help remedy the situation by lifting the cap on H-1B visas that permit them to import skilled workers from abroad. Legislation introduced this summer by Senator Phil Gramm (R-Texas), the New Workers for Economic Growth Act (S. 1440), would raise the annual limit to 200,000 for the period 2000-2002. Last November the cap for 1999-2001 was raised from the baseline 65,000 to 115,000 per year, and all of this year's visas were claimed by June. The Gramm bill would also repeal the earnings test that reduces Social Security benefits for some seniors who continue working.

Last year's action was highly controversial and only succeeded at the end of the Congressional session by being buried in a huge omnibus funding bill. The Administration typically opposes lifting caps on immigration and would prefer homegrown measures to meet the rising demand for information technology workers.

In a June report, "The Digital Work Force: Building Infotech Skills at the Speed of Innovation," the Department of Commerce suggests a number of new approaches for attracting Americans into IT jobs and training them adequately: Businesses are called on to expand worker training programs; universities are urged to better address the needs of the future IT workforce;

and a national information and advertising campaign to improve the image of technical jobs is proposed. Further information is available at <http://www.ta.doc.gov/PReI/pr063099.htm>.

Another idea being circulated for the easing of corporate difficulties in acquiring needed worker skills is the establishment of a technology training tax credit program. Senator Kent Conrad (D-North Dakota) and Representative Jim Moran (D-Virginia) have introduced similar bills that would allow employers a credit against income tax of twenty percent of their qualified information technology training expenses. Mr. Conrad's proposal was offered as an amendment to a broader tax bill but failed on a 46-54 vote. ■

## CS Community Mourns loss of John Gannon

Professor John D. Gannon, Chair of the Department of Computer Science at the University of Maryland, died in his sleep of cardiac arrest at his home in Silver Spring, MD, early on Saturday June 12, 1999. He was 51.

Dr. Gannon was born in Providence, Rhode Island, and raised in Warwick, Rhode Island. He received Bachelors and Masters degrees from Brown University, and the Ph.D. in Computer Science from the University of Toronto. He joined the University of Maryland faculty in 1975.

Dr. Gannon was a leading figure in computer science through his research on software engineering: the

specification, analysis, and testing of software systems. He was also a gifted teacher and received many awards for his work with students, including the University of Maryland Distinguished Scholar-Teacher Award. His recent public service included membership on the Board of Directors of the Computing Research Association, chairing the Graduate Record Examination Board computer science committee, and serving as a program officer with the National Science Foundation. Dr. Gannon was an elected Fellow of the Association for Computing Machinery (ACM).

Professor Gannon is survived by his wife, Nancy Garrison, of Silver Spring, Maryland, and a brother,

Rickard Gannon of Foster, Rhode Island. He is also fondly remembered by his nieces, Allison and Michaela, and a nephew, Matthew Gannon.

The John D. Gannon Scholarship Fund has been established to commemorate John's commitment to students and education at the University of Maryland. Contribution and condolences information is available at [www.cs.umd.edu/](http://www.cs.umd.edu/).

A Memorial Service was held in the Large Memorial Chapel with a reception that followed in the A. V. Williams Building on the University of Maryland Campus.

Information provided by the Department of Computer Science, University of Maryland. ■

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## Special Insert

# Computing Research Association

## Best Practices Memo

# Evaluating Computer Scientists and Engineers For Promotion and Tenure

The evaluation of computer science and engineering faculty for promotion and tenure has generally followed the dictate “publish or perish,” where “publish” has had its standard academic meaning of “publish in archival journals” [*Academic Careers*, 94]. Relying on journal publications as the sole demonstration of scholarly achievement, especially counting such publications to determine whether they exceed a prescribed threshold, ignores significant evidence of accomplishment in computer science and engineering. For example, conference publication is preferred in the field, and computational artifacts — software, chips, etc. — are a tangible means of conveying ideas and insight. Obligating faculty to be evaluated by this traditional standard handicaps their careers, and indirectly harms the field.

This document describes appropriate evidence of academic achievement in computer science and engineering.

## Computer Science and Engineering — Structure of The Field

Computation is synthetic in the sense that many of the phenomena computer scientists and engineers study are created by humans rather than occurring naturally in the physical world. As Professor Fred Brooks of the University of North Carolina, Chapel Hill observed [*Academic Careers*, 94, p. 35],

When one discovers a fact about nature, it is a contribution *per se*, no matter how small. Since anyone can create something new [in a synthetic field], that alone does not establish a contribution. Rather, one must show that the creation is better.

Accordingly, research in computer science and engineering is largely devoted to establishing the “better” property.

The computer science and engineering field in academe is composed of faculty who apply one of two basic research paradigms: theory or experimentation. Generalizing, theoreticians tend to conduct research that resembles mathematics. The phenomena are abstract, and the intellectual contribution is usually expressed in the form of theorems with proofs. Though conference publication is highly regarded in the theoretical community, there is a long tradition of completing, revising, and extending conference papers for submission and publication in archival journals. Accordingly, faculty who pursue theoretical work are often more easily evaluated by traditional academic mechanisms. Nevertheless, the discussion below regarding “impact” will apply to theoretical work, too.

As a second generalization, experimentalists tend to conduct research that involves creating computational artifacts and assessing them. The ideas are embodied in the artifact, which could be a chip, circuit, computer, network, software, robot, etc. Artifacts can be compared to lab apparatus in other physical sciences or engineering in that they are a medium of experimentation. Unlike lab apparatus, however, computational artifacts embody the idea or concept as well as being a means to measure or observe it. Researchers test and measure the performance of the artifacts, evaluating their effectiveness at solving the target problem. A key research tradition is to share artifacts with other researchers to the greatest extent possible. Allowing one’s colleagues to examine and use one’s creation is a more intimate way of conveying one’s ideas than journal publishing, and is seen to be more effective. For experimentalists conference publication is preferred to journal publication, and the premier conferences are generally more selective than the premier journals [*Academic Careers*, 94]. In these and other ways experimental research is at variance with conventional academic publication traditions.

The reason conference publication is preferred to journal publication, at least for experimentalists, is the shorter time to print (7 months vs 1-2 years), the opportunity to describe the work before one’s peers at a public presentation, and the more complete level of review (4-5 evaluations per paper compared to 2-3 for an archival journal) [*Academic Careers*, 94]. Publication in the prestige conferences is inferior to the prestige journals only in having significant page limitations and little time to polish the paper. In those dimensions that count most, conferences are superior.

## Impact — The Criterion for Success

Brooks noted that researchers in a synthetic field must establish that their creation is better. “Better” can mean many things including “solves a problem in less time,” “solves a larger class of problems,” “is more efficient of resources,” “is more expressive by some criterion,” “is more visually appealing in the case of graphics,” “presents a totally new capability,” etc. A key point about this type of research is that the “better” property is not simply an observation. Rather, the research will postulate that a new idea — a mechanism, process, algorithm, representation, protocol, data structure, methodology, language, optimization or simplification, model, etc. — will lead to a “better” result. For researchers in the field, making the connection between the idea and the improvement is as important as quantifying how much the improvement is. The contribution is the idea, and is generally a component of a larger computational system.

The fundamental basis for academic achievement is the impact of one’s ideas and scholarship on the field. What group is affected and the form of the impact can vary considerably. Often the beneficiaries of research are other researchers. The contribution may be used directly or be the foundation for some other artifact, it may change how others conduct their research, it may affect the questions they ask or the topics they choose to study, etc. It may even indicate the impossibility of certain goals and kill off lines of research. Clearly, it is not so much the number of researchers that are affected as it is how fundamentally it influences their work. Users are another group that might feel the impact of research.

For the purposes of evaluating a faculty member for promotion or tenure, there are two critical objectives of an evaluation:



## Special Insert

(a) Establish a connection between a faculty member's intellectual contribution and the benefits claimed for it, and

(b) Determine the magnitude and significance of the impact.

Both aspects can be documented, but it is more complicated than simply counting archival publications.

### Assessing Impact

Standard publication seeks to validate the two objectives indirectly, arguing that the editor and reviewers of the publication must be satisfied that the claims of novelty and ownership are true, and that the significance is high enough to meet the journal's standards. There is obvious justification for this view, and so standard publication is an acceptable, albeit indirect, means of assessing impact. But it can be challenged on two counts. First, the same rationale can be applied to conference proceedings provided they are as carefully reviewed as the prestige conferences are in the computer science and engineering field. Second the measure of the impact is embodied in the quality of the publication, i.e. if the publication's standards are high then the significance is presumed to be high. Not all papers in high quality publications are of great significance, and high quality papers can appear in lower quality venues. Publication's indirect approach to assessing impact implies that it is useful, but not definitive.

