COMPUTING RESEARCH NEWS

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How will election affect R&D community?

By Fred W. Weingarten
CRA Staff

A wave of concern swept across the R&D community immediately after the November election. The concern was, in part, a normal reaction to an unexpected and traumatic upset of the existing conditions for science policy. It was not so much that Democrats were being replaced by Republicans, but that an entirely new and unknown batch of players will be setting the rules and deciding budgets.

A natural and immediate question when political control changes hands, even within the same party, is "How will this affect me and the programs I care about?" Couple that with the magnitude of the change and the underlying sense of a deeper change in voter attitudes, and the question becomes even more urgent.

In the absence of good tea leaves to read and clear astrological indicators, the scientific community was left to dig for signs in the Republican "Contract With America," a document signed a few weeks before the election by most Republican candidates for House seats. Because the contract said nothing about R&D directly, particular attention was given to an addendum prepared by Republican House Budget Committee staff members listing possible budget cuts, many of which would affect higher education and research.

For example, the addendum proposed to eliminate the National Institute of Standards and Technology's Advanced Technology Program (ATP). It also proposed about a 20% cut in the High-Performance Computer and Communications (HPCC) program and a 1% cut in the National Science Foundation's growth.

> *Few newly elected members of the House have science and technology backgrounds, and even fewer have any experience with S&T issues.*

Judging from some of the early reaction of the scientific community, one might conclude that the Republicans already had declared war on science and higher education. It is foolish to make these kinds of political judgments now. An overly hasty call to arms could create an unnecessary and destructive backlash.

As a political prescription, the contract and its addendum present their own problems. When the contract was announced, it was not clear how seriously it would be taken. The national press did not give it much attention because it seemed to be a rehash of old proposals, and because the promise of tax cuts and budget balancing did not seem to add up. Also, the possibility of a Republican takeover of the House became apparent only in the last week before the election.

After the election, the contract became a principal focus of the press, pointed to by victorious Republicans and by Republican leadership as their action agenda. Many House members feel compelled to take it seriously as their legislative mission.

Republicans are by no means as unified as they may have appeared to the president when they were in the minority. Cracks have already begun to appear. But Republicans as a party need to respond quickly to what could be an brief opportunity given by an impatient electorate and show that they can govern in Congress. Developing an action agenda from scratch that all could agree on would have been difficult. The contract gave them a start.

However, all the contract promises is a vote in the House within 100 days. It did not promise to pass legislation, or that the Senate would pass it or that the president would sign it. Because of the structure and culture of the House of Representatives, which stresses majority control and discipline, the promise does have some chance of being met. Even in the House, not all parts of the contract are being

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Senators: Reduce research funding

By Fred W. Weingarten
CRA Staff

Last month two key Republican senators influential in defense policy sent a letter to President Clinton harshly criticizing his spending priorities and recommending severe cuts to defense research funding

In their December 3 letter, Senators John McCain (R-AZ) and John Warner (R-VA) raised their concerns about declining defense readiness and a lagging Defense modernization program.

In addressing the question of from where funding would come, the senators said: "We have identified nearly $8 billion in fiscal 1995 appropriations for programs which are wasteful and which contribute little, if anything, to our defense posture.…We request that you immediately notify Congress…that you intend to defer obligation of these funds."

Programs they proposed eliminating included:

• The Technology Reinvestment Program, budgeted at $550 million. Proposal: "Rescind fiscal 1995 appropriations and terminate planned program."

• Defense conversion programs, budgeted at $1.5 billion. Proposal: "Rescind fiscal 1995 appropriation for dual-use and conversion programs, including manufacturing technology, SEMATECH, advanced simulation, etc."

• Medical and university research, budgeted at $1.5 billion. Proposal: "Rescind fiscal 1995 appropriation for medical research and $1.1 billion for university research grants, most of which is not defense specific."

On its face, the letter was a message from two senators to the president—it was not a legislative action. But given the influence of these senators on defense policy and their positions on the Senate Armed Services Committee, the letter was viewed by many observers as an early statement of Republican spending priorities and attitudes toward research.

Last year McCain was the ranking minority member of the Subcommittee on Military Readiness and Defense Infrastructure, and Warner was the ranking minority member of the Subcommittee on Coalition Defense and Reinforcing Forces. Both senators are expected to play important roles in the 104th Congress on the Armed Services Committee, chaired by Strom Thurmond (R-SC).

The effects of these cuts—should they take place—on the computing research community are hard to estimate with much precision. Last year, faced with proposals for similar cuts in university research funding, administration officials estimated the following percentages of Defense Department university funding: math and computer science, 50%; engineering sciences, 42%; and electrical engineering, 53%. Nearly 50% of current graduate student support in computer science comes from DOD funding

"To cancel DOD university research is to trade technological superiority tomorrow for readiness today—at a time when no other military power is comparable to the United States," said Anita Jones, director of Defense Research and Engineering. "This is a very poor trade."

Kenneth H Bacon, a DOD public affairs officer, defended the administration's spending priorities and, in particular, the technology reinvestment and Defense conversion programs, saying, "Ultimately the Defense establishment is only as good as its people and only as good as the nation's industrial base."

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Letters may be edited for space and clarity.

Opinions

Public deserves share of blame

BY Fred W. Weingarten
CRA Staff

When the 103rd Congress went home in October it left behind a lot of unfinished business. (It did return in lame-duck session to consider GATT in December.) It was difficult, even for a long-time observer of Congress, to watch the bitter partisan fighting on the Senate floor and see many important bills consigned to the trash can. The real question seemed to be, "Can these turkeys do anything right?"

Crime, health care reform and two bills of particular interest to the computing research community—telecommunications reform and High-Performance Computing and Communications (HPCC) II—did not pass. (The crime bill was resuscitated after a loud public outcry, but the political credibility of Congress and the White House already had been damaged.)

We saw a tiresome and embarrassing display of bitterness, partisanship and stalemate. Now that some time has passed and one can view the proceedings with more objective detachment, it is reasonable to ask if this apparent failure of the process was due to lack of political leadership (or, as important, followership). My conclusion is that, although Congress deserves its share of blame, it also reflected the political confusion, uncertainty and conflict in US society. The enemy probably is us.

Though *CRN* usually focuses on the narrower issues of R&D and information policy, it is useful to look at broader political events. We need to gain insight into political processes and the larger environment in which science and technology issues are considered.

Compared to the thousands of bills considered and the hundreds passed by Congress each year, few major legislative initiatives capture the public's attention. The ones that do attract widespread debate are covered on the nightly news, divide parties and mobilize large stakeholder groups. They form what we might call the "political agenda."

My theory is that passage of agenda legislation usually depends on three conditions:

1) There is a broad public sense that a problem exists, is critical and needs to be addressed politically. The problem is talked about in political campaigns, by the president and by Congress. People want something done about the issue.

2) A set of alternative policy approaches needs to be on the table, so the general outlines of a solution can be hammered into a consensus. Much of the art of legislation is the search for lines of compromise.

3) There is a general agreement, even if it is grudging or reluctant, among major stakeholders that the bill is acceptable. Changes in important areas of policy can create big winners and losers. For better or worse, these groups have significant interests that cannot be ignored—and they express them loudly.

Let's see how the four bills mentioned earlier measure up against these conditions.

Crime

A public barraged with daily reports of violent crime put crime high on its agenda. The legislation was a mish-mash of preventative and punitive pieces, each intended to buy the support of one side and deeply offend the opposite side. The resulting compromise seemed less a movement toward the middle than an attachment of programmatic pieces on each ideological end—"three strikes" and increased use of the death penalty on one side and midnight basketball and gun control on the other.

There was much in the bill for both sides to hate and, more importantly, to use as a public excuse for opposition. The campaign benefits from attacking the bill's defects began to outweigh the benefits of passing it (or so it seemed to the members).

Finally, although organized groups such as law enforcement, cities and the incarceration industry

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Clipper: Another point of view

(On occasion, Computing Research News prints the views of the different sides in the Clipper debate.)

BY Susan Landau

Communications technology has shrunk distances in a way unimagined a generation ago. As we increasingly use telephone, fax and E-mail for personal and business communications, cryptography has emerged as the most effective way to ensure the authenticity, integrity and confidentiality once provided by signatures and sealed envelopes. But unlike envelopes, cryptography presents a significant impediment to legally authorized access. How do we balance the need for privacy against the need for effective law enforcement?

The question only *appears* to be a technical one. The solution will have broad social implications. Twenty-one months ago the Clinton administration introduced the Escrowed Encryption Standard (EES)—Clipper—an encryption scheme in which users' private keys are available to the government.[1] This proposal has encountered strong public opposition. The choices the United States makes about confidentiality of communications will reverberate across the globe. These are not decisions to be made lightly.

Ever since the EES announcement, the debate on cryptography in general, and Clipper in particular, has seen hyperbole and many misstatements of fact. The issues are serious and important. They deserve careful thought and discussion. I will attempt to clear the rhetoric from the discussion and lay out the facts. For a deeper look at these issues, I urge you to read the USACM study *Codes, Keys and Conflicts: Issues in US Crypto Policy*.[2]

In the beginning

The current debate had its genesis in two events of the 1970s: the release of the Data Encryption Standard (DES) by the National Bureau of Standards (now the National Institute of Standards and Technology, or NIST) and the invention of public-key cryptography by Whitfield Diffie and Martin Hellman. The former was the first time that the US government distributed a strong cryptographic algorithm for public use; the latter was the harbinger of widespread development of cryptographic algorithms in the public realm.

The release of DES was a mixed success. DES proved enormously successful in providing US businesses with a technique to ensure secure communications. But the release of DES had unintended side effects. Internationally, DES provided the same security it gave domestically. Export restrictions notwithstanding, the availability of the algorithm in software means DES can be found on the streets of Moscow as readily as on the streets of Manhattan. Release of the algorithm meant that the design principles approved by security agencies[3] in developing cryptosystems were available for public scrutiny. These agencies presumably would just as soon have kept these design principles behind closed doors.

Nearly 20 years later, DES is coming to the end of its useful life. What will replace it? Electronic communications have become ubiquitous in business and personal life. From a national security viewpoint, securing civilian electronic communications is of paramount importance. At the same time, the intelligence community opposes repeating the DES experience of making a strong cryptographic algorithm available internationally.

A growing problem

Several years ago another government player entered the discussion. Members of the law enforcement community have grown increasingly concerned by the *potential* use of encryption by criminals and terrorists. Widespread use of

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Expanding the Pipeline

Graduate information for women in CS&E

By Sandra Johnson Baylor

Computer Science and Engineering (CS&E) research has fueled numerous innovative and technological advances, resulting in the improvement of the quality of life for many Although women have made major contributions to these advances, they are underrepresented in the fields. The 1992-93 CRA Taulbee Survey found that only 9.5% of the faculty of Ph.D.-granting CS departments were female and only 61 full professors were women (out of a total of 1,085 full professors). Also, although women who choose technical disciplines as undergraduates are more likely to earn their bachelor's degree than men, women drop out of Ph.D. programs at twice the rate of men.

The CRA Committee on the Status of Women in Computing Research (CRAW) is sponsoring a project to publish and disseminate graduate school information for women. The objective of the project is to encourage more women to pursue an advanced degree in computer science and engineering and help them better understand the graduate school experience so they will be more likely to succeed. This project includes a list of fellowships available to women in computer science and engineering.

The graduate school information kit will be published in early 1995 and be available via the World Wide Web. For more information on this kit, access the URL address http://cra.org/ and search for the subtitle "CRA Committee on the Status of Women in Research" on the CRA home page.

This article includes excerpts from the kit, which discusses each of the following topics in detail.

Why graduate school?

Attending graduate school facilitates your ability to advance the state of the art in your chosen area through cutting-edge research. Having an advanced degree adds depth and breadth to your academic background, which may improve your chances of obtaining a job or improve your job performance if you already are employed. An advanced degree gives you more flexibility in choosing projects and provides you with the expertise needed for increased levels of responsibility. An advanced degree is viewed as a distinguishing criterion for separating job seekers in the applicant pool, and it provides research and writing experiences vital for launching a career onto the fast track. Throughout your career, these are the attributes that often make the critical difference in job satisfaction and lifetime earnings. Also, some jobs require an advanced degree—for example, if you plan to teach or do research at an academic institution, a Ph.D. usually is required (and a master's certainly is).

Choosing the right school

Once you decide to attend graduate school, there are many factors to consider when determining what school is right for you. You should make a realistic assessment of your abilities and determine the CS&E areas that most interest you. You may not be able to make a realistic assessment yourself—some women tend to underestimate their abilities. Get to know as many of your undergraduate course professors as possible, particularly in the technical areas that interest you. It may be possible to conduct research with a professor while an undergraduate. Research Experiences for Undergraduates and the CRA Distributed Mentor Project are examples of programs sponsoring this type of activity.

Look into these programs and take advantage of the opportunities they offer. Experience gained from this type of activity can be a major selling point when applying to graduate school. Also, the supervising professor will be able to more readily assess your ability to do research.

Questions you should ask yourself about the graduate program include:

- What are my financial needs?
- Does the faculty exhibit special strengths and research qualities through their graduate advisees, published works and funded research?
- Are the libraries, laboratories, computers and other research facilities adequate for my education needs?
- Are graduates of the program sought by recruiters? Does the department of interest offer sufficiently large and varied curriculum to allow a broad offering of courses and options?
- How senior are the professors in my area, what are their interests and what will their availability be?
- What are the degree requirements? number of hours required? Will I have to do a thesis or dissertation?
- What is the completion rate of the general graduate population? the female graduate population?
- How long will it take for me to complete my program?
- Are study spaces and office carrels available for graduate students?

Where you do graduate work is important because the reputation of the institution affects the value of your credentials upon completion. The national reputation of a school is determined by the quality of its faculty, library holdings, research facilities and the success of its graduates. Three sources to consult for comparative rankings of programs are the *Gourman Report* and periodic surveys published in the *Chronicle of Higher Education* and the annual survey published by *US News & World Report*.

For descriptions of degree offerings, enrollment, number of graduates, admission requirements, academic calendar and faculty size, the *Directory of Graduate Programs*, published by the Educational Testing Service, and *Peterson's Annual Guide to Graduate Study*, published by Peterson's Guides, are good sources. These publications should be available in most university libraries.

Application process

The application process consists of writing letters or sending electronic mail to the graduate programs to request application materials, completing and submitting the application materials prior to the deadline and sending letters of acceptance or rejection once you are admitted to a program. The graduate school application package generally includes an application, your personal statement, transcripts, GRE scores and letters of recommendation. The objective of the graduate committee reviewing these applications is to assess and quantify your ability to conduct a successful research program within the department. Therefore, your application preparation and presentation should show a professional set of credentials that make the case for admission. This includes using a clear, concise and coherent writing style and completing all parts of the application as directed.

Two important components of the application are the personal statement and the letters of recommendation. The personal statement gives you the opportunity to elaborate on your motivation for wanting to pursue an advanced degree, your interests in the graduate program at the specific school, your technical area of interests and your professional goals. This allows the graduate admissions committee to assess your ability to conduct a successful research project in that school's environment, your thinking ability and your writing skills. It is important that all your letters of recommendation are positive. Approach professors who know you and your abilities and ask them if they would give you a positive recommendation. While this may be awkward and difficult for some women, it is imperative that you know that positive letters of recommendation are included in your total application.

Financing graduate study

Funds for graduate study are available. However, you must be diligent in searching for and applying to the various programs. There are numerous sponsorship, research, institution and fellowship dollars available. Make a list of all available graduate funding programs. Seek advice from the career counseling and placement center and the graduate financial aid office at your undergraduate institution. You also can seek advice from the graduate financial aid offices of the schools to which you apply. Read graduate study announcements and department bulletin boards, and talk to faculty. Go to the reference section of your school's library or your local public library. You should gather information about graduate aid during your junior year or the summer preceding your senior year. Many programs have

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Expanding the Pipeline

Increasing the number of minorities in CS

By David Bellin and Joseph Monroe

North Carolina Agricultural & Technical State University (NC A&T) is developing a model national strategy to increase the number of minority students graduating in computer science, enhance the educational achievements of these students and increase the number of these students who attend graduate school and pursue careers in computer science.

Our approach has three main components:

• *Recruiting*—attracting outstanding precollege, high school and junior college students to our undergraduate computer science program.

• *Mentoring*—guiding and graduating all of our students so they are equipped with a firm foundation for further studies.

• *Graduate study*—ensuring opportunities for capable students to engage in graduate research and studies.

This article focuses on the development of the human infrastructure necessary to increase the stream of minority and female computer scientists rather than on equipment infrastructure.

We have seen three significant benefits from following this model:

1) NC A&T's computer science program is growing in support, thereby increasing the number of underrepresented minorities obtaining undergraduate and graduate degrees in computer science.

2) Links with education enrichment programs currently supported by state and federal funds are more effective.

3) Other universities can use this model to increase their production of underrepresented minorities in the discipline.

Historic role

NC A&T has had an enormous national impact on the number of minority engineers and computer scientists that graduate each year. For the past five years, for example, the School of Engineering has been one of the top producers of black engineers in the nation. In addition, a steadily increasing female enrollment (currently 34% and 24% for undergraduate and graduate programs, respectively) solidifies the school's position as a leader in the production of female engineers. Now that the computer science program is housed in the School of Engineering, a major goal is to enhance the program's means for recruiting, retaining, educating and graduating its students.

The department offers a B.S. degree in computer science and, in collaboration with the Department of Electrical Engineering, offers an M.S. in software engineering.

After retaining David Bellin as graduate director, we began offering an M.S. degree in computer science in spring 1994. We plan to begin offering a Ph.D. in computer science by fall 1997, an historic event at a Historically Black College and University (HBCU). Over the past five years, the Computer Science Department has produced an average of more than 40 underrepresented minority computer science graduates each year at the bachelor's level. Total undergraduate enrollment in this program over the past six years has averaged more than 332 students annually. (See Table 1.)

Table 1. Enrollment in B.S. Program

	Fresh.	Soph.	Jr.	Sr.	Total B.S. Enrollment	Total B.S. Grads
1987-88	166	83	63	40	352	50
1988-89	127	89	52	41	309	54
1989-90	128	73	71	38	310	32
1990-91	121	74	68	50	313	40
1991-92	158	68	63	52	341	40
1992-93	198	56	55	58	367	49

Current enrollment in the new M.S. program is about 45 full-time and 20 part-time students. The first graduates were expected in December 1994.

The university has acquired a national reputation for conducting quality research programs, and ranks third among the 16 state universities in North Carolina. NC A&T professors actively engaged in R&D projects totaling more than $18 million for the academic year 1991-92 and $22 million for 1992-93. The majority of this funding was attracted by College of Engineering faculty. The National Science Foundation provided a grant for the five academic years ending 1993-94 to establish research projects and a Communications, Signal Processing Expert Systems and ASIC VLSI Lab facility. Annual reviews of this past funding have been uniformly positive, and the project met all goals. This previous project leaves a strong physical infrastructure that we use as a skeleton for building an ongoing infrastructure of human development.

We expect that readers of *Computing Research News* are well aware of our nation's dismal record of producing minority and female computer scientists. However, the College of Engineering at NC A&T has grown to become one of the top choices for African-American students, more than doubling enrollment in the last four years.

Minority engineers

The student body at NC A&T is representative of the population of minorities pursuing college degrees in the United States. Our students continue to enter computer science in significant numbers (nearly 200 new majors this year). However, too many drop out of the major (over 40% the first year), and far too many of our graduates do not earn grade point averages competitive enough for acceptance into graduate school. Although 80% of our computer science graduates are hired by industry, only a handful of the remaining 20% attend graduate school. The major contributing factors here are not scholastic aptitude. Instead, inadequate preparation upon entering and external conditions during the undergraduate experience do not promote scholastic excellence. Our analysis suggests that these are the major contributing factors:

• Many of our undergraduate computer science majors do not devote adequate time to studying because they work many hours off campus. And 80% of our majors hold part-time jobs unrelated to academic pursuits.

• Most of our majors come from the middle third of their high school classes, rather than the top third as measured by their high school GPA and SAT scores.

• Most of our majors are not motivated to pursue graduate study because they are not exposed to enough research-oriented activities to develop an interest in research and teaching.

Solution-oriented approach

Although the problems associated with the production of underrepresented minority computer scientists may appear to be overwhelming, they can be solved without invention or discovery. They do, however, require a well-managed approach from recruitment until graduation. The solutions also require a broad perspective of the problems in the context of the total life cycle of student progression through graduation. Accordingly, managing all the components of student progression, instead of focusing on a single aspect, forms the basis of our proposed solution.

We also are concerned that once students are recruited for graduate study, appropriate attention continues to be paid to mentoring, including attention to study and research skills and the students' ability to devote full-time attention to schoolwork. This often is overlooked as a source of loss of minority students from the pipeline into higher degrees in the sciences. The following components should be used to accomplish the proposed goal of increasing the number of computer science graduates: recruitment enhancement, mentoring program enhancement and graduate study.

Recruitment enhancement

Over 80% of our students from the top 10% of their class receive some form of financial aid. With climbing enrollment and a relative decrease in funding available from all sources, it is imperative that this department increases its scholarship funding base to attract and retain outstanding high school graduates as computer science majors. Thus, an essential aspect of the department's effort to enhance its ability to produce high-quality computer science graduates is strengthening its ability to offer competitive scholarship support to outstanding computer science students. Accordingly, funding support is a major element of this component.

We are establishing recruitment links with education enrichment programs currently supported by state and federal funds.

We plan to establish recruitment links with high schools in every county in North Carolina and with all 56 community colleges in the state. If funding is available, we plan to offer scholarships to outstanding students.

Mentorship program

The mentoring program is the central operational component of our approach, and it supports recruiting enhancements. The objective of the mentoring program is to produce qualified, competitive minority candidates for graduate programs in computer science. This will be accomplished by working with minority students from undergraduate recruiting through completion of the B.S. in computer science. We already offer release time to faculty members who serve as mentors.

Each student who receives a scholarship will be guaranteed at least one summer research experience at our institution. Our mentoring program is designed to provide a supportive and nurturing experience to enhance the academic, professional, intellectual and personal development of all computer science majors.

This component of our model allows us encourage students, fuel the desire to succeed, guide students, enhance achievement, assist in making academic and career choices and assist in addressing and solving academic or personal problems that may impede academic progress. Our experience in becoming the largest producer of African-American engineers in the nation has taught us that mentoring is crucial to the success of aspiring engineers from underrepresented groups.

A mentoring program should be coordinated by a faculty member responsible for Total Quality Management. We suggest that programs be organized as follows:

• Each faculty mentor should be responsible for mentoring a subset of

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Association News

Workshop for new faculty

As part of its workshop series, the Computing Research Association is sponsoring Effective Teaching in Computer Science and Engineering: A Workshop for New Faculty June 7-9, 1995, in Snowbird, UT.

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

The purpose of the workshop is to help new faculty members teach more effectively. This highly interactive workshop includes theoretical material on educational objectives and learning styles, and practical tips on effective lecturing, course organization, creative problem solving and collaborative learning.