The primary direct means of assessing impact — to document items (a) and (b) above — is by letters of evaluation from peers. Peers understand the contribution as well as its significance. Though some institutions demand that peer letter writers be selected to maximize the peer's stature in the field, e.g. membership in the National Academy, a more rational basis should be used.

From the point of view of documenting item (a), the connection between the faculty member's contribution and its effects, evaluators may be selected from the faculty member's collaborators, competitors, industrial colleagues, users, etc. so that they will have the sharpest knowledge about the contribution and its impact. If an artifact is involved, it is expected that the letter writers are familiar with it, as well as with the candidate's publication record. These writers may be biased, of course, but this is a cost of collecting primary data. The promotion and tenure committee will have to take bias into consideration, perhaps seeking additional advice.

The letter writers need to be familiar with the artifact as well as the publications. The artifact is a self-describing embodiment of the ideas. Though publications are necessary for the obvious reasons — highlighting the contribution, relating the ideas to previous work, presenting measurements and experimental results, etc. — the artifact encapsulates information that cannot be captured on paper. Most artifacts "run," allowing evaluators to acquire dynamic information. Further, most artifacts are so complex that it is impossible to explain all of their characteristics; it is better to observe them. Artifacts, being essential to the research enterprise, are essential to its evaluation, too.

Some schools prohibit letters of evaluation from writers not having an academic affiliation. This can be a serious handicap to experimental computer scientists and engineers because some of the field's best researchers work at industrial research labs and occasionally advanced development centers. Academic-industry collaborations occur regularly based on common interests and the advantage that a company's resources can bring to the implementation of a complex artifact. Letters from these researchers are no

less informed, thoughtful, or insightful because the writer's return address is a company.

In terms of assessing item (b) the significance of impact, the letter writers will generally address its significance, but quantitative data will often be offered as well. Examples include the number of downloads of a (software) artifact, number of users, number of hits on a Web page, etc. Such measures can be sound indicators of significance and influence, especially if they indicate that peers use the research, but popularity is not equivalent to impact.

Specifically, it is possible to write a valuable, widely used piece of software inducing a large number of downloads and not make any academically significant contribution. Developers at IBM, Microsoft, Sun, etc. do this every day. In such cases the software is literally new, as might be expected in a synthetic field, but it has been created within the known state-of-the-art. It is not "better" by embodying new ideas or techniques, as Brooks requires. It may be improved, but anyone "schooled in the art" would achieve similar results.

Quantitative data may not imply all that is claimed for it, and it can be manipulated. Downloads do not imply that the software is actually being used, nor do Web hits imply interest. There are techniques, such as the Googol page-rank approach [<http://www.google.com>], that may produce objective information about Web usage, for example, but caution in using numbers is always advised.

### Summary

Computer science and engineering is a synthetic field in which creating something new is only part of the problem; the creation must also be shown to be "better." Though standard publication is one indicator of academic achievement, other forms of publication, specifically conference publication, and the dissemination of artifacts also transmit ideas. Conference publication is both rigorous and prestigious. Assessing artifacts requires evaluation from knowledgeable peers. Quantitative measures of impact are possible, but they may not tell the implied story.

### References

*Academic Careers for Experimental Computer Scientists and Engineers*, 1994, National Academy Press

Googol Page Rank System

Approved by the  
Computing Research Association  
Board of Directors  
August 1999

Prepared by:  
David Patterson (University of California, Berkeley)  
Lawrence Snyder (University of Washington)  
Jeffrey Ullman (Stanford University)

## CRA New Board of Directors Members

### Incumbents

**James D. Foley** of Mitsubishi Electric Information Technology Center America rejoins the Board of Directors for his second term. He also continues as treasurer of the Computing Research Association. Foley's experience includes being a Fellow of both IEEE and ACM, serving on various editorial boards, and co-authoring three books. He was also named "Most likely to make students want to grow up to be professors" (Georgia Tech College of Computing Graduate Student Committee Award, 1992). He received his Ph.D. in Computer, Information, and Control Engineering from the University of Michigan.

His supporting statement included the following:

"Having lived in academia for many years and now in industrial research for nearly three years, I would want to continue and strengthen CRA's traditional role as an interface between these two interdependent worlds by way of Snowbird sessions and special workshops. I will continue to be active in recruiting and retaining industrial labs as CRA members. As this is best done by ensuring that industrial labs perceive value in CRA, I will work as an executive committee member to ensure that our programs provide appropriate value."

**Daniel A. Reed** has been very active in CRA's Government Affairs program and takes over this year as Chair of the committee. His past experience includes being the Review Committee Chair for the Presidential IT Advisory Commission, a member of an NSF CISE Advisory Committee, and a member of the Executive Committee of the NSF PACI National Computational Science Alliance. He was also awarded the NSF Presidential Young Investigator Award.

He believes, "[that] with the recent PITAC report and IT<sup>2</sup> Initiative, we are poised to move computing to the forefront of the national research agenda. However, we must act with unity and with vision."

Reed received his Ph.D. in Computer Science from Purdue University and is now Professor and Head of the Department of Computer Science, University of Illinois at Urbana-Champaign. His research interests include: high-performance computing, experimental performance analysis, parallel I/O, resource management, virtual environments, and mobile computing.

**Lawrence Snyder** earned a Ph.D. in Computer Science from Carnegie Mellon University. He is a Fellow of the IEEE and of the ACM and has served on several National Research Council Committees, and been a member of the NSF Advisory Committee of the Science and Technology Centers.

He believes that through community dialogue issues of relevance to CRA are raised and that CRA is obligated to be balanced and responsible. He states that "CRA has met this obligation well... [and that he] offers steady leadership balanced across CRA's four mission areas [to continue in] keeping computer research healthy... for both its intellectual and economic value.

At the University of Washington, Snyder's research interests are parallel algorithms and models of parallel computation, parallel architectures and interconnection networks, and parallel programming languages and environments.

He has served for several years on the CRA Outstanding Undergraduate Award Committee.

**Mary Lou Soffa** has served on the Board of Directors since 1996. Her involvement and dedication to CRA can be seen in her many activities, including being a member of the Committee on the Status of Women in Computing Research (CRA-W), member of the Government Affairs Committee, member of the Executive Committee, and through the organization of a workshop on mentoring at Snowbird '98, as well as through being a panelist at the CRA Workshops for Academic Careers for Women in Computer Science and Engineering. She is currently the Vice Chair of the Board of Directors, beginning her second two-year term.

She "thinks it is most important that CRA play a major role in promoting computing research, and in educating and influencing governments and organizations about issues in computing research." She feels that "CRA should continue to actively address problems in the computing research community through its committees and programs."

Soffa received her Ph.D. in Computer Science from the University of Pittsburgh and is currently a Professor of Computer Science at the University of Pittsburgh. She is an ACM Fellow, was an Invited tutorial speaker at the Sixth International Symposium on Static Analysis, and received an NSF Professorship for Women, Berkeley.

**John A. Stankovic** is a BP America Professor in the Department of Computer Science at the University of Virginia. He is also currently Chair of the Computer Science Department. He has served as Chair of the IEEE Technical Committee on Real-Time Systems, and Editor-in-Chief of IEEE Transactions on Parallel and Distributed Computing and Real-Time Systems journals. He is both a Fellow of the IEEE and ACM.

For CRA, he has chaired the electronic services committee, the communications committee, the professional awards committee, and ran the new chairs workshop at Snowbird '98.

Stankovic earned his Ph.D. in Computer Science from Brown University. His Ph.D. thesis was published as a book in part of a series of the best Ph.D. theses in computer science.

### Appointees:

**Doris L. Carver** is Professor of Computer Science at Louisiana State University. Carver has a doctorate degree in computer science from Texas A&M University. Her research interests are software engineering, formal methods, reverse engineering, and object-oriented software development methods.

Carver was the 1998 president of the IEEE Computer Society, and she is the 1999 IEEE Division V Director-Elect. She is a member of the Executive Committee of the IEEE Computer Society/ACM Software Engineering Coordinating Committee and a member of the IEEE Computer Society/ACM Steering Committee for Computing Curricula 2001. She has served as a IEEE Computer Society Distinguished Visitor. She has also served on numerous conference committees and editorial boards. She currently serves as the associate Editor-in-Chief of COMPUTER. She is an IEEE Fellow. She is also currently serving as the IEEE-Computer Society Representative to the CRA Board.

**Frank Tompa's** awards and honors include being named a "leader in Canadian Science" by the Natural Sciences and Engineering Research Council of Canada and being a recipient of a University-Industry Synergy R&D Partnership Award from the Conference Board of Canada and NSERC.