Attendees are asked to bring a syllabus and an examination from one of their courses. Participants will actively participate as individuals, in pairs and in small groups. Each person will receive a booklet of readings and a bibliography on effective college teaching.

The workshop leaders are Michael C. Loui of the University of Illinois at Urbana-Champaign and Michael B. Paulsen of the University of New Orleans.

For more information about the workshop, contact Kimberly Peaks of CRA at tel. 202-234-2111 or via E-mail at kpeaks@cra.org. Space is limited.

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Board nominees sought

The Computing Research Association is seeking nominations for its Board of Directors.

Every spring, CRA's member organizations elect about a third of our board members. However, candidates are not required to be CRA members. Our nominating committee, chaired by Richards Adrion of the University of Massachusetts at Amherst, is seeking nominations. It is important that the CRA Board represent the interests of the entire computing research community, and it is our policy to solicit a broad range of candidates.

Please contact the person you are nominating before submitting his or her name. Nominees will receive information on CRA and its activities.

Our board is a working board, and all members are expected to actively participate in CRA. Although we have a small professional staff at our headquarters, board members are involved in all our major projects. Recent projects have included:

• planning the biennial CRA Conference at Snowbird,

• conducting the annual CRA Taulbee Survey,

• coordinating the Grace Hopper Celebration of Women in Computing and

• increasing the participation of women in computing research with the help of National Science Foundation grants.

Board members also are asked to attend at least two board meetings per year. Members are asked to pay their travel costs to the meetings.

We understand that these time demands can be daunting to overburdened researchers. But research in computer science and computer engineering is facing major challenges as the political environment for government support changes. In the United States, Canada and many other countries, computing has been identified as a technology of critical social importance. This increased political attention places new demands on our field and offers new opportunities.

To receive a copy of the nomination form, contact Joan Bass of CRA at tel. 202-234-2111 or E-mail: jbass@cra.org. The deadline for submitting nominations is March 3.

New features on CRA Web

CRA is taking steps to improve the quantity, quality and searchability of information on its World Wide Web server.

In December, CRA made available a searchable database of computer science and computer engineering departments that includes contact information and links to Web servers maintained by each department. A search can be conducted with any forms-capable Web client. The interface offers the use of keyword searching (or PERL regular expressions), Boolean operators and field-specific search criteria.

CRA is also developing congressional Web pages that focus on key members, committees and legislation of interest to computing researchers. Check out our progress by pointing your Web client to CRA's home page at http://cra.org/.

Other information available on CRA's home page includes:

- CRA Bulletin archives
- Job Announcement archives
- The *R&D for the NII: Technical Challenges* report
- Conference literature
- CS statistical trends
- Keyword search capability via WAIS.

Send error reports, suggestions or questions to josuna@cra.org

Mentoring from Page 4

the undergraduates and be assisted by two graduate students.

• Each graduate assistant should be a mentor for two undergraduate seniors.

• Each senior should be a peer adviser and a role model for up to 10 undergraduate students.

• All faculty mentors, graduate student mentors and peer advisers should meet with their mentees each week of the academic year in a non-credit colloquium for mentoring purposes.

A mentoring center should be established and managed by a part-time faculty member coordinator responsible for operating the center, acquiring material, setting up programs and scheduling student activities.

The mentoring center should consist of a workstation network and multimedia-enabled instructor/presenter stations with screen projection display capability. Software should be provided for student tracking. Systems should be provided for self study (in areas such as GRE preparation, math skills enhancement and computer science skills enhancement). Seminars should be conducted throughout the year on subjects such as teacher effectiveness, GRE preparation, the research process, technical writing, presentation skills and literature searches. Network access should be provided for computer science research.

Mentoring process

As students are recruited from the feeder programs and enter the department, they should be assigned to a faculty member, a graduate student mentor and a peer adviser.

• During the freshmen year, skills development in mathematics and computer applications are emphasized, giving students the tools needed to excel in the program. The freshmen experience culminates with a summer job opportunity at a national research laboratory or industry site where students will be motivated to do research.

• During the sophomore year, presentation skills are emphasized. The summer experience should be an internship.

• During the junior year, project management skills and presentation of papers at conferences are emphasized. The summer experience is research work with a faculty member in an area where the student desires to pursue graduate work.

• During the senior year, technical writing skills are emphasized. Students will develop tutoring skills through the role of peer advisers. If graduating seniors enroll in the MS. program at NC A&T, the students have the option of continuing to work on research projects with faculty members during the summer.

• Under the supervision of faculty mentors, graduate students will focus on developing skills in teacher effectiveness and mentoring. They will work with peer advisers and undergraduate students, conduct seminars in the mentoring center and assist students in the labs. Peer advisers will develop tutoring skills.

Graduate study

Although the overall number of students graduating with a PhD. in computer science has increased dramatically over the past decade,

Continued on Page 11

1993-94 CRA Taulbee Survey

CRA improving quality of Taulbee Survey

Salary information from the 1993-94 CRA Taulbee Survey on the Production and Employment of Ph.D.s and Faculty in Computer Science and Computer Engineering

For 24 years, the Computing Research Association and its predecessor—the Computer Science Board—have been charting the growth of Ph.D production and employment of computer scientists and computer engineers in North America.

The CRA Taulbee Survey† has changed this year in response to requests for more complete and accurate data on the supply and demand of Ph.D faculty in the computing field. The new survey contains many new questions and refinements of old questions.

Additions include new questions on bachelor's, master's and Ph.D student enrollment and the specialty areas of those awarded Ph.D's. The survey also was restructured in two major areas: 1) it now distinguishes between computer science and computer engineering as separate programs in each department, and 2) it uses a system for categorizing minorities similar to that used by the Education Department.

The new system now includes a category for non-resident aliens, which will particularly affect certain groups. For instance, only Asians and Pacific Islanders who are citizens or residents are counted in the category "Asian." Asians who study temporarily in North America and plan to return to their home countries will be counted in the new category for non-resident aliens.

Overall, we have attempted to incorporate new elements while maintaining consistency among new data, historical data and data maintained by other agencies such as the Education Department.

Each September, this survey is mailed to all organizations included on the CRA Forsythe List* of departments that offer a Ph.D in computer science or computer engineering.

Beginning this year, we have changed our publication strategy for the survey.

The CRA Taulbee Survey has a long and reputable history. It has resulted in a long-term data history of the development of computing research as a graduate academic discipline. Since its inception, CRA has worked to ensure a nearly 100% response rate. This has never been an easy task, and in recent years it has become increasingly difficult to achieve and meet our publication deadline for the January issue of *CRN*.

The field has become much larger and more complex in its structure. There are more responses to verify and respondents for us to track down. At the same time, the demands for new data and analyses from our own community and from policy makers have made the job of filling out the survey more time consuming.

Because of these delays—and to ease the reporting burden on our respondents—we have decided to publish the survey results in two parts. This month's *CRN* carries statistics on faculty salaries because there is a high demand for making this data available in January and because the data is published as statistical averages that are less likely to be affected by incomplete responses.

The complete survey will be published in the March issue of *CRN*.

If your institution has not yet completed the survey, we strongly urge you to do so and return it by the end of this month. It is vitally important we have an accurate survey. Academic departments and industrial laboratories depend on this data for their planning, and government science agencies frequently make program and budgeting decisions based on this type of demographic information.

Rankings

For Tables 1-9, which group computer science departments by the rank of 1-12, 13-24 and 25-36, we based our ranking on information from a 1980 assessment of research doctorate programs in the United States done under the auspices of the National Research Council. We modified our ranking to include top Canadian universities.

NRC is expected to release new rankings as soon as February. If the new rankings are available in time, we will update the ranking information in the March issue of *CRN* when we publish the complete CRA Taulbee Survey.

Our top 12 schools are Stanford University, Massachusetts Institute of Technology, Carnegie Mellon University, University of California at Berkeley, Cornell University, University of Illinois at Urbana-Champaign, University of California at Los Angeles, University of Toronto, University of Washington, University of Texas at Austin, University of Wisconsin at Madison and the University of Southern California.

The departments ranked 13-24 are the University of Maryland, Princeton University, Brown University, University of Utah, New York University, University of Massachusetts at Amherst, the State University of New York at Stony Brook, University of North Carolina at Chapel Hill, University of Pennsylvania, Yale University, University of Waterloo and the Georgia Institute of Technology.

The departments ranked 25-36 are the University of California at San Diego, the California Institute of Technology, Columbia University, Ohio State University, Rice University, Duke University, Northwestern University, Syracuse University, Rutgers—the State University of New Jersey, University of California at Irvine, University of Minnesota and the University of Rochester.

Salary tables

For Tables 1-9, each department was asked for the minimum, mean and maximum salary for each category of professor. Because tables show the minimums and maximums of the minimums and maximums reported by each department, these figures reflect salaries of individual professors. Also shown are the means of the minimums and maximums reported by each department. Finally, the average of all salaries is the average of the means reported by each department. If a department gave only a partial answer for a category of professor, it was discounted. All Canadian salaries are in Canadian dollars.

†*The title of the survey honors the late Orrin Taulbee of the University of Pittsburgh, who conducted these surveys for the Computer Science Board from 1970 until 1984.*

**The CRA Forsythe List is a list of departments in the United States and Canada that grant a Ph.D. in computing—computer science (CS) and computer engineering (CE). It is maintained by the Computing Research Association. This is the eighth year computer engineering departments have been included.*

Table 1. Nine-Month Salaries, 110 Responses of 137 US CS Departments

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	548 of 555	$30,200	$49,815	$61,600	$52,583	$43,300	$55,625	$70,800
Associate	747 of 757	$36,641	$55,049	$71,400	$60,809	$50,500	$67,643	$93,200
Full	873 of 895	$38,940	$66,633	$103,000	$81,931	$54,998	$102,100	$181,500

Table 2. Nine-Month Salaries, 11 Responses of 11 US CS Departments Ranked 1-12

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	76 of 77	$48,855	$52,616	$60,000	$54,593	$54,200	$58,286	$70,800
Associate	92 of 92	$49,100	$57,750	$63,500	$62,988	$60,156	$70,551	$82,100
Full	142 of 145	$38,940	$65,652	$75,050	$86,431	$84,320	$110,097	$126,400

Table 3. Nine-Month Salaries, 11 Responses of 12 US CS Departments Ranked 13-24

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	52 of 56	$50,000	$52,548	$59,900	$54,971	$53,040	$57,511	$61,200
Associate	93 of 93	$53,183	$59,876	$69,200	$66,242	$63,266	$73,301	$91,982
Full	132 of 133	$58,904	$72,122	$95,500	$91,959	$105,054	$120,411	$142,000

1993-94 CRA Taulbee Survey

Table 4. Nine-Month Salaries, 10 Responses of 12 US CS Departments Ranked 25-36

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	37 of 37	$35,000	$51,263	$61,600	$54,911	$56,250	$59,534	$70,800
Associate	48 of 50	$56,000	$61,880	$71,400	$66,373	$61,800	$73,332	$86,300
Full	60 of 63	$60,500	$71,508	$86,100	$93,933	$82,246	$124,735	$181,500

Table 5. Nine-Month Salaries, 78 Responses of 102 US CS Departments Ranked Higher than 36

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	383 of 385	$30,200	$48,916	$56,400	$51,727	$43,300	$54,645	$68,178
Associate	514 of 522	$36,641	$53,312	$65,800	$59,046	$50,500	$65,875	$93,200
Full	539 of 554	$43,500	$65,489	$103,000	$78,413	$54,998	$96,301	$137,593

Table 6. Nine-Month Salaries, 11 Responses of 24 US CE Departments

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	58 of 59	$44,637	$49,918	$56,450	$50,951	$44,637	$52,836	$61,720
Associate	65 of 67	$46,573	$55,141	$62,000	$59,365	$51,500	$63,075	$75,500
Full	80 of 82	$53,418	$65,052	$82,500	$76,368	$65,422	$94,576	$136,700

Table 7. 12-Month Salaries, 12 Responses of 15 Canadian CS Departments (Canadian Dollars)

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	67 of 70	$31,639	$49,424	$61,336	$55,514	$52,333	$62,899	$80,961
Associate	154 of 155	$40,815	$59,221	$76,086	$68,884	$66,367	$81,323	$124,987
Full	143 of 145	$52,748	$72,312	$86,388	$87,956	$84,165	$109,672	$159,539

Table 8. Nine-Month Salaries, 121 Responses of 161 US CS and CE Departments

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Faculty Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
Assistant	606 of 614	$30,200	$49,827	$61,600	$52,413	$43,300	$55,305	$70,800
Associate	812 of 824	$36,641	$55,060	$71,400	$60,657	$50,500	$67,123	$93,200
Full	953 of 977	$38,940	$66,487	$103,000	$81,429	$54,998	$101,348	$181,500

Table 9. Salaries of Newly Appointed Faculty, 54 Responding CS & CE Departments

	# Reporting	Reported Salary Minimums				Reported Salary Maximums		
Dept. Rank	Salary Data	Min.	Mean	Max.	Avg. of all Salaries	Min.	Mean	Max.
US: CS 1-12	6 of 6	$49,000	$51,900	$55,500	$52,440	$49,000	$52,940	$55,500
CS 13-24	10 of 10	$50,000	$51,664	$53,500	$53,092	$53,000	$55,063	$58,700
CS 25-36	4 of 4	$54,000	$54,500	$55,000	$54,500	$54,000	$54,500	$55,000
CS Other	52 of 52	$34,000	$47,636	$56,000	$48,513	$34,000	$49,956	$76,000
CE	9 of 9	$40,000	$46,720	$50,500	$49,980	$46,885	$49,419	$52,690
CS&CE	**81 of 81**	**$34,000**	**$48,674**	**$56,000**	**$49,748**	**$34,000**	**$50,875**	**$76,000**
Canadian: CS&CE	13 of 13	$27,500	$45,704	$55,000	$48,984	$45,521	$53,555	$58,000

Gridlock from Page 2

supported the bill, the National Rifle Association was strongly opposed, and its opposition played a role in the initial collapse.

Bottom line: Public concern and outcry was so strong that the vote was nearly immediately revisited and passed despite members' distaste for parts of the bill and the lobbying opposition.

Health care

This was another obvious agenda item. Recent polls show that, despite the collapse of the president's bill, the public still cares deeply. During the debate, when some senators floated a trial balloon that there was no crisis, public reaction forced them to quickly back off. But I think it's fair to say that there is no social consensus on what should be done. There did not seem to be clear alternatives or much room for compromise among them, possibly because the administration's proposal so dominated the debate.

Most large stakeholders—doctors, hospitals and insurance and drug companies—opposed the legislation.

Bottom line: Strong public concern ran up against a lack of consensus on a solution and strong stakeholder opposition. A positive interpretation of the health care debate was that the public was convinced that a problem existed and forced, for the first time, to debate about what to do. Many questions need to be answered: What should be the scope of reform? How much government control should there be? What are we willing to pay to bring more people into the system? Who should pay? In an area that so closely affects our personal well-being, the lack of a consensus could be deadly

Telecommunications

Public urgency about telecommunications reform seemed weak. The administration has pushed its vision of the National Information Infrastructure for a few years. But linking that vision to a bill containing more than a hundred pages of competitive "do's and don'ts" and regulatory reform was a Herculean political task. The voters were angry in November, but few seemed angry about the lack of telecommunications reform.

However, there is a reasonably broad consensus for deregulation and removing barriers to investment and innovation. The experts and politicians who watch such things are in general agreement. Some public interest concerns about universal service, access and information policy issues such as privacy and copyright attracted debate. But in the center, most sides are fairly close together. I suspect this year's Republican bill will be similar to last year's Democratic bill. If that is so, there will be room for negotiation and compromise.

It is not clear how committed the communications companies were to this legislation, especially at the end. In fact, Sen. Ernest F. Hollings (D-SC), the bill's author and the chair of the Senate Commerce, Science and Transportation Committee, accused the Baby Bells of backing off from their support. It is an uncertain technological and market future after all, and a great deal of money is at stake. The status quo can begin to look attractive, even to companies that claim to want to be allowed to compete in new markets.

Bottom line: Despite reasonable consensus on what to do, lack of public interest (and, therefore political benefit from doing something) and stakeholder indifference allowed the bills to sink without a trace.

HPCC

If the public was confused about the NII, most people probably had never heard of HPCC. Except for cold fusion, R&D programs rarely are the topic of Ted Koppel's "Nightline" discussions. But HPCC had been tied by Congress and the administration to things high on the agenda, notably economic growth and industrial policy. (In the Senate, it literally was tied to economic growth by being folded into S 4, a much broader bill focusing on industrial policy.) In some sense, it was interesting that so few people noticed the bill or its failure. The Clinton administration apparently was unable to make the connection in the public's mind between future economic security and investment in education, infrastructure and research.

There was fairly good consensus on what should be done. The HPCC bills that passed each house were reasonably convergent and HPCC always had received bipartisan support. Even when Congress and the White House were controlled by different parties, administration HPCC plans and congressional legislation looked very similar.

However, some industry groups have become more than a little cool to the program, even though they supported it earlier, brought into the

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Policy News

GAO urges shift in HPCC

By Juan Antonio Osuna
CRA Staff

The General Accounting Office, an investigative arm of Congress, urged the Clinton administration to shift its $1.1 billion High-Performance Computing and Communications (HPCC) program into high gear or the program can no longer remain the closely coordinated, scientifically oriented research effort it once was.

Specifically, the 40-page report, released in November, urged the administration to produce a detailed agenda of technical priorities, develop consistent guidelines for budget reporting, work more closely with industry and increase emphasis on software tools.

Such a technical agenda, according to GAO, would ensure that the shift toward the so-called "National Challenges" is more than just cosmetic. At the start of the Clinton administration, HPCC was expanded to meet a set of National Challenges that address education, heath care and other broad economic and social needs. To do this, the administration added a new component to HPCC called "Information Infrastructure Technology and Applications."

However, the report said, "Both participants and outside observers have questioned the extent to which the program is actually shifting its emphasis toward NII technology issues, given that the level of funding for IITA projects to develop applications in areas such as education and health care is minimal compared with funding for hardware systems development."

Funding levels for each of HPCC's five components may not reflect reality, GAO said, as each agency has its own informal guidelines for deciding which activities fall under HPCC and which components of HPCC they belong to.

For example, the report noted that the National Science Foundation includes four supercomputer centers under HPCC but not supercomputers at the National Center for Atmospheric Research.

In another example, GAO said hardware spending normally falls under the High-Performance Computing Systems component but also shows up in the Advanced Software Technology and Algorithms and Basic Research and Human Resources components, depending on the judgment of agency HPCC managers.

"Because of these inconsistent classifications, it is difficult to determine what areas HPCC is really emphasizing," GAO said, adding that better reporting procedures along with a prioritized, technical agenda would allow more strategic planning of limited HPCC funds.

Finally, the report relayed comments from industry officials that the program has neglected their needs. To remedy this, the report said the director of the White House Office of Science and Technology Policy should expedite the creation of an HPCC advisory committee that includes industry representatives, as originally mandated by the HPCC Act of 1991.

Encryption bill introduced

Rep. George Brown (D-CA), chair of the House Committee on Science, Space and Technology, introduced a bill October 6 authorizing federal development of escrow encryption standards such as the Clipper chip, already implemented by the Clinton administration.

The Encryption Standards and Procedures Act of 1994 sought to govern the development and use of key-escrowed encryption technology for unclassified information. Brown said he introduced the bill in the final days of the 103rd Congress to send a signal that he is serious about pursuing similar legislation at the start of this year's 104th Congress.

The encryption legislation would authorize the National Institute of Standards and Technology to develop and issue federal encryption standards for both the government and private sectors, impose new legal requirements on key-escrow agents, establish an R&D program at NIST and authorize appropriations.

Although the Computer Security Act, which the House Committee on Science, Space and Technology reviewed in 1987 before passage, already authorizes NIST to issue standards for protecting unclassified information in federal computer systems, it does not explicitly authorize issuance of standards for private communications and for ensuring access to decrypted text by law enforcement and intelligence communities.

The Clinton administration has said it wants to retain flexibility in modifying its encryption policy and Clipper program in response to changing circumstances and does not seek legislation authorizing Clipper or any other key escrow standards.

However, the administration's desire for flexibility "contributes to the public's mistrust and opposition to Clipper," Brown said. "For this reason alone, the public is unlikely to ever accept Clipper chip in its present form."

In September, the Office of Technology Assessment issued the report, *Information Security and Privacy in Network Environments*, which recommended congressional involvement as a way of making the process more accountable to various public sectors.

NSF awards $6.5 million to supercomputing subcenters

The National Science Foundation awarded $6.5 million to six supercomputing subcenters that will provide greater access to high-performance computing and communications (HPCC) tools. These centers form what are called Metacenter Regional Alliances (MRAs), which are agreements among existing supercomputing centers to increase availability and use of HPCC capabilities.

This project will benefit researchers in the academic community and the private work force by fostering a broader involvement in the emerging National Information Infrastructure and boosting the nation's ability to address business and scientific needs.

"These new awards will allow the technologies of High-Performance Computing, so long the focus of only nationally funded centers, to penetrate into local and regional activities," said Paul Young, assistant director of NSF's Computer and Information Science and Engineering Directorate. "MRAs are akin to agricultural extension services for high-performance computing. For example, they will allow this technology to be used [to]…allow a new generation of students to acquire the skills that will be necessary for economic competitiveness in the 21st century."

The six recipients are:

• *California Institute of Technology, Los Angeles Regional Gigabit Environment ($1.2 million):* This alliance will provide high-speed computer network access for industrial partners and selected academic research groups in Southern California. It will focus on helping industrial partners access large-scale computing and communications facilities of the NSF Metacenter and Caltech. These industrial partners include users of high-performance computing systems and independent software vendors that develop application software for high-performance systems. Contact Robert O'Rourke at tel. 818-395-6225 or E-mail: robert_orourke@starbase1.caltech.edu.

• *University of Illinois at Chicago, Augmenting and Complementing NII Metacenter Activities ($1.3 million):* This alliance, known as the Virtual Reality Alliance, will bring together the NSF Metacenter, the Software Technologies Research Center at the University of Illinois at Chicago and the Chicago Manufacturing Center. The metacenter will offer a high-end virtual reality test bed for manufacturing product design and rapid prototyping to large companies and a consortium of smaller ones. Partners also include Caterpillar, General Motors, the National Center for Supercomputng Applications and the San Diego Supercomputing Center. Contact Rick Asa at tel. 312-996-8277 or E-mail: U63973@uicvm.uic.edu.

• *MCNC, Stimulating and Enhancing Entrepreneurial Development ($1.4 million):* This North Carolina alliance is designed to nurture the adoption of computational knowledge by small businesses. The center will focus on businesses in North Carolina in the first year, later expanding to include one additional state in the region for each of the next two years. The program is a partnership between MCNC, North Carolina Supercomputing Center, the Southern Technology Council (a division of the Southern Growth Policies Board), nine North Carolina small-business development organizations, IBM Corp., the Cornell Theory Center, the National Center for Supercomputing Applications and the Pittsburgh Supercomputing Center. Contact Eileen Sarro at tel. 919-248-1827 or E-mail: eileen@mcnc.org.