He is the current chair of the CRA Canada Committee. He is a Professor in the Department of Computer Science at the University of Waterloo. And earned his Ph.D. in Computer Science at the University of Toronto.

Tompa's supporting statement:

"In bringing together the needs of academia, business, and government, CRA plays a major role in advancing computer science and computer engineering as disciplines. Through the Board, I can apply my experiences from university life (as professor, department chair, member of senate) and from corporate participation (as researcher, founder of Open Text Corp., board member) to help guide CRA as it continues to fulfill its mandate. More specifically, I am interested in strengthening CRA's impressive contributions to collecting and disseminating information that highlights the impact and potential of computing research and to supporting the education and deployment of computing professionals."

Tompa replaces John Gannon on the CRA Board. He will serve out the rest of Gannon's term ending in 2001.

### Newly Elected:

**Lori A. Clarke's** research interests include software verification and testing of distributed systems and software engineering infrastructure, particularly object management and interoperability. She states, "she [is] interested in addressing issues in certification/licensing of software professionals for safety critical applications and in exploring ways to increase participation by women and minorities."

She has served as ACM SIGSOFT Chair, Vice Chair, and Secretary-treasurer. She strengthened this community by serving as a member of the SIGSOFT executive committee for fourteen years and counting. Clark is also involved with IEEE Transactions On Software Engineering as an Associate Editor and ACM Transactions On Programming Languages and Systems.

She is a Professor of Computer Science at the University of Massachusetts at which she has been instrumental in building the computer science program. Her current work includes developing a dataflow analysis approach for verifying safety properties for distributed systems.

Her Ph.D. in Computer Science is from the University of Colorado.

Association News

# CRA Hires New Staff

CRA is growing further to meet the needs of the computing research community. We are pleased to announce that we have recently hired two new staff members. Our Washington office now consists of seven fulltime staff.

Jay Vegso is serving as our Member Services Associate. This is a brand new position in our organization — one that we believe will focus greater attention on the needs of our members. Jay's responsibilities will include the coordination of our

determine more ways in which CRA can better, more effectively serve the community. They will be targeting special projects for membership drives and will be creating new programs for membership recognition.

Dana Neill is CRA's new Business Manager. This is also a new position. Dana is taking over in part for Kimberly Peaks, former Director of Administration, who left the organization this past summer. Kimberly joined CRA back in

February 1990, and was witness to and contributed in many parts to the establishment of CRA as the influential organization it is today. Her experience and dedication will be missed. We

workshops and meetings aimed at educating the community on issues and topics of concern. Jay will be managing CRA member data resources and he will also be the primary contact for member questions and relations. He can be reached at [jvegso@cra.org](mailto:jvegso@cra.org) and at 202-234-2111, extension 109.

Jay most recently was studying toward his Ph.D. in Medieval History at Cornell University. Prior to this, he received his Masters in Medieval History from Cambridge University and a Masters in Library Sciences from the State University of New York at Buffalo. He received his undergraduate degree in History from Catholic University of America.

He believes that he will be able to blend his experience in the workings and concerns of higher education with his dedication to service in an effort to advance the cohesiveness of the computing research community.

Jay will be working closely with the membership committee to

thank her for her many years of service and wish her and her family well.

Dana Neill's role within CRA will be primary responsibility for handling all of CRA accounts. She will be working closely with the Treasurer, Jim Foley. She will also be administering the biennial CRA Conference at Snowbird in Utah, as well as other. Dana will handle all vendor contracts as well as payables and receivables and all inquiries of this nature should be directed to [dneill@cra.org](mailto:dneill@cra.org) or 202-234-2111, extension 102.

Dana comes to CRA from United Rental at which she was the office manager with similar accounting duties as she now has at CRA. She received her education in part from George Mason University where she studied Early Childhood Education.

Dana is very excited to be working in the dynamic field of computing research and has enjoyed the dialogue and relations she has had thus far with the community. ■

## Association Corner:

(Be sure to check out our website [www.cra.org](http://www.cra.org) for more CRA information.)

**CRA has a new look!**



**The 1998-99 Taulbee Survey is in the mail. The deadline date for submission is November 5, 1999**

**Special Thanks to Telcordia Technologies for membership at the Sponsoring Member Level and Sun Microsystems at the Supporting Member Level in 1998-99**

**Membership packets have been sent out for U.S. academic departments for the 1999-2000 membership year**

Fellowship from Page 5

gallery. The mother said to the son, "now if you behave here we can go to the Air and Space Museum and see the Imax film." Somehow this put the year and the impeachment in perspective.

Learning about the process of government has given me some significant new insights. I have learned how important the political parties are in Washington and how much policy is made not just by legislation, but by political appointees in all the agencies run by the executive branch. It was difficult to learn who is a political appointee and who is a career civil servant. I learned that elections really are important and it matters whether a Republican or a Democrat wins a particular House or Senate seat. I expect to become much more active in local politics as a result of my stay in Washington.

My year in Washington fully met my expectations. I was able to reorient myself towards electronic commerce and was able to learn about the processes of government. In addition I made many contacts that

will be helpful when I return to the University of Michigan. I came to Washington with a normal degree of cynicism about government. As the year progressed my cynicism lessened as I watched able and talented people working hard for the public good. Now that I am leaving and am watching the extreme partisan bickering the cynicism is beginning to return.

### Recommendations

In a recent action the CRA board decided to discontinue the Senior Executive Fellowship program, but it might be a good idea to look at a more junior Congressional fellowship. Many of the participants in the AAAS program are fresh from post-docs or are junior faculty members who want to get into the policy arena. Washington could certainly use more people with skills in computer science as the issues they are dealing with increasingly involve computer or communications technology. Without effective input from the computer science community Congress can most likely be counted on to negatively affect the progress of technology. ■

**Kathleen R. McKeown** earned her Ph.D. in Computer Science at the University of Pennsylvania. Her current research interests include natural language processing, natural language generation, digital libraries, text summarization, and multimedia explanation. She is Professor and Chair of the Department of Computer Science at Columbia University and Chair of Columbia's Commission on the Status of Women

McKeown's experience includes being an elected officer for one of our affiliate societies, the American Association for Artificial Intelligence

She believes, "computer science is seeing major changes as interest in the field reaches all-time highs." She is "interested in the role CRA can play in keeping research funding levels high with a focus on basic research, in helping to change undergraduate education as enrollments grow, in defining issues for computer literacy, and in drawing women and minorities to the field."

**William A. Woods** joins the CRA Board of Directors as and Industrial Representative. He is a Principal Scientist, Distinguished Engineer at Sun Microsystems Laboratories. He earned his Ph.D. in Applied Mathematics from Harvard University. His research interests include knowledge represen-

tation, information retrieval, natural language processing, mechanical reasoning, speech understanding, artificial intelligence, and expert systems.

He has been involved with the National Research Council Panel on Applied Mathematics Research and Committee on Computerized Speech Recognition Technologies, as well as Alternatives for the Navy. He's worked with the Association for Computational Linguistics and is a Fellow of both the American Association for Artificial Intelligence and the American Association for the Advancement of Science.

### Supporting statement:

"At a time when research agendas emphasize technology impact and practical benefits, it is important to also provide funding for projects aimed at fundamental advances with longer range significance. Many important problems will take years of continued research on fundamentals before they yield their most significant benefits. The integration of machine reasoning with language processing and speech understanding is an example of such a problem. It is important to make the investment to continue fundamental research in such areas, while we reap the benefits of past research, in order not to miss significant opportunities for the future." ■

# 1998-99 Computing Research Association Membership

## Academic Members

- |   |  |   |  |
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| Colorado State University-CS                    | State University of New York, Buffalo-CSE    | University of Pittsburgh-CS                               | Wake Forest University-MCS   |
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| Ohio State University-CIS                       | University of Houston-CS                     |   |  |
| Ohio University-EECS                            | University of Idaho-CS                       |   |  |
| Oklahoma State University-CS                    | University of Illinois, Chicago-EECS         |   |  |
| Old Dominion University-CS                      | University of Illinois, Urbana-Champaign-CS  |   |  |
| Oregon Graduate Institute-CSE                   | University of Iowa-CS                        |   |  |
|   | University of Kansas-EECS                    |   |  |
|   | University of Kentucky-CS                    |   |  |

## Industrial Members

## Affiliate Professional Society Members

- American Association for Artificial Intelligence
- Association for Computing Machinery
- IEEE Computer Society
- Society for Industrial and Applied Mathematics
- USENIX Association



History from Page 6

founded, and within one year it was providing more funds for research in computer science than all other federal agencies combined. The federal government also began to improve the data it collected about computing. For example, NSF contracted with John Hamblen of the Southern Regional Education Board for a series of surveys about academic computer expenditures, sources of funds, and utilization for research and instruction.