• *MCNC, Regional Training Center for Parallel Processing ($922,000):* This center is being developed by the North Carolina Supercomputing Center at MCNC and North Carolina State University. Participating partners include the Cornell Theory Center and the National Center for Supercomputer Applications. With the increasing availability of parallel computers, the project will train scientists and students in the concepts of parallel processing by developing and distributing multimedia computer-based instruction. These materials will provide a self-paced education environment covering all aspects of parallel processing. Contact Eileen Sarro at tel. 919-248-1827 or E-mail: eileen@mcnc.org.

• *Ohio Supercomputer Center, Metacenter Alliance to Expand Industrial and Scientific Parallel Processing ($840,000):* This alliance will allow the Pittsburgh Supercomputing Center, Arctic Region Supercomputing Center and Ohio Supercomputer Center to focus on common issues associated with parallel processing on a Cray T3D computer. All three centers have similar hardware architectures and application software, allowing them to address common challenges in using new Massively Parallel Processing supercomputer systems. The alliance will concentrate on converting and developing key production-quality applications running on MPP and heterogeneous systems. Affordable and efficient tools in the fields of medical rendering, computational chemistry, scientific visualization and coal combustion will benefit industry and academic partners. Contact Cheryl Johnson at tel. 614- 292-6067 or E-mail: cjohnson@osc.edu.

• *Rice University, Retooling the Supercomputing Community for Scalable Parallelism ($850,000):* The Center for Research on Parallel Computation will collaborate with national, regional and state supercomputer centers to collect and further develop educational materials from the computational science research community on leading-edge parallel computing methods and technologies. These materials will be disseminated to supercomputer centers for use in short courses for users. The effort builds on the synergistic strengths of the center, a leading research institution on parallel computing, and the existing supercomputer centers, which have broad experience in educating end users. Contact Kevin Timson at tel. 713-285-5922 or E-mail: ktimson@cs.rice.edu.

Policy News

Clipper from Page 2

strong non-escrowed encryption could make wiretaps useless to law enforcement agencies. The FBI argued for a form of encryption that would enable law enforcement agents to decrypt communications whenever equipped with legal authorization to do so.

Because wiretaps play a crucial part in this story, it is worth a brief detour into their legal history. In the landmark 1928 case of *Olmstead v United States*, defendants argued that wiretaps were a violation of the Fourth Amendment's prohibition against unreasonable search. The Supreme Court disagreed, ruling that the Fourth Amendment protected tangible goods, speech not being one such. Forty years of cases led to a narrowing of the *Olmstead* decision, and in 1967 the court overturned its 1928 decision ruling that the Fourth Amendment does apply to phone conversations because the amendment protects "the person," regardless of the manner in which communications are conducted. A warrant was necessary for a wiretap.

An effective tool

Wiretaps are searches that leave no trace, and thus are a particularly invasive form of surveillance. Law enforcement had found wiretaps too effective a tool to readily give them up. In 1968, Congress passed Title III of the Omnibus Crime Control and Safe Streets Act and established the set of circumstances under which wiretap orders could be issued. The crimes had to be serious and indictable and there had to be probable cause that the communications

For many of the high-profile cases in which electronic surveillance played a role, electronic bugs—not wiretaps—led to the convictions.

device was being used to facilitate the crime. Other investigative tools had to have been tried and found wanting; only certain crimes could warrant a wiretap order. About 1,000 electronic surveillance orders are issued under federal and corresponding state statutes annually; about three-quarters of these orders are for wiretaps.

From the point of view of law enforcement, the Clinton administration proposal of an encryption method with escrowed keys fits the bill perfectly. Keys are split and the halves are escrowed with two executive branch agencies: Treasury's Automated Services Division and NIST. Under legal authorization, the keys for domestic users of the technology are available to law enforcement agents. The algorithm is classified to limit the spread of strong encryption techniques. Although these features satisfy the perceived needs of the US government for an algorithm that provides strong cryptography domestically without making it available internationally, the solution was an anathema to many others.

Many objected to a civilian cryptography standard that used a classified algorithm, arguing that cryptographic methods need public scrutiny to prove their strength. The National Security Agency, as the designer of cryptographic algorithms for military and diplomatic purposes, developed the EES algorithm. NSA's role is controversial in light of recent history.

During the 1970s and 1980s, there had been a series of conflicts between the agency and non-governmental developers of cryptography who felt NSA was trying to impede the development of cryptography in the civilian sector. In an attempt to resolve these conflicts, Congress passed the Computer Security Act in 1987, which assigned the responsibility for development of civilian computer security standards, including cryptography, to NIST, a civilian agency. NSA was given an advisory role in the development of cryptography in the civilian sector. Many believe NSA's role in the development of EES violated the intent of the Computer Security Act. When Matthew Blaze of AT&T Bell Labs discovered a method for using EES that circumvented the law enforcement access aspect of the standard, critics of classification felt vindicated. It should be noted, however, that Blaze's attack did not compromise the security of the EES system, nor did it threaten the law enforcement aspects of the present EES system, which is for circuit switched telephones. Blaze's attack did work on EES-based E-mail transmissions. The government is modifying its Personal Computer Memory Card International Association cards accordingly.

A product containing keys escrowed with the US government is less than attractive to many foreign purchasers. Presumably, the classified nature of EES means that the algorithm cannot be imported into France, where all cryptographic algorithms must be registered with the government.

US manufacturers can continue to include cryptographic algorithms other than EES in their equipment for export. Manufacturers argue that maintaining dual product lines adds complexity and expense and causes delays in production. Many in the industry fear that widespread domestic adoption of EES for secure communications will lead to a situation in which US products are less competitive internationally.

The strongest objections to EES arose from the civil liberties community. EES opponents point to numerous examples in which the government violated individuals' privacy rights, from Nixon and Kissinger's tapping telephones of employees of the National Security Council, to recent instances in which IRS employees browsed the tax returns of friends, neighbors and celebrities, agents of the government have abused power and invaded individuals' privacy.

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NII vision and stood to benefit from the work that was funded. But the groups felt the program was drifting and unresponsive to their concerns. (A recent General Accounting Office report criticized the administration for not making more of an effort to coordinate management and provide opportunities for outside input to program plans and priorities—something industry had been pushing for some time.)

Few tears were shed when the bill went down, but there should have been. The failure does not bode well for the future, and I believe the failure was not necessary.

Bottom line: There was a reasonable consensus on the bill, but lack of strong incentive to move it forward because of strong public or industry support turned this legislation into political road kill in the final partisan days of the legislative session.

One ought to hesitate before drawing fixed conclusions based on one or a few select events. However, there are some general observations we could apply to future strategy.

• R&D itself rarely will be a high-agenda item. But we increasingly will find information technology and R&D a part of other issues that are high on the agenda. That carries potential benefits and significant risks in a volatile political environment.

• Computing research does not always have the choice of whether it wants its profile boosted. HPCC, for example, started as a fairly small internal National Science Foundation initiative focused on supercomputer use by basic researchers, then other forces, political and economic, raised its profile immensely.

• We need to know what arena the issue we care about is in. Is it a high-profile political debate or one of the many quieter, specialized and generally bipartisan issues that get resolved routinely but invisibly in Congress? The answer has a lot to do with our own choice of strategy and expectations.

• We need to be concerned about the following issues:

1) We have to ensure that the public better understands the nature and role of research in our society.

2) We need to direct our expertise at providing alternative policy approaches and developing consensus, at least among our community and those closely allied with us.

3) Industry is a key stakeholder in computing research. We need to foster an open and continuing dialogue between the industrial and academic research communities so that we are all singing out of the same book (if not always on the same page) when an issue arises.

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Policy News

Election from Page 1

cheered by Republicans. For example, now that Republicans are the majority party, term limits look less interesting. What good does it do to finally win a long fight for control if the first thing you do is vote yourself out of office?

Senate Republicans were not part of the contract and do not feel any compulsion to follow its dictates. The Senate is a different type of institution, no matter which party runs it. And few elected politicians in Congress officially signed on to the list of proposed cuts.

Science traditionally has fared well under Republicans, who always have supported civilian and military research. They have shown more skepticism toward applied technology programs and so may be expected to push programs back to long-term and basic research. (That does not mean they do not share in the general sense that R&D needs to be linked to specific social goals and purposes.)

Some Republicans did join in the anti-university rhetoric that accompanied the Defense research cuts, but it is not clear that research is a partisan issue in Defense policy

A key problem will be that some computer- and communications-related programs have been politicized by being identified with administration initiatives such as the National Information Infrastructure, HPCC and various technology initiatives. How that will affect their support in a Republican Congress remains to be seen. We are, however, unlikely to see any new initiatives or major expansion of existing ones.

Republican anti-technology ire is likely to be focused on shorter-term, industrially focused programs such as NIST's Advanced Technology Program.

If the campaign suggests any thing, it is that Republicans may be more sensitive to the potential of the Internet and new electronic information technologies than their liberal counterparts. The conservative community actively used computer networking and the panoply of electronic communication systems for organization and to energize their constituencies. The contract is a case in point. It has been posted widely on the network. It is a brief, text-oriented format that is amenable to public electronic access. The Computing Research Association, which made the contract available on our World Wide Web home page, we tried—in the name of bipartisanship—to add some Democratic response. We could not find any on the network.

When we finally found some thing on paper, it was long, rambling and filled with tables. It was not amenable to getting it online quickly in a form that would be usable to anyone without high-capacity access to the Internet.

Some predictions

• There will be severe pressures on R&D budgets, but they are likely to be structural, not partisan. Lawmakers were going to be much tougher this year, even under a Democratic Congress. If taxes are cut, the pressures will be even greater

• It serves no constructive purpose, as some on the network have done, to identify either party as the devil. We will have friends and contacts on the Hill, just as we did before. We need to nurture them. Republican anti-technology ire is likely to be focused on shorter-term, industrially focused programs such as NIST's ATP, some of which also have raised broader concerns and objections among some Democrats and technology policy experts.

• HPCC is in trouble. It was in trouble in the Democratic Congress. The recent General Accounting Office report that repeats several industry objections to the program simply will add fuel to the fire. Whether the pressure from the Republicans will be greater or not is an unanswerable (and unimportant) question.

• Educating Congress is critical. Over 50% of the members of the House are new since January 1993. Few, if any, have science and technology backgrounds, and even fewer have any experience with science and technology issues. We are not aware that any of them raised S&T policy as a major issue in their campaigns. Similarly, entire committee staffs will be replaced, with a significant loss of institutional memory

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Sometimes the invasion has been officially sanctioned: the FBI tapping of Martin Luther King's telephone in the 1960s, and NSA's surveillance of private individuals, contrary to law, from 1948 to 1975. Sometimes the government has collected information for one purpose—census data—and used it for another—internment of Japanese-Americans during the Second World War (contrary to laws regarding census data that limited the use of the information to census related issues). EES opponents argue that an encryption system in which the government holds the keys is a system ripe for abuse.

Proponents of the Clipper system counter that by having an automatic erasure of the keys at the end of the wiretap period and an electronic audit trail generated automatically for the surveillance, EES will prevent such abuses. However, the present prototype decrypt processor has manual erasure of the keys. Similarly, the electronic audit trail has not been used in the prototype decrypt processor

Proponents observe that EES is a voluntary system; the Clinton administration has stated it will continue to allow other forms of encryption. However, FBI Director Louis Freeh holds a different position on this issue.