It was also a time for national studies of computing. With NSF funding, the National Research Council conducted its first computer study, beginning in 1962 (published in 1966). Known widely as the Rosser Report for its chairman, the mathematician J. Barkley Rosser, the study focused on computers and their use in research. The report was somewhat useful as a planning tool for the federal agencies, documenting the rapid growth of academic computing and the critical role of the federal government in financing it. However, the report was too technical and was viewed by Congress as self-serving, so it did not succeed in increasing federal support for academic computing.

A second study (1965-1967), commissioned by the Presidential Science Advisory Committee and focusing on computers and education, was more politically effective. This report—known by the name of its chairman, the distinguished electrical engineer from Bell Labs, John Pierce—convinced President Lyndon Johnson to make computers a cornerstone of his educational platform, as a delivery system to poor and rural areas. As a result of a presidential directive, NSF formed an Office of Computing Activities (OCA), reporting directly to the NSF director (previously computing had been a program under mathematics within NSF). OCA not only supported the computerized delivery of education programs, but also supported computer science research and education. These latter programs would endure, whereas expense of computerized education coupled with the technology not being advanced enough at the time led NSF within a few years to largely divest itself of the charge to promote computerized education.

Federal action during the period between 1968 and 1976 had a generally unfavorable effect on the fledgling field of CS. In the summer of 1968, domestic programs were cut in order to pay for the Vietnam War. NSF cut its support for capital items in order to continue support for individual researchers. In effect, this was the beginning of the end for NSF's computer facilities program, which for a decade had been the federal government's most effective program for helping the universities train people in computer science. NSF decided to spread its cutbacks approximately evenly across the various scientific disciplines. This hit computer science especially hard,

inasmuch as it was growing rapidly and had not existed long enough to build an adequate financial base.

Other legislative and executive actions had a similarly negative effect on computer science. The 1968 NSF Act, known generally for its sponsor, Congressman Daddario of Connecticut, split the NSF funding pie into more pieces by mandating new programs in the social sciences and applications. In order to exert greater control, the Nixon Administration largely eliminated the institutional grants that were being provided by various federal agencies, including NSF, to the universities. The universities had been able to use these grants at their own discretion, and they were one of the principal ways to support academic computing centers. Computer center directors quickly found they could not survive on the computer usage fees they received from scientific research grants, which was the way in which the Office of Management and Budget (OMB) wanted the centers supported.

The amendment to the 1972 Military Procurement Authorization, sponsored by Senator Mike Mansfield, required military agencies to divest themselves of research grants that were not directly military-related. Other mission-oriented agencies, such as NASA and the Atomic Energy Commission, voluntarily followed this practice as well. The result was an overall reduction of federal support for computing research (and hence for computer education, which was closely interlinked). Although NSF had a one-time increase in its computing support as a result of the mission agencies transferring programs to NSF, the process was disruptive and the funding was not sustained in subsequent years. Finally, in this era, there were a number of hostile questions from OMB, the General Accounting Office, Congress, and even the National Science Board about the arcane nature, practical relevance, social impact, and need for computing research given the strong industrial base.

This was the federal context in which federal agencies, particularly NSF, were working to meet the national need for computer scientists. Undergraduate enrollments were growing rapidly, but not enough doctorates were being produced to staff faculty positions in computer science. There were 200 computer science faculty members in the United States in 1967. Projections were that 223,000 undergraduates and 61,000 graduate students would take computer courses in 1968, and these would require 400 faculty members to provide the instruction. But only 40 new doctorates in computer science were being produced each year, and only 80 percent of them were entering academic careers.

OCA tried to build up research and education in computing, but it was receiving resistance, especially from OMB. Noting the surplus of

scientists in many fields, OMB began a campaign in 1971 to eliminate NSF support for traineeships. In the end, both fellowships and traineeships for computer science were reduced. Although the origins are unclear, in the early 1970s there are various references within the computer science community to a goal of producing 1,000 doctorates per year by 1980. Unfortunately, the community did not come close to succeeding; 107 doctorates were produced in 1970 rising to 213 in 1975, but then reaching stasis and only producing 218 doctorates in 1980.

The solution to this problem and others in academic computing resulted in a series of new programs, which would lead the computer science community into a new era. These will be explored in the next article.

This article is based on a paper on the history of IT labor policy presented by the author in July 1999 at a conference on the international history of information technology policy held at the London School of Economics. Oxford University Press will publish the conference proceedings in 2000. The research was supported in part by the National Science Foundation. ■

FCRC from Page 6

they are already set up to do much better in the future.

As to the future, plans are beginning to take shape. Although originally initiated through the efforts of the CRA, the Federated Computing Research Conference is now a de facto ACM event, and that appears to be the best way for it to continue. For this to happen, the FCRC steering committee needs a permanent organizational parent within ACM. The ACM SIG Governing Board seems a likely possibility, and discussions are ongoing as to how to set this up.

At present, it seems likely that the next FCRC will take place in 2003. This would be a 4-year gap, rather than the previous 3-year gaps—a longer interval will make FCRC seem more special and will impose a less frequent burden on the constituent conferences. More importantly, it would allow more time for planning and site selection, which can contribute greatly to FCRC's success.

Anyone with suggestions, ideas, or offers of organization help for future FCRCs is encouraged to contact David Johnson (dsj@research.att.com). ■

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

The rate is \$2.25 (U.S.) per word. Purchase orders, money orders, and checks are acceptable (please do not send cash). All CRA members receive 200 free words per dues year. CRA's standard advertising package consists of running an ad in *CRN*, and distributing it electronically to CRA's jobs listserv and webpage (where it remains for no less than two months). As an alternative to this package, advertisers may request that their Professional Opportunities ads just be published in *CRN* or just distributed electronically. The cost of the ad is the same whether the standard or the alternative package is selected.

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

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

**Arizona State University**  
Computer Science and Engineering Department

We anticipate that we will have several tenure-track faculty positions open at all ranks (Assistant, Associate, Full) starting as early as Spring semester of 2000 and invite outstanding candidates to apply. Applicants are required to have completed a Ph.D. in Computer Science, Computer Engineering, or a closely related field by the appointment date. Applicants at the assistant professor level must show exceptional promise and applicants at the associate professor level and higher must demonstrate established excellence in research and teaching appropriate to rank. Desired areas of interest include software engineering, computer architecture/systems, embedded systems, networking, distributed systems, database systems, knowledge-based systems, and visualization.

We also invite applications for a non-tenure track lecturer position that requires an MS in Computer Science, Computer Engineering, or related field. The applicant must demonstrate evidence of being an excellent teacher.

ASU is a major research university widely recognized as a rapidly emerging educational institution in the United States. The main campus is located in the city of Tempe, in the metropolitan Phoenix area. The Department of Computer Science and Engineering provides a stimulating and fast-growing environment for research and teaching, with ample opportunities for partnerships with high-technology industry and emphasis on quality, leading-edge graduate and undergraduate education. For more information about the department, refer to the website: <http://www.eas.asu.edu/~csdept/>

Applicants must include a detailed curriculum vitae, hard copies of their most important publications, and the names and addresses of four references. Complete applications and nominations must be received by post and directed to:

Chair of Faculty Search Committee  
Department of Computer Science and Engineering  
Arizona State University  
PO Box 875406  
Tempe, AZ 85287-5406  
Tel: 480-965-3190

The initial closing date is November 1, 1999. Applications received after that date will be reviewed on a bi-weekly basis until the positions are filled. Salary is competitive. Positions pending budgetary approval.

ASU is an Equal Opportunity/Affirmative Action employer.

**Brown University**  
Computer Science Department  
Computer Science Faculty Position

Applications are invited for a senior position in computer science with tenure, commencing no later than July 1, 2000. Outstanding applicants are sought in systems and artificial intelligence (AI). Systems candidates are sought in the following areas: databases, distributed systems, environments, networks, operating systems, programming languages, software engineering, and Web-related technologies. AI candidates are sought who are adept in both building systems and improving our theoretical understanding of such systems; special consideration will be given to applicants in the areas of machine perception and robotics.

Candidates are expected to have outstanding research credentials, a strong commitment to teaching, and demonstrated leadership ability. They must also have a doctoral degree in computer science or closely related areas. Candidates are sought who will meet the teaching and research needs of the department.

Successful applicants will find at Brown a stimulating environment conducive to professional growth. Brown has a strong department with a variety of interesting research projects in analysis of algorithms, artificial intelligence, combinatorial optimization, computational complexity, computational geometry, computer graphics, concurrent data structures and architectures, database systems, graph drawing, operating systems, parallel computation, parallel and distributed debugging, programming environments, programming languages, robotics, and software engineering. The undergraduate and graduate students are first-rate.

Applicants should send a resume in hard copy and have at least five referees send letters of recommendation to:

Prof. Stanley Zdonik  
Dept. of Computer Science  
Brown University, Box 1910  
Providence, RI 02912  
Inquiries may be addressed to [faculty\\_search@cs.brown.edu](mailto:faculty_search@cs.brown.edu). All application materials must be received by October 15, 1999 for full consideration. Additional letters of recommendation may be requested.  
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**City University of New York, Graduate Center**

**Computer Science**  
*Three Positions*  
CUNY Graduate School and University Center, in midtown Manhattan, has some 4,000 students enrolled in thirty-one doctoral programs. The Ph.D. Program in Computer Science, with over forty doctoral faculty at CUNY constituent campuses, anticipates three positions based at the Graduate Center (to begin 9/2000). The positions are for Associate Professor or Professor, possibly at the Distinguished Professor level. We are seeking individuals who have had a major impact in the field, who are active in preferably more than one area, who have a consistent grant record, and some of whose work is applied.

Primary responsibilities include teaching doctoral-level students, research, departmental service, and supervision of dissertations. A distinguished candidate of substantial merit or accomplishment in the field who has an international reputation may be nominated as a Distinguished Professor.

Requirements: earned doctorate; record of significant (for Associate) or exceptional (for full) academic achievement; demonstrated ability to teach graduate students successfully.

Review of applications begins 11/1/1999. Send letter of application, curriculum vitae, and names/addresses of three references to:

Search Committee Chair  
Ph.D. Program in Computer Science  
CUNY Graduate Center  
365 Fifth Avenue  
New York, NY 10016  
EO/AA/IRCA/ADA

**Computists International**  
Computists' Weekly

Weekly digests of AI-related M.S./Ph.D. research and teaching jobs, grant opportunities, industry news, research software, free online resources, career tips, insight, etc. Professional association of AI/IS/CS researchers and advanced software technologists since 1991. Browse archives at <http://www.computists.com>.

**Concordia University**  
Department of Computer Science

Concordia University Department of Computer Science invites applications for at least one tenure-track faculty position at the Assistant or Associate Professor rank in the general area of Computing and Information Systems. The established strengths of the faculty members in this general area include databases, human-computer interfaces, machine intelligence, real-time systems and networks. The new positions require a Ph.D. degree in Computer Science or a related field. We are particularly interested in candidates whose expertise includes one or more of the following: systems design, security, human computer interfaces, multimedia systems, network and mobile computing, intranet/internet-based systems, databases and knowledge based systems.

The department places a strong emphasis on teaching, applied and basic research, and interdisciplinary research partnerships. For the Assistant Professor level we primarily seek a recent graduate with some publication record, a

strong research potential, and with interest and ability to teach effectively at the Bachelor's, Master's and Ph.D. levels. For the Associate Professor level, good credentials in both research and teaching are required. A successful candidate is expected to participate in the development of course and laboratories, supervision of graduate students, and the pursuit of external research funding, industrial collaborations and technology transfer.

The Department houses approximately 700 undergraduates and 250 graduate students. Thirty fulltime faculty and fifteen staff members support its activities. The Department has established a research centre, CENPARMI (Centre for Pattern Recognition and Machine Intelligence) with a specialization in pattern recognition and related expert-systems research. The Department is also involved in two inter-university research centres in mathematical computing and in VLSI architectures. Several members participate in the Network of Centres of Excellence (for example, CITR and IRIS). To promote the development of new faculty members, the university has the FRDP program to provide seed grants for research in the beginning years. There are excellent opportunities of external funding from both government research agencies (NSERC and FCAR) and industries.

Concordia University is located in Montreal, which is a dynamic and vibrant city with no shortage of opportunities for personal enrichment, entertainment, recreation, and sport. Montreal has long been recognized for its vibrant cultural scene, the numerous festivals, great restaurants, spirited nightlife, art museums, historical and heritage sites, the "joie de vivre" of its inhabitants, and the great outdoors. It is also a leading educational centre with four major Universities, and a leading industrial centre in many hi-tech domains including software, telecommunications, multimedia, aerospace, and pharmaceutical industries. Opportunities for industrial collaboration with information technology companies are among the best. Some of the local leading companies with significant R&D work include Nortel, Ericsson, Teleglobe, SR-Telecom, Softimage, Discreet Logic, Matrox, UbiSoft, Bombardier, CAE, Pratt & Whitney, Spar Aerospace, and Canadian Space Agency. Additional opportunities exist with industries in Ottawa, the Silicon Valley North, which is only two hours away. Also, opportunities for collaboration exist with Computer Research Institute of Montreal (CRIM), with strengths in networking, HCI, and software engineering. Although the primary language of instruction is English, proficiency in French will be considered an asset. Interested applicants should arrange to send a detailed curriculum vitae, a list of publications, and at least three references to:

Dr. H.F. Li, Chair  
Department of Computer Science  
Concordia University  
1455 de Maisonneuve West  
Montreal, Quebec H3G 1M8  
Canada  
Phone: 514-848-3001  
Fax: 514-848-2830  
E-mail: [hiring@cs.concordia.ca](mailto:hiring@cs.concordia.ca)  
Website: [www.cs.concordia.ca](http://www.cs.concordia.ca)

In accordance with the Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Concordia University is committed to Employment Equity and encourages applications from women, aboriginal peoples, visible minorities, and disabled persons.

**Concordia University**  
Department of Computer Science

Concordia University Department of Computer Science invites applications for at least two tenure-track faculty positions at the Assistant or Associate Professor rank in the area of Software Engineering. The department started a new undergraduate software engineering program in September 1998. This four-year program covers the specification, design, implementation, and maintenance of large-scale software, as well as management issues concerned with the production of such software. There are several faculty members in the department working in the area of software specification, design and reuse, program slicing and comprehension, and user interfaces. The new positions require a Ph.D. degree in Computer Science or a related field. Applicants with a wide range of teaching and research interests in software architecture, software requirements engineering, software quality assurance, software reuse, reverse engineering, software project management, and distributed software development are encouraged to apply.

The department places a strong emphasis on teaching, applied and basic research, and interdisciplinary research partnerships. For the Assistant Professor level we primarily seek a recent graduate with some publication record, a strong research potential, and with interest and ability to teach effectively at the Bachelor's,

Professional Opportunities Ads Available on Web

Not all departments and organizations choose to run their Professional Opportunities ads in *CRN*—their ads can only be distributed electronically to the Computing Research Association's website and jobs listserv. If you are interested in seeing more Professional Opportunities ads, access the Jobs webpage at <http://www.cra.org/Jobs>. If you would like to subscribe to [jobs@cra.org](mailto:jobs@cra.org) so you can read the announcements before they are published in *CRN* (or see the ones that don't appear in *CRN*), send the following mail message to [listproc@cra.org](mailto:listproc@cra.org): `subscribe jobs firstname lastname`.

## Professional Opportunities

Master's and Ph.D. levels. For the Associate Professor level, good credentials in both research and teaching are required. The successful candidates are expected to participate in the development of course and laboratories, supervision of graduate students, and the pursuit of external research funding, industrial collaborations and technology transfer.

The Department houses approximately 700 undergraduates and 250 graduate students. Thirty fulltime faculty and fifteen staff members support its activities. The Department has established a research centre, CENPARMI (Centre for Pattern Recognition and Machine Intelligence) with a specialization in pattern recognition and related expert-systems research. The Department is also involved in two inter-university research centres in mathematical computing and in VLSI architectures. Several members participate in the Network of Centres of Excellence (for example, CITR and IRIS). To promote the development of new faculty members, the university has the FRDP program to provide seed grants for research in the beginning years. There are excellent opportunities of external funding from both government research agencies (NSERC and FCAR) and industries.