Two months ago the Digital Telephony Bill became law. This measure requires that telecommunications providers build their systems wiretap-ready and authorizes a four-year federal expenditure of $500 million to cover the costs of transforming the present telecommunications infrastructure to achieve this goal. While the bill was being considered, opponents of Clipper raised concerns that if the government invested half a billion dollars in digital telephony to ensure law enforcement's continued ability to wiretap, government would be loath to later lose wire-tapping ability because of encrypted communications.

But the Clinton administration was clear on the issue of encryption: "Today any American can purchase and use any type of encryption product. The administration does not intend to change that policy. Nor do we have any intention of restricting domestic encryption."[6]

Recently Freeh said otherwise. At a conference on Global Cryptography, Freeh said that if he found that wiretap orders were impeded by the use of non-Clipper cryptography, he would seek support for the outlawing of non-escrowed encryption.

It all comes back to wiretaps, and the issue of wiretaps is a clouded one. Many members of the law enforcement community strongly believe that wiretaps form a critical component in fighting certain types of crimes. That is hard to evaluate. The issue of encrypted communications thwarting court-authorized wiretaps is admittedly speculative. According to the FBI, problems already exist with executing legally authorized wiretaps. The bureau has been unwilling to make public the cases in which it has been unable to execute court-authorized taps.

Courts are not scientific laboratories, and in many cases there is no way to know what ultimately leads to a conviction. For many of the high-profile cases in which electronic surveillance played a role, electronic bugs—not wiretaps—led to the convictions. That was the case with the Gotti conviction in New York, for example.

Finally, it is worth noting that while computer technology, in the form of advanced telecommunications switching or encryption, may impede the execution of wiretaps, computer technology also has greatly enhanced crime-fighting techniques. Electronic surveillance, in the form of video cameras in public places, is widespread. Modern telephone signaling systems provide much more information, revealing in real time the origination and destination of the call. Electronic database information, whether for fingerprints or more mundane records, makes many searches effective when paper files did not. All of these are substantial advances over 1968, when the federal wiretap statute was enacted.

A decision to be made

This nation is experiencing fundamental transformations in the way people and organizations communicate. The National Information Infrastructure will only accelerate the changes. Confidentiality of electronic communications is a serious technical and policy issue facing society. What cryptography policy best accommodates national needs for secure communications and privacy, industry success, effective law enforcement and national security? Ultimately, the choice will be one of values: How important is protecting society from potential attacks by criminals versus how important is protecting personal privacy from all threats of eavesdropping—including by the government? This debate will rest on facts, so it is important to get those facts right.

Susan Landau is a research associate professor in the Computer Science Department at the University of Massachusetts. She is co-author of the USACM study Codes, Keys and Conflicts: Issues in US Crypto Policy

Footnotes

[1] EES is a voluntary Federal Information Processing Standard (FIPS). Any agency that chooses to protect the communication of sensitive but unclassified information (e.g. Social Security records or IRS returns) could choose to use EES or any other FIPS cryptographic scheme. However, the only other FIPS approved for encrypting electronic communication is the Data Encryption Standard (DES) and there is a good chance that DES will be shelved at its next review later this decade.

[2] A copy of this USACM report is available on the World Wide Web at http://Info.acm.org/reports/acm_crypto_study.html/.

[3] DES was designed by IBM Corp. and vetted by the National Security Agency

[4] General Accounting Office, *IRS Information Systems: Weaknesses Increase Fraud and Impair Reliability of Management Information*, Washington, DC, Government Printing Office, September 1993.

[5] US Senate, 1974, *Final Report of the Select Committee to Study Governmental Operations with Respect to Intelligence Activities*, Washington, DC, April 26, 1974.

[6] Office of the White House, White House press statement on EES, Feb. 4, 1994.

Policy News

Roth: Clipper lacks support

An aide to Sen. William V Roth (R-DE), the incoming chair of the Senate Governmental Affairs Committee, said the senator plans to take a hard look at the Clinton administration's Clipper key escrow encryption policies as well as other issues that may threaten privacy.

Walter Kosinski, a LEGIS fellow on Roth's staff, told members of the National Institute of Standards and Technology's Computer System Security and Privacy Advisory Board that the Clipper initiative suffers from a lack of support from industry that will hinder its success. Consequently, Roth and his staff will seek changes, he said.

"The Clipper chip had no buy-in from industry," Kosinski said. "Clearly whatever we do in the future will require the cooperation of industry."

He added that Roth also plans to reconsider the government's process of creating Federal Information Processing Standards (FIPS) for security products. He said the FIPS "may not serve any purpose," and standards may be best developed cooperatively by industry and government. One criticism of the Clipper standard has been that it was developed by the National Security Agency in a classified environment that did not allow industry and the general public to participate in the process.

Kosinski said the committee will hold hearings on Clipper and other issues early this spring. "Privacy is the senator's number one concern," he said. "His view and the public's perception of government as big brother is absolutely heinous." It's something he wants to attack head on."

Roth also will hold hearings on how to "clean up government's own house" and better protect federal data and computers, Kosinski said. "Lack of management attention, training and security focus makes government vulnerable to security breaches," he told the board.

He said personnel at the Office of Management and Budget are working on a revision of the guidelines to agencies to help them comply with the Computer Security Act of 1987. Kosinski said Roth intends to keep an eye on OMB's work.

How should 'obscenity' be defined in cyberspace?

By Juan Antonio Osuna
CRA Staff

Although our society has traditionally shunned pornography, it has learned to cope by keeping it out of public view—hiding adult videos in back rooms, limiting sex shops to red-light districts and confining the sex industry to big cities where people are more tolerant. But as these activities migrate to the Internet and public bulletin board systems, traditional legal and social mechanisms of control are proving less effective.

Some experts forecast a political storm just over the horizon, especially as the Internet attracts increasing publicity and a wider audience of young children and conservative elders. They even suggest that new technologies ultimately may force the Supreme Court to revisit its 1973 interpretation that balances First Amendment rights with state and local obscenity laws.

"What we are now headed for is a new crisis in obscenity law," Mike Godwin, staff counsel for the Electronic Frontier Foundation, said at the recent Sex, Cyberspace and the First Amendment forum.

Held at the CATO Institute—a conservative, libertarian think tank in Washington, DC—forum participants raised a number of thorny issues regarding the affect of technology on obscenity law.

Perhaps the most pressing legal concern centers around the Supreme Court's standing interpretation of what constitutes "obscene" material. Chief Justice Warren Burger formulated an opinion in 1973 based on "community standards." Material is obscene if, according to local community standards, it appeals to an immoral, prurient interest and has no artistic, literary, political or scientific value.

The court's interpretation of the First Amendment does not seem to take into account the changing social landscape, where geographic communities are being replaced by virtual ones. And this has led many local prosecutors and district attorneys to impose local standards on electronic providers of pornography somewhere across the continent.

"Cyberspace now has the potential of allowing Kansas City to dictate the standards for Times Square," Godwin said. "There's the question of whether the community standards doctrine makes sense any more."

Godwin's concern is more than just theoretical. He is quick to mention the case of Robert and Carleen Thomas of Milpitas, CA, and their "Amateur Action BBS," offering adult forums and sexually explicit graphics.

A Tennessee postal inspector, working with an assistant US attorney in Memphis, joined the Thomases' BBS and later downloaded sexually oriented images, ordered a videotape by mail and sent the couple an unsolicited child-porn video.

A Memphis jury convicted the Thomases on 11 obscenity counts but acquitted them on the child-porn count because of entrapment implications. For each count, the couple now faces a maximum of five years in prison and $250,000 in fines.

What was especially disturbing to Godwin was that the Memphis postal inspector was the only person in Tennessee with an account on the BBS, and still the court imposed Tennessee standards for obscenity on a BBS located in California.

While some national porn vendors have learned to avoid mailing their products to places such as Tennessee, operators of a BBS or a Web server do not always have the technical means of determining the true origin of a caller or client. Nor would it make sense to develop such technology, if values and attitudes about obscenity tend less to follow geographic patterns as they do patterns evolving through online interactions in the Global Village.

If geography is not the issue, what is? Godwin suggested that we "should focus on empowering individuals to make their own choices."

But the issue is not so simple. How does society go about empowering certain users with the choice of not having access or not allowing their children access? Is it appropriate for a company or university to allow students or employees to use limited computer resources to browse sexually explicit graphics requiring high bandwidth?

Such questions were raised by recent events at Carnegie Mellon University, where sex-related news groups were removed from university computer systems. After fervent protests from students, the university formed a committee to examine the issue more closely. The question remains, however, whether the university's actions constitute censorship or simply a refocusing of resources.

While CMU officials said they were forced to remove the groups because of state obscenity laws, Godwin suggested another reason. "They were afraid of having to explain [the sex groups] to donors and alumni," he said. "They reached out for a fairly tenuous legal explanation."

These events and the tendency of mainstream media to pursue the Internet's sensational aspects may soon lead to wider public scrutiny of Internet activities and heightened controversy. At CMU, student protests overwhelmed university officials to the point where its Bulletin Board Committee decided to restrict its members from talking to the press, further infuriating student representatives.

It is unlikely the controversy will end with the CMU or California BBS incidents. "There's a certain media hunger for the downside of the Internet, especially when it comes to sex," Godwin said. "Sex over the Internet is the hottest issue now."

Mentoring from Page 5

the number of African-Americans and women earning the degree has remained dismally low. The number of African-American Ph.D. recipients accounts for less than 1% of the doctorates granted each year, for an average of 0.6% of the total for the past 20 years. This has occurred at the same time that the number of foreign students earning a Ph.D. in computer science from US universities has increased from 32% in 1981 to 55% in 1991. The total graduate (M.S. and Ph.D.) population of African-Americans in computer science currently is 5%; it is 8% at the undergraduate level. The small progress made at the undergraduate level has not resulted in substantive progress at the graduate level.

Success at the undergraduate level is not sufficient amelioration of the underrepresentation of females and minorities amongst our nation's research scientists. This component of our model ensures that those students with the capability and perseverance to engage in research at the graduate level will do so. The continuation of our mentoring and research activities for undergraduates is an integral part of our M.S. in computer science.

We must address the need for minority participation at the highest levels of academic achievement: through the completion of graduate study at the M.S. and Ph.D. levels. Analysis of NSF data shows that the underrepresentation problem gets worse as students earn higher degrees. This exacerbates the problem universities have in attempting to hire faculty and industry has attempting to diversify the work place. According to the 1992-93 CRA Taulbee Survey, at the 143 universities in North America that grant computer science Ph.D.s, only 0.69% of the faculty are African-American.

Clearly, the rate of retention and production of minority computer scientists must be improved. The most promising undergraduate students must be encouraged to engage in further study. Our approach will likely have to continue at the graduate level. Graduate scholarships and mentoring (as opposed to advising) are not only appropriate, but necessary.

At the graduate level, research activity is the center of the educational experience. Encouragement, mentoring and funding of research activities and articles are key parts of our plan. The advanced degree component is so critical that the doctoral program of study should be made part of the mission of at least one HBCU in the nation. No HBCU currently offers a doctorate in computer science.

We propose to begin planning for that degree at NC A&T. Such a degree program could, by itself, dramatically increase the supply of minority and female computer scientists in the nation.

David Bellin is director of graduate studies in the Department of Computer Science, North Carolina Agricultural & Technical State University.

Joseph Monroe is chair of the Department of Computer Science, North Carolina Agricultural & Technical State University.