Concordia University is located in Montreal, which is a dynamic and vibrant city with no shortage of opportunities for personal enrichment, entertainment, recreation and sport. Montreal has long been recognized for its vibrant cultural scene, the numerous festivals, great restaurants, spirited nightlife, art museums, historical and heritage sites, the "joie de vivre" of its inhabitants, and the great outdoors. It is also a leading educational centre with four major Universities, and a leading industrial centre in many hi-tech domains including software, telecommunications, multimedia, aerospace, and pharmaceutical industries. Opportunities for industrial collaboration with information-technology companies are among the best. Some of the local leading companies with significant R&D work include Nortel, Ericsson, Teleglobe, SR-Telecom, Softimage, Discreet Logic, Matrox, UbiSoft, Bombardier, CAE, Pratt & Whitney, Spar Aerospace, and Canadian Space Agency. Additional opportunities exist with industries in Ottawa, the Silicon Valley North, which is only two hours away. Also, opportunities for collaboration exist with Computer Research Institute of Montreal (CRIM), with strengths in networking, HCI, and software engineering. Although the primary language of instruction is English, proficiency in French will be considered an asset. Interested applicants should arrange to send a detailed curriculum vitae, a list of publications, and at least three references to:

Dr. H.F. Li, Chair  
Department of Computer Science  
Concordia University  
1455 de Maisonneuve West  
Montreal, Quebec H3G 1M8  
Canada  
Phone: 514-848-3001  
Fax: 514-848-2830  
E-mail: hiring@cs.concordia.ca  
Website: www.cs.concordia.ca

In accordance with the Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Concordia University is committed to Employment Equity and encourages applications from women, aboriginal peoples, visible minorities and disabled persons.

### Gettysburg College

#### Department of Computer Science

Gettysburg College invites applications for a tenure-track Assistant Professor position in computer science beginning August 2000. A Ph.D. in Computer Science or a closely related field, promise of excellence in teaching, and a commitment to continued scholarship are essential. Applicants are expected to have a strong interest in undergraduate teaching and a desire to involve undergraduate students in their research programs.

Gettysburg College is a highly selective liberal-arts college located within ninety minutes of the Baltimore-Washington area. Established in 1832, the College has a rich history and is situated on a 220-acre campus with an enrollment of 2,200 students. The College has received national recognition for its innovative use of advanced technology.

The computer science major was established in 1987, and as the result of rapid growth a new Department of Computer Science has been organized. The Department currently has three fulltime faculty members and will expand to four when this position is filled. Thus, the successful applicant will have a unique opportunity to influence the direction of a growing department.

All department members are active in undergraduate research, which frequently results in student presentations at regional and national conferences. The College is prepared to assist in establishing a research program that actively involves undergraduate students. This assistance

includes a paid pre-tenure leave program.

Send letter of application, curriculum vitae, statement of teaching interests and scholarship goals in a liberal-arts environment, and three letters of recommendation to: Professor Rodney S. Tosten, Chair, Department of Computer Science, Gettysburg College, Gettysburg, PA 17325. At least one letter must address teaching effectiveness.

Review of applications will begin immediately and will continue until the position is filled.

The College seeks to promote diversity in its community through its Equal Opportunity/Affirmative Action programs; included in an attractive benefits package is a Partner Assistance Program.

### Massachusetts Institute of Technology

#### Aeronautics & Astronautics Engineering Department

##### Appointments in Teaching & Research

MIT's School of Engineering has some of the top rated undergraduate and graduate programs in the nation. Aeronautics & Astronautics Engineering is an innovative multidisciplinary department, a leader in the design and development of complex aircraft, space, transportation, information, and telecommunication systems, and it is implementing a new thrust in Aerospace Information Systems. A new undergraduate major emphasizing information systems topics has been established, as well as graduate and research programs in software engineering, autonomy, and communications. Two types of positions are open at this time in a strong growth area: Software engineering for complex, real-time or embedded systems.

Tenure-track faculty openings—Successful candidates will be responsible for designing and teaching SW engineering classes at both the undergraduate and graduate level and will lead research groups composed of students with a variety of backgrounds. Topics include the processes of end-to-end SW development, from system requirement definitions to error checking and verification and validation. Candidates should be interested in interacting with students and faculty who may be outside the usual computer science boundaries. A joint appointment with the Electrical Engineering and Computer Science Department is possible.

Senior Research Scientists—There are opportunities for researchers who enjoy defining and solving problems related to real validation and verification issues in large complex systems (embedded real-time systems) to do SW design; requirements specification and analysis; modeling, real-time application issues (analysis, scheduling, verification) SW process management; safety, reliability, fault tolerance, and other quality attributes, testing and other assurance activities for aerospace applications. Activities are not limited to the above list. Responsibilities include leading research groups, developing and maintaining relationships with major industrial research partners, and teaching a course on a relevant topic, if interested. Successful candidates will have a Ph.D. or MS in Computer Science or related field and real project experience, and will view software engineering as encompassing much more than coding. Appointments may be made at the Senior, Principal, or Research Scientist level, depending on the qualifications of the candidate, and one or two-year Research Fellow positions are possible as well, for candidates with industry experience.

Learn more at <http://www.mit.edu/aeroastro/www/hq/strategicplan.html>

Send letter and curriculum vitae in MS Word 6 or plain text to:

Irene Miller  
Dept of Aeronautics and Astronautics  
MIT  
77 Mass Ave, Room 33-413  
Cambridge, MA 02139, USA  
imm@MIT.edu

We welcome applications from women and members of U.S. minority groups. MIT is an AA/EEO employer.

### Miami University

#### Department of Systems Analysis

Nine month, fulltime, visiting faculty position to teach undergraduate courses in computer programming (Visual Basic, C++), networking, or other computer science areas. Beginning August 1999. A master's degree in computer science or a related field or equivalent experience is required. Please send resume as soon as possible to:

Dr. Douglas Troy, Acting Chair  
230 Kreger Hall  
Miami University  
Oxford, OH 45056  
or  
E-mail: troyda@muohio.edu

### Montana State University-Bozeman

#### Computer Science Department

The Computer Science Department seeks candidates for a fulltime, tenure-track position at the Assistant Professor level. Requirements for the position include a Ph.D. in Computer Science or a related field, the potential for excellence in teaching, the potential for excellence in research, and an area of research that complements that of the existing faculty. Preferred qualifications include previous teaching experience, previous research experience, and excellent communication skills. For departmental and area information, please visit [www.cs.montana.edu](http://www.cs.montana.edu). Questions may be addressed to [search@cs.montana.edu](mailto:search@cs.montana.edu).

Candidates are asked to send a letter addressing their ability to fulfill the position requirements, a current curriculum vitae, and must arrange for three letters of recommendation to be sent separately to:

John Paxton, Chair  
Computer Science Search Committee  
Computer Science Department  
Montana State University-Bozeman  
Bozeman, MT 59717-2320

The position is available for Spring or Fall 2000 and review of complete applications will begin 9/1/99 and continue until the position is filled. ADA/AA/EO/VetPref.

### Oregon State University

#### Department of Computer Science

Anticipating a period of rapid growth, the Department of Computer Science at OSU invites applications for tenure-track faculty positions at the rank of Assistant or Associate Professor. Appointments can begin in either January or September 2000. Candidates must hold or be completing a Ph.D. in Computer Science or a closely related field. Applicants for an assistant professor position should have records that demonstrate clear promise for innovative research and quality teaching. Applicants for an associate professor position must have well established records of accomplishment in research, teaching, and scholarly activity. We desire candidates whose research complements our existing research strengths, particularly in the areas of systems and software engineering.

To apply, send a complete resume, a statement of research interests, and at least three sealed letters of recommendation (e-mail is acceptable) to:

Faculty Search Committee  
Dept. of Computer Science  
Oregon State University  
303 Dearborn Hall  
Corvallis, OR 97331-3202  
Phone: 541-737-3273  
E-mail: [kites@cs.orst.edu](mailto:kites@cs.orst.edu)  
Web: [www.cs.orst.edu](http://www.cs.orst.edu)

Review of applications will begin September 16, 1999. Positions will remain open until filled. OSU has an institution-wide commitment to diversity and multiculturalism; it provides a welcoming atmosphere with unique professional opportunities for leaders who are women and/or people of color. All are encouraged to apply. OSU is an AA/EEO employer and has a policy of being responsive to dual-career needs.

### Purdue University

#### School of Electrical and Computer Engineering

Purdue University, School of Electrical and Computer Engineering, seeks outstanding candidates in computer engineering for research and teaching in the following areas: artificial intelligence, compilers, computer architecture, computer networks, distributed computing, multimedia systems, operating systems, software engineering, VLSI and CAD. Strong candidates in all areas of computer engineering are encouraged to apply. Openings are for tenure-track faculty at all levels.

Send a resumé, including a statement of research and teaching interests and a list of at least three references, to:

Head, School of Electrical and Computer Engineering  
Purdue University  
1285 EE Building  
West Lafayette, IN 47907-1285

Applications will be considered as they are received. Purdue University is an Equal Opportunity/Affirmative Action employer.

### Stanford University

#### Department of Computer Science

The Computer Science Department of Stanford University invites applications for a tenure-track faculty position from candidates with expertise in the areas of continuous and discrete modeling, numerical analysis, or high-

performance scientific computing. Candidates are expected to have an excellent background in applied mathematics and computer science, and to be actively involved in the development of computational tools in relation to application areas such as (but not restricted to) biocomputation, imaging, physical simulation, data mining, and statistical learning. Higher priority will be given to the overall innovation and promise of the candidate's work than to contributions to any of these specific topics.

Applicants should have a Ph.D. in a relevant field. The successful candidate will be expected to teach courses, both in scientific computing and in related subjects, at the graduate and undergraduate levels, and to build and lead a team of graduate students in Ph.D. research.

The appointment will be made at the level of an Assistant Professor. The position is available immediately. Further information about the Computer Science Department can be viewed at <http://www-cs.stanford.edu>.

Applications should include a curriculum vitae, statements of research and teaching interests, and the names of at least four references. The application should be sent to:

Professor Rajeev Motwani - Search Committee Chair  
c/o Laura Kenny-Carlson  
Computer Science Department  
Stanford University  
Gates 278  
Stanford, CA 94305-9025

Applications will be accepted until March 15, 2000 or until the position is filled. Stanford University is an equal opportunity employer and welcomes applications from women and minority candidates.

### Stevens Institute of Technology

#### Department of Computer Science

##### Part-time Faculty Position

Stevens has one part-time position available immediately in the Department of Computer Science of Stevens Institute of Technology. We are seeking outstanding candidates in software engineering to teach one undergraduate course per semester.

Salary will be commensurate with qualifications and experience.

Applicants should send a curriculum vitae, and names of at least three references by e-mail to:

Stephen L. Bloom, Director  
Department of Computer Science  
Stevens Institute of Technology  
Hoboken, NJ 07030  
[bloom@cs.stevens-tech.edu](mailto:bloom@cs.stevens-tech.edu)  
Stevens Institute of Technology is an Equal Opportunity Employer.

### Swiss Federal Institute of Technology

#### Lausanne (EPFL)

##### Department of Computer Science

##### Processor Architecture

The Swiss Federal Institute of Technology Lausanne (EPFL) invites applications for a faculty position in processor architecture (Assistant, Associate or Full Professor) for the Department of Computer Science.

This position is open to candidates with a higher education in computer sciences and engineering. Candidate must have an outstanding research record in the field of hardware architecture (processors or systems). Industrial experience is an advantage.

This position requires a strong personality, teaching talents, and the ability to guide students and young researchers. The successful candidate will be talented for interdisciplinary research.

Starting date upon mutual agreement.

Interested applicants can ask for the application forms by writing or faxing to: Présidence de l'Ecole polytechnique fédérale de Lausanne, CE-Ecublens, CH-1015 Lausanne, Switzerland, fax: +41 21 693 70 84.

For further information, please consult also URL: <http://www.epfl.ch>, <http://diwww.epfl.ch/> or <http://admwwww.epfl.ch/pres/profs.html>, <http://research.epfl.ch>

### University of Alberta, Edmonton

#### Department of Computing Science

Do you have a commitment to the science of computing? Are you looking for an academic environment that focuses on the science of your discipline? Join us in a dynamic Computing Science department, known for its collegial atmosphere and collaborative research environment. Our department is in the Faculty of Science at the University of Alberta, in Edmonton, the capital of Alberta. We have eight established research laboratories, including Algorithmics, Artificial Intelligence and

## Professional Opportunities

### Jobs from Page 15

Cognitive Science, Database Management, Graphics, Networks and Communications, Parallel and Distributed Systems, Software Engineering, and Vision and Robotics. We have abundant computing facilities, and our department leads broadly-based multidisciplinary research within the Multimedia and Advanced Computational Infrastructure (MACI) project, and the Research Institute for Multimedia Systems (RIMS).

In addition to the standard computational research facilities, we also have a large SGI Origin 2000, and a 3-D immersive display powered by an SGI Onyx2. We are currently constructing a new research laboratory building, adjacent to a renovated historical building, to provide us with office and research space consolidated in the middle of our campus of about 30,000 students (see the WebCam at [www.cs.ualberta.ca](http://www.cs.ualberta.ca)). Our current complement of thirty-six regular faculty work within a department of twenty-eight support staff, 130 graduate students (50/50 MSc/Ph.D.) and 300 undergraduate students. Our consistent performance in ACM World Programming Contests is evidence of our claim to be one of the best undergraduate programs in the country, and our graduate students are successful in industrial and academic research labs around the world.

We are looking for eager, computing scientists experienced in several areas, especially graphics and visualization, database management, and software engineering. We are also looking to complement our strengths in artificial intelligence, parallel and distributed systems, and networks and communications, with scientists who can demonstrate that they are driven by curiosity and interested in collaborative research across these sub-disciplines. Candidates should have a Ph.D. in Computing Science, a proven research record, and a strong commitment to excellence in teaching. Responsibilities include research as well as teaching at the graduate and undergraduate level. Most positions will be at the Assistant Professor level; however, we will consider Associate and Full Professor appointments for outstanding candidates.

We offer an environment that is congenial and supportive of new Ph.D.s, with the challenge to help you be your best, and the support to help you succeed within an academic environment. Our department is part of a full-service university, in a province that has the fastest economic growth in the country, with over 1,600 existing software development companies.

In accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. If suitable Canadian citizens and permanent residents cannot be found, other individuals will be considered. Our current recruiting segment will end September 30, 1999. Find further details about us at [www.cs.ualberta.ca](http://www.cs.ualberta.ca) and send your curriculum vitae and the names and addresses of three referees to: Iris Everitt, Administrative Assistant, Department of Computing Science, University of Alberta, Edmonton, Alberta, Canada, T6G 2H1, or E-mail: [everitt@cs.ualberta.ca](mailto:everitt@cs.ualberta.ca).

The University of Alberta is committed to the principle of equity in employment. As an employer, we welcome diversity in the workplace and encourage applications from all qualified women and men, including Aboriginal peoples, persons with disabilities, and members of visible minorities.

### University of Arizona Department of Computer Science <http://www.cs.arizona.edu>

Applications are invited for tenure-track faculty positions at all ranks, beginning employment August 2000. Candidates must hold a doctorate in Computer Science or related field, have a commitment to excellence in teaching, and have demonstrated strong potential for excellence in research. Primary consideration will be given to computer scientists who work in algorithms, theory of computation, computer graphics, and computer systems and networks.

The Department of Computer Science at The University of Arizona has a long history of research accomplishment, influential software distribution (e.g., Icon, SR, FAKtory, x-kernel, glimpse) and substantial external funding to individual faculty, exceeding 2.5 million dollars last year. Major funding has included two NSF Institutional Infrastructure grants and a Research Infrastructure grant, providing a broad array of equipment for computing research. Research areas include programming languages, compilers, operating systems, networks, algorithm design, database systems, and theory of computation.

Applicants must send a curriculum vitae and the names of at least three references to:

Faculty Recruiting Committee  
Department of Computer Science

The University of Arizona  
PO BOX 210077  
Tucson, AZ 85721-0077

We will start the review of applications on October 1, 1999, and will continue to consider applicants until the positions are filled, subject to availability of funds. The University of Arizona is an EEO/AA employer - M/W/D/V.

### University of California, Irvine Department of Information and Computer Science

#### Open Faculty Positions

The Department of Information and Computer Science (ICS) has several tenured or tenure-track positions open in the following areas of research emphases:

A. Computer Graphics  
B. Systems Software: Databases, Operating Systems, Compilers, and Networks

C. Computer-supported cooperative work: social impacts of computing, information studies, and human-computer interactions.

D. Other areas of computer science such as software and software engineering, computer security, cryptography, bioinformatics or medical informatics.

Available positions are for an Associate or Assistant Professor in Computer Graphics and Assistant Professor positions in other areas, but exceptional candidates from all ranks will be considered. In all cases, we are looking for applicants with a Ph.D. degree in Computer Science or a related field, and strong research credentials as evidenced by scholarly publications. Applicants for senior positions must also demonstrate a proven track record in funded research activities.

The ICS Department is organized as an independent campus unit reporting to the Executive Vice Chancellor. It runs the second most popular major at UCI and has designed an undergraduate honors program that attracts the campus' most qualified students. External funding from government and industrial sponsors exceeded \$10 million last year. The Department currently has thirty-eight fulltime faculty and 150 Ph.D. students involved in various research areas including computer science theory, embedded computer systems, artificial intelligence, networks and distributed systems, databases, multimedia systems, computer systems design, software/software engineering, human-computer interaction, and computer-supported cooperative work. ICS faculty are involved in the forefront of research in the emerging areas of the computer science discipline such as multimedia/embedded computing, knowledge-discovery in databases, bioinformatics and the role of information in computer science and society. The faculty has effective interdisciplinary ties to colleagues in digital arts, biology, cognitive science, engineering, management, medicine, and the social sciences.