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Auburn University
Department of Computer Science and Engineering

The Department of Computer Science and Engineering invites applications for a senior level faculty position beginning September 1995. Responsibilities include initiation and supervision of research programs, graduate student supervision, and graduate and undergraduate teaching. Applicants should have a Ph.D. in computer science, computer engineering or a closely related field, and a proven record of accomplishment, as demonstrated by publications and the ability to attract external research funding. The appointment will be made at the associate professor or professor level, depending on experience and qualifications.

The department currently has 13 full-time faculty members and supports strong undergraduate and graduate programs. Faculty research areas include parallel computation, software engineering, artificial intelligence, computer networks and human-computer interaction. Departmental resources include a network of Sun workstations linked to the College of Engineering's Sun network and the Internet. Parallel computing research is supported by a 32-processor Ncube and a network of 16 T800 Transputers. Auburn University, with more than 21,000 students, is Alabama's land-grant university, located 100 miles southwest of Atlanta.

Applicants should send a curriculum vitae and the names, addresses and telephone numbers of four references to Professor Stephen B. Seidman, Head, Department of Computer Science and Engineering, Auburn University, AL 36849-5347. Questions can be E-mailed to seidman@eng.auburn.edu. Review of applications will begin Jan. 15, 1995, and continue until the position is filled.

Auburn University is an affirmative action, equal opportunity employer. Women and minorities are encouraged to apply.

Cornell University
Department of Computer Science

Applications are invited for tenure-track positions beginning August 1995. These positions are at the assistant professor level, although appointments at the associate and full professor level will be considered for highly qualified applicants. Applicants should have a Ph.D. in computer science or in a closely related field. The department requires demonstrated research accomplishment at a very high level as well as teaching ability and leadership qualities.

The Department of Computer Science at Cornell University encompasses a wide range of research areas, including algorithms, applied logic and semantics, artificial intelligence, computing theory, concurrency and distributed computing, databases, information organization and retrieval, numerical analysis and scientific computing, programming languages and methodology, robotics and computer vision.

Other available positions:

• Lecturer to teach first- and second-year computer science courses and participate in curriculum development.

• Research positions in scientific computing and software systems.

Applicants should submit a curriculum vitae and the names of at least three references to Chair, Faculty Recruiting Committee, Department of Computer Science, 4130 Upson Hall, Cornell University, Ithaca, NY 14853-7501.

Cornell University is an equal opportunity employer and welcomes applications from women and underrepresented minorities.

Purdue University
Department of Computer Sciences

The Department of Computer Sciences has no regular faculty vacancies for academic year 1994-95 at this time. If vacancies occur, it is anticipated that one-year visitors will be hired. It appears likely that one to three such visitors might be hired. Definitive information is expected early in 1995. We expect to have several regular faculty positions to fill for 1996-97. It is likely that the fields given the highest priority for these positions will be computational science and engineering, computer systems and programming languages. However, candidates with outstanding credentials in other fields will be given serious consideration.

We have about 30 faculty members in operating systems, networks, programming languages, database systems, robotics, software engineering, solid modeling, supercomputing, theory and numerical analysis. The department affords great opportunities for people who want to get involved in exciting research. Each faculty member has access to the departmental computing facilities (many Sun file/compute servers, a 64-processor Ncube 2 and many workstations), to the computing center's Intel Paragon supercomputer and to national computer networks.

Visitor applicants should submit resume and names of references by March 1, 1995, to Chair, Personnel Committee, Department of Computer Sciences, Purdue University, West Lafayette, IN 47907.

Purdue University is an equal opportunity, affirmative action employer.

University at Albany-SUNY
Department of Computer Science

The University at Albany Department of Computer Science invites applications for faculty positions at all levels in the systems area beginning September 1995, contingent upon funding. Candidates must have a doctorate in computer science or a related field. Candidates should be committed to both research and teaching. Senior candidates must have a demonstrated capability for research leadership and external funding in large-scale systems-building projects. Junior candidates should be actively engaged in some form of systems-building research.

The department has well-established strengths in algorithms and data structures, automated reasoning, formal methods in hardware and software design, and computational complexity. Our goal is to build up applied areas to a similar strength. In particular, we seek applicants working in operating systems, databases and networks, although all areas will be considered.

Applications should be sent to Neil V. Murray, Chair, Faculty Search Committee, Computer Science Department, University at Albany, 1400 Washington Ave., Albany, NY 12222. E-mail: nvm@cs.albany.edu.

The University at Albany is an equal opportunity, affirmative action employer. Applications from women, minorities, handicapped persons and/or special disabled or Vietnam-era veterans are especially welcome.

Georgia Institute of Technology
College of Computing

Georgia Tech seeks a distinguished scholar with substantial accomplishments in the general area of software systems to fill a new endowed position, the Johnson Imlay Jr. Chair. A candidate should have most of his or her accomplishments in research areas such as operating systems, system architecture, distributed systems, parallel systems, programming language design and implementation, and/or software engineering. We are especially interested in candidates with demonstrated leadership capability in emerging areas that bridge traditional subdisciplines.

Our emphasis in filling this position will be on a record of achievement and the ability to lead intellectually. We expect the Imlay Professor to provide forward-looking leadership to strengthen our existing substantial research program in software systems and to contribute substantially to our educational programs.

A successful candidate for the position may be a traditional academic scholar or may have pursued the majority of his or her career in industry and established a reputation in ways beyond research publications. His or her work will demonstrate originality, the ability to communicate and the preservation and presentation of results in a manner consistent with the academic tradition of communicating new knowledge to future generations.

Georgia Tech's College of Computing provides research and educational leadership in the field of computing by combining a strong intellectual core in computer science with programs that involve interdisciplinary interactions in such areas as cognitive science, computer graphics and scientific visualization, high-performance computing and telecommunications. With a current academic faculty of 40 and a research faculty of 16, the college offers computer science degrees at the undergraduate and graduate levels. Georgia Tech is located in Atlanta and is a unit of the University System of the State of Georgia.

Nominations or applications, current curriculum vitae and names of five references should be submitted in confidence to Professor Karsten Schwan, Imlay Chair Search Committee, College of Computing, Georgia Institute of Technology, Atlanta, GA 30332-0280. E-mail: schwan@cc.gatech.edu.

Georgia Tech is an equal opportunity, affirmative action institution.

University of Maryland, Baltimore County
Department of Computer Science

The Department of Computer Science at the University of Maryland, Baltimore County (UMBC) invites applications for a tenure-track position at the assistant or associate professor rank. We are particularly interested in candidates in telecommunications and computer networks, computer engineering, software engineering and programming languages, databases and distributed systems. Substantial opportunities exist in collaborative efforts with a well-funded Department of Electrical Engineering in optical communication networks, signal and image processing systems, and computer engineering.

The department consists of 16 full-time faculty and 24 adjunct faculty. It offers B.S., M.S. and Ph.D. degrees and has approximately 130 graduate students and 650 undergraduate majors. We are building a strong research program supported by grants from industry and many government agencies including ARPA, NASA, NIST, NSF, AFOSR and NOAA.

We have moved into a new building with new computational facilities including a Cray Y-EL, a 16-node SGI Challenge symmetric multiprocessor, a gigabit networking test bed, a computer graphics laboratory and hundreds of new color Unix workstations.

The UMBC campus has 10,500 students and is attractively located in the Baltimore–Washington corridor, providing easy access to both metropolitan areas and to numerous federal agencies and industrial research centers. UMBC is joined at the graduate level with the University of Maryland at Baltimore, resulting in the University of Maryland Graduate School Baltimore, with combined research funding of more than $140 million.

Send your application, including curriculum vitae, to: Faculty Search, Computer Science, University of Maryland at Baltimore County, Baltimore, MD 21228-5398. Tel. 410-455-3000; fax: 410-455-3969. Arrange for three letters of reference to be sent to the same address. For full consideration the application and letters should be received by Feb. 15, 1995. To receive additional information, send E-mail to search-info@cs.umbc.edu or access http://www.cs.umbc.edu/.

UMBC is an affirmative action, equal opportunity employer.

University of California, Davis
Department of Computer Science

The Department of Computer Science at the University of California at Davis invites applications for tenure-track faculty positions at all ranks. Applicants for junior positions are expected to demonstrate exceptional promise in research and teaching. Applicants at the senior level are expected to have a distinguished record in teaching and research. The department expects to hire three to four additional faculty this academic year and it is particularly interested in the following four areas: architecture as related to high-performance computing; networks with an emphasis on high-performance communications; graphics with an emphasis on geometric modeling, animation and visualization; and programming languages with an emphasis on compilation techniques, language design, language tools and environments, and formal methods.

Please send a curriculum vitae with a list of at least three references (including E-mail addresses) to Professor Kenneth I. Joy, Chair, Faculty Recruiting Committee, Department of Computer Science, University of California at Davis, Davis, CA 95616.

These positions are open until filled.

UC Davis is an equal opportunity, affirmative action employer.

Duke University
Department of Computer Science

We invite applications and nominations for a tenure-track or tenured faculty position at all ranks starting September 1995. The search is restricted to two fields of interest: experimental systems and artificial intelligence. Areas of primary interest in experimental systems include operating systems, computer architecture and digital systems design, high-speed networks, software development environments, parallel processing, databases and object-oriented systems, multimedia, graphics and algorithm animation, and compilers. Areas of primary interest in artificial intelligence include robotics and intelligent systems, natural language processing, planning, knowledge representation, reasoning systems, learning, automatic programming, collaborative agents, multimodal communication, and artificial intelligence architectures and languages.

The department has major research efforts and funding in the areas of systems architecture, algorithms complexity, scientific computing and artificial intelligence. Facilities include a CM-5 parallel computer, more than 120 computers and high-performance graphics workstations and access to a variety of supercomputers through MCNC in nearby Research Triangle Park. The department also connects to the North Carolina Information Highway, the first fully integrated and functioning high-speed statewide network in the United States.

The department recently relocated to spacious new quarters in the $80 million

Professional Opportunities

Levine Science Research Center, a state-of-the-art facility devoted to interdisciplinary research in computer science, environmental science, biomedical science and engineering and medicine.

The Durham, NC, area, rated by *Money* and *Fortune* magazines as the best place in the United States to live and work, offers a wide variety of professional, cultural and recreational attractions.

Applications should include a curriculum vitae, a list of publications and copies of the most important publications. A Ph.D. in computer science or a related area is required. Applicants should also request at least four letters of reference to be sent directly to the faculty search chair. To guarantee full consideration, applications and letters of reference should be sent by Feb. 1, 1995, to Professor Carla Ellis, Faculty Search Chair, Department of Computer Science, Duke University, Durham, NC 27708-0129

Duke University is an affirmative action, equal opportunity employer

Ohio State University
Department of Computer and Information Science

We are seeking outstanding candidates for faculty positions. Our current needs are strongest in systems, software engineering and architecture, but we also are interested in very strong candidates in AI. While we expect to hire mostly at the junior levels, outstanding senior candidates will be considered as well.

The department is celebrating its 25th anniversary this year. We just moved into a new state-of-the-art building and have a world-class instructional computing facility

This year we plan to make maximum use of computer mail both for receiving applications and for internal review. Thus, we prefer that applicants submit their applications electronically. Instructions for electronic submissions of applications and references can be obtained by sending a message to faculty applications@cis.ohio-state.edu, with the word "instructions" in the subject field of the message.

Hard-copy applications and references will still be accepted if sent to Chair, Faculty Search Committee, Department of Computer and Information Science, Ohio State University, 2015 Neil Ave., Columbus, OH 43210-1277. These applications are likely to be processed more slowly than electronically submitted ones. The search committee will consider applications until available positions are filled.