Although UCI is a young university, it has attained remarkable stature in the past three decades. Two Nobel prizes were recently awarded to UCI faculty. UCI is located three miles from the Pacific Ocean near Newport Beach, approximately forty miles south of Los Angeles. The climate is ideal year-round avoiding extreme temperatures in winters and summers. Irvine is consistently ranked among the safest cities in the U.S. and has an exceptional public school system. The campus is surrounded by high-technology companies that participate in an active affiliates program. Both the campus and the area offer exciting professional and cultural opportunities. Mortgage and housing assistance are available including newly built, for-sale housing located on campus and within short walking distance from the department.

Applicants should send a cover letter indicating which of the areas above [A-D] best fits their research, a curriculum vitae, three sample papers and contact information for three or four references to: [recruit@ics.uci.edu](mailto:recruit@ics.uci.edu) (PDF, postscript, Word, or ASCII).

Applicants are requested to ask their references to send letters of evaluation to [recruit@ics.uci.edu](mailto:recruit@ics.uci.edu) by January 15, 2000. Those that insist upon sending hard copy may send it to:

ICS Faculty Position [A-D]  
c/o Lori Miskell  
Department of Information and Computer Science

University of California, Irvine  
Irvine, CA 92697-3425

Application screening will begin immediately upon receipt of curriculum vitae. Maximum consideration will be given to applications received by January 7, 2000.

The University of California is an Equal Opportunity Employer, committed to excellence through diversity.

### University of Oklahoma School of Computer Science

The School of Computer Science at the University of Oklahoma, Norman, invites applications for a faculty position in the area of telecommunications and networking. Applicants must hold a Doctorate in Computer Science or a related discipline, with sufficient academic accomplishments or significant industrial experience for appointment as Associate or Full Professor. In addition to research experience, candidates must demonstrate a strong commitment to excellence in teaching at both the undergraduate and graduate levels.

Developing an even stronger telecommunications and networking research core is an integral part of the strategic plan of the school. In addition to having excellent research qualifications, candidates should be highly motivated, energetic, and have demonstrated communication and leadership skills necessary to successfully interface with colleagues in both the university and industrial settings. Many exciting opportunities in the networking area exist within the School of Computer Science with support from the College of Engineering. One example is the development of a statewide terabit testbed, to be used in developing and evaluating next generation, high speed switching technology. Opportunities for industrial collaboration also exist, and the school and college actively support research activities that involve or result in technology transfer. The School of Computer Science is CSAB accredited, and offers bachelors, masters, and doctoral degrees. There are approximately 350 undergraduate and 100 graduate students. Faculty research interests currently focus on database systems, telecommunication networks, software engineering, fault tolerance and testing, computer vision, human-computer interaction, artificial intelligence, parallel and distributed computing, large scale scientific computing, graph theory and combinatorial optimization, and theoretical computer science.

Norman is a suburb of about 90,000 people within the Oklahoma City metropolitan area (approximate population of 1,000,000). Norman offers award winning schools, cultural festivals, diverse local industry and an inexpensive cost of living.

Applications with a list of five references must be submitted to:

S. Lakshmirarahan, Chair, Faculty Search Committee  
School of Computer Science  
The University of Oklahoma  
200 Felgar Street, Room 114  
Norman, OK 73019-6151  
Tel. 405-325-2978  
Fax: 405-325-4044  
E-mail: [varahan@cs.ou.edu](mailto:varahan@cs.ou.edu)

The preferred start date is January of 2000, but a later start date is also possible. Screening will begin on October 1, 1999. Applications will be accepted until the position is filled. The University is an Equal Opportunity/Affirmative Action Employer. Women and minorities are especially encouraged to apply. OU is responsive to the needs of dual-career couples.

### University of Texas at Dallas Department of Computer Science Tenure-track Positions

The Computer Science Department of The University of Texas at Dallas invites applications for tenure-track faculty positions at all levels, starting September 2000. Visiting positions may also be available.

Candidates in all areas of computer science will be considered. However, priority will be given to individuals with expertise in system areas including software engineering, programming languages, distributed databases, multimedia, e-commerce, computer graphics, and Internet technologies. Candidates must have a Ph.D. degree in Computer Science, or equivalent. Candidates for junior positions should show strong potential for excellent teaching and research; candidates for senior positions should have a strong record of research, teaching, and external funding.

The Computer Science Department offers the Ph.D. degree in Computer Science and has Master's degrees in CS with major in Software Engineering as well as tracks in Telecommunications, and traditional Computer Science. We have experienced very rapid growth in enrollment in recent years. The University is located in the most attractive suburbs of the Dallas metropolitan area. There are over fifty high-tech companies with in ten miles of the campus, including Texas Instruments, Nortel Network, Alcatel, Ericsson, DSC, Nokia, Fujitsu, MCI, EDS, and Perot Systems. Almost all the country's leading telecommunication's companies have major research and development facilities in our neighborhood. Opportunities for joint university-industry research projects and consulting are excellent.

In addition to individual faculty worksta-

tions, the department has six computer/research laboratories, equipped with high performance workstations and high end PCs. The Academic Computer Center supports both UNIX based workstations and PCs. Computers on campus are connected via Ethernet and have access to the Internet. Students and faculty have dial-in access to campus computing facilities.

Currently the Computer Science Department has twenty-two tenured/tenure track faculty and seven senior lecturers. The potential for growth is excellent. For more information contact: Dr. S.Q. Zheng, Chair of the Search Committee, at 972-883-2329 or 972-883-2808; send e-mail to [szheng@utdallas.edu](mailto:szheng@utdallas.edu), or view the Internet webpage at <http://www.utdallas.edu/dept/cs/>. The search committee will begin evaluating applications on January 1, 2000 and will continue until the positions are filled.

Applicants should mail their resume with a list of at least five academic or professional references as soon as possible to:

Academic Search #739  
The University of Texas at Dallas  
PO Box 830688-M/S AD 23  
Richardson, TX 75083-0688

Indication of sex and ethnicity for Affirmative Action statistical purposes is requested but not required. The University of Texas at Dallas is an Equal Opportunity/Affirmative Action employer and strongly encourages applications from candidates who would enhance the diversity of the University's faculty and administration.

### University of Utah Department of Computer Science

The University of Utah's Department of Computer Science seeks applicants for tenure-track faculty positions at either the Assistant or Associate Professor level. The department places a strong emphasis on interdisciplinary, multi-investigator research activities addressing large-scale problems of significant impact. Both research areas and course offerings benefit from the quality and breadth of our faculty and emphasize a balance of theoretical foundations and practical engineering.

Our recruiting emphasis is in systems, networking, languages, and artificial intelligence, but we will consider strong candidates in all areas of computer science. Applicants should have earned a Ph.D. in Computer Science or a closely related field.

The University of Utah is located in Salt Lake City, the hub of a large metropolitan area with excellent cultural facilities and unsurpassed opportunities for outdoor recreation only a few minutes drive away. Additional information about the department can be found at <http://www.cs.utah.edu>.

Please send curriculum vitae, a research goals statement, a teaching goals statement, and names and addresses of at least four references to:

Faculty Recruiting Committee  
c/o Shawn Darby  
Department of Computer Science  
50 So. Central Campus Drive  
Rm 3190 MEB  
University of Utah  
Salt Lake City, UT 84112-9205

The University of Utah is an Equal Opportunity/Affirmative Action Employer and encourages nominations and applications from women and minorities, and provides reasonable accommodation to the known disabilities of applicants and employees.

### Wheaton College (Illinois) Department of Mathematics and Computer Science

The Department of Mathematics and Computer Science at Wheaton College invites applications for a tenure-track position, Assistant or Associate Professor, beginning August 2000. A Ph.D. in Computer Science or a closely related field is required. A commitment to effective teaching, an ongoing program of research, and close interaction with students is essential. There is opportunity to contribute to the development and expansion of an established program.

The Department offers a major and a minor in both mathematics and computer science.

Applicants should send curriculum vitae including names of three references and a list of computer science courses taught to:

Dr. Robert Brabenec, Chair  
Department of Mathematics and Computer Science  
Wheaton College  
Wheaton, IL 60187

Application deadline is November 30, 1999. Wheaton is an evangelical Christian liberal arts college whose faculty and staff affirm a Statement of Faith and adhere to lifestyle expectations. The College complies with federal and state guidelines for nondiscrimination in employment. Women and minority candidates are encouraged to apply.