The Ohio State University is an equal opportunity, affirmative action employer Qualified women, minorities, Vietnam-era veterans, disabled veterans and individuals with disabilities are encouraged to apply

University of Massachusetts, Amherst
Department of Computer Science

The Department of Computer Science's Research Computer Facility develops and maintains state-of-the-art computing capabilities in support of the department's academic and research missions. Two to four staff positions are available in the group.

Associate software specialist: Responsible for user support of Macintosh, PC and Unix system software and applications for the Research Computer Facility's 400 multiple-platform computing environment.

Qualifications are a B.S. in computer science or equivalent experience and excellent written and oral communications skills. Experience with Macintosh, PC and/or Unix system administration and script programming preferred. Networking and programming experience would be a plus. Reference Search R35336.

Software specialist: Responsible for Unix system administration, to include software installations, updates and maintenance to support the Research Computer Facility's 400 multiple-platform computing environment.

Qualifications are an M.S. in computer science or equivalent experience. Experience required includes Unix system administration, shell-script programming, C, X11, TCP/IP and DECnet. Macintosh and PC experience would be a plus. Reference Search R35338.

Salary is commensurate with qualifications and experience. A comprehensive benefits package is offered.

Send cover letter, resume and three letters of recommendation to Search #(fill in R35336 or R35338), Employment Office, 167 Whitmore, University of Massachusetts, Amherst, MA 01003-8170. Review of applications began Dec. 1, 1994, and will continue until the positions are filled. These are grant-funded positions. Renewal of appointments beyond three years is contingent on funding

The University of Massachusetts is an affirmative action, equal opportunity employer

University of Massachusetts, Amherst
Department of Computer Science

The Department of Computer Science invites applications for tenure-track faculty (one to three positions) at the assistant and associate levels, research-track faculty (one to three positions) at the assistant level and postdoctoral researchers (one to three positions) at all levels in all areas of computer science. Applicants must have a Ph.D. in computer science or related area and should show evidence of exceptional research promise. Senior-level candidates should have a record of distinguished research. Salary is commensurate with education and experience.

Our department has grown substantially over the past several years and currently has 32 tenure-track faculty, eight research faculty, seven postdoctoral research scientists and approximately 180 graduate students. Continued growth is expected over the next several years. We have ongoing research projects in robotics, vision, natural language processing, machine learning, connectionism, expert systems, distributed problem solving, human-computer interfaces, distributed processing, database systems, information retrieval, operating systems, object-oriented systems, software engineering, real-time systems, real-time software development and analysis, knowledge-based tutoring systems, programming languages, computer architecture and medical informatics (with the University of Massachusetts Medical School).

The department contains the National Center for Research on Real-Time Intelligent Complex Computing Systems, which includes several NSF and ARPA-sponsored activities funded in conjunction with state, university and industrial support. Among these are the Center for Intelligent Information Retrieval, the Center for Autonomous Real-Time Systems and the Center for Knowledge Communication. To support our research, we have an extensive research computer facility including more than 400 workstations, numerous servers, two Sequent Balance multiprocessors, a 4,096-node Connection Machine, a variety of graphics devices, both Salisbury and Utah/MIT robotic hands, several Denning mobile robots and a real-time test bed.

To apply, send a letter with your curriculum vitae and three letters of recommendation to Search # (R35333 for tenure-track positions, R35334 for research-track positions, R35335 for postdoctoral positions), c/o Chair of Faculty Recruiting, Department of Computer Science, LGRC, Box 34610, University of Massachusetts, Amherst, MA 01003-4610. Please specify whether you are applying for tenure-track, research-track or postdoctoral positions, or any combination of the three. Review of vitae began January 1 and will continue until available positions are filled. A comprehensive benefits package is offered.

Positions available subject to funding

The university is an affirmative action, equal opportunity employer

Abilene Christian University
Department of Computer Science

The Department of Computer Science announces a tenure-track position open to applicants at all levels, available fall 1995. Persons applying must have at least a master's degree in computer science or a closely related field; a doctorate is preferred. In addition, the successful candidate will have a commitment to teaching in an undergraduate environment and demonstrated professional development and/or research activities. Applicants are sought in all areas of computer science and computer engineering

Abilene Christian is a private, independent university closely associated with the Churches of Christ. In addition to its Board of Trustees and administration, all full-time faculty members must be active members of the Churches of Christ.

Applications will be accepted until the position is filled; those received before Feb. 15, 1995, will receive full consideration. Send curriculum vitae, graduate transcripts, two letters of reference and two other references including telephone number, address and E-mail address to Dr. Cary G. Gray, Chair, Department of Computer Science, Abilene Christian University, Abilene, TX 79699. Tel. 915-674-2173; fax: 915-674-2009; E-mail: gray@cs.acu.edu.

Abilene Christian University is an equal opportunity employer and has a policy to employ without regard to race, color, sex, age, handicap or national or ethnic origin, to the extent required by law

Washington State University
School of Electrical Engineering and Computer Science

The School of Electrical Engineering and Computer Science (EECS) solicits applications for a permanent computer science faculty position at the associate or full professor level. Responsibilities include initiation and supervision of research programs and instruction at undergraduate and graduate levels. Applicants should have an earned Ph.D. degree with proven records of accomplishment in their fields as evidenced by sponsored research programs and publications.

We seek outstanding and accomplished candidates in specific areas of computer science, which include software engineering, specification and verification, operating systems, database systems and other related software areas. Screening of applications began December 15 and will continue until the position is filled. Position starts Aug. 15, 1995.

Washington State University has offered the Ph.D. in computer science since 1970, and also offers B.S. and M.S. degrees. The School of EECS has more than 40 faculty members (approximately 15 with primary interests in computer science and engineering), 60 computer science graduate students and active research groups devoted to parallel and distributed processing, imaging (computer graphics, visualization, image processing and vision), artificial intelligence, neural networks and other areas. Computing facilities in the School of EECS include PCs, graphics workstations and servers, all with Internet access.

WSU has about 17,000 students and is located in Pullman, a quiet university town in the southeast corner of the state (approximately 75 miles south of Spokane). Nearby are some of the nation's most pristine and uncrowded places for outdoor recreation. The Pullman school system is widely acknowledged to be one of the very finest in the Pacific Northwest.

Applicants should send a cover letter, curriculum vitae and the names and addresses of three references qualified to comment on their research and teaching qualifications to Chair, Computer Science Search Committee, School of Electrical Engineering and Computer Science, Washington State University, Pullman, WA 99164-2752.

WSU is an equal opportunity, affirmative action educator and employer. Protected group members are encouraged to apply

New York University
Department of Computer Science

The Department of Computer Science expects to have several faculty positions available beginning in September 1995 and invites applications at all levels. This includes regular and visiting positions; the visiting positions can be for terms of one semester or a full year.

Candidates for junior positions need to show evidence of strong research potential. Candidates for senior positions must have an outstanding track record. The department is most interested in candidates in systems areas such as distributed computing, networks, multimedia, operating systems and real-time and fault-tolerant computing

Successful candidates are expected to pursue an active research program and, in the case of junior candidates, show potential for leadership. Senior candidates must have a proven leadership track record. In addition, successful candidates are expected to participate in teaching core courses at all levels.

The department is also interested in junior or senior candidates with a proven track record in interdisciplinary research combining computer science and a science area (e.g., biology, chemistry, physics, medical science) or finance. A senior candidate must have a proven leadership track record.

The Computer Science and Mathematics departments together form the Courant Institute of Mathematical Sciences, a division of New York University. The Computer Science Department has 27 regular faculty and a number of visiting, adjunct and research faculty members.

The department maintains a state-of-the-art computing environment consisting of well over 100 workstations. In addition, there are specialized research facilities for graphics, multimedia, parallel computing, robotics and vision.

Substantial external funding, at the level of $6 million per year, from AFOSR, ARPA, DOE, NIH, NSF, ONR, New York State and industry supports research in a broad array of areas including algorithms, artificial intelligence, compilers, computer graphics, databases, multimedia, natural languages, numerical analysis, parallel architectures and computation, programming languages, robotics, software engineering and computer vision. There are considerable opportunities for collaborative research. Presently there are joint projects with industrial laboratories at AT&T and IBM Corp. and with the following university departments/divisions: biology, chemistry, mathematics, physics, psychology, the Institute for Neural Sciences, the Medical School, Stern School of Business and the Tisch School of the Arts.

New York University, the largest private university in the country, is located in Greenwich Village, one of the most attractive residential areas of Manhattan. Applications should be sent to Professor Richard Cole, Chair, Department of Computer Science, New York University, 251 Mercer St., New York, NY 10012-1185.

The department is an equal opportunity, affirmative action employer. The department welcomes applications from women and underrepresented minorities.

University of Nebraska, Lincoln
Department of Computer Science and Engineering

Applications are invited for an anticipated tenure-track position in CSE starting August 1995. Filling of this position is contingent upon availability of funds. We are interested in candidates in VLSI design, distributed systems and distributed computing. Rank and salary will be commensurate with experience. Hiring preference is at the assistant professor level. The department has 20 full-time faculty active in research and offers B.S., M.S. and Ph.D. programs. It has more than 90 graduate and 300 undergraduate students.

UNL has many computing resources linked by a comprehensive campuswide network. It is the lead institution in the NSF funded regional network MIDnet, and a node on the NSFnet backbone. UNL has state supported centers including the Center for Communication and Information Sciences and the Center for Technology Development and Decision Sciences.

Send resume, names of three references and letter describing current teaching and research interests by Jan. 15, 1995, to Douglas R. Stinson, Department of Computer Science and Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588-0115. E-mail: stinson@bibd.unl.edu.

The university is an affirmative action, equal opportunity employer. Women and minorities are encouraged to apply

University of Wyoming
Department of Computer Science

Applications are invited for one tenure-track position in computer science at the assistant professor rank or at the associate professor rank from candidates with an exceptional research and funding record. A Ph.D. in computer science or a closely related field is required.

A successful candidate will teach and advise undergraduate and graduate students, serve on committees and perform research, preferably in computer architecture or database systems. Persons with teaching or industrial experience also are preferred.

Candidates should send a curriculum vitae and arrange for three letters of recommendation to be sent to Professor Henry Bauer, Chair, Department of Computer Science, University of Wyoming, PO Box 3682, Laramie, WY 82071-3682. Screening of applications begins Jan. 17, 1995, with a closing date of February 3. Send questions

Continued on Page 14

Professional Opportunities

Jobs from Page 13

only to bauer@uwyo.edu.

As an equal opportunity/affirmative action employer, the university encourages female and minority applicants.

College of William and Mary
Department of Computer Science

Applications are invited for a tenure-track faculty position in computer science for fall 1995 at either the assistant or associate professor level. Applicants must hold a Ph.D in computer science or computational science. Appointment at the assistant level requires that the applicant must hold a Ph.D at the time of appointment and demonstrate strong interests in both research and teaching. Appointment at the associate level requires a documented record of sustained excellence in both research and teaching. We primarily are interested in individuals with research expertise in one of the following areas: scientific databases, parallel computing, high-performance systems, and parallel and distributed numerical algorithms. A demonstrated interest in multidisciplinary applied research is highly desirable.

The department currently consists of 12 faculty members who support B.S., M.S. and Ph.D. programs enrolling approximately 25 Ph.D. and 40 M.S. students. Teaching loads and salary are consistent with those in other Ph.D. granting departments. More information about the department and the college can be obtained by connecting to the WWW server "http://cs.wm.edu/" or to the gopher server "gopher.cs.wm.edu".

The department maintains a network of Sun, Sun-clone, SGI and RS6000 Unix workstations used for both teaching and research and a 1,024-node MasPar MP-2. Opportunities exist for joint research activity with scientists and engineers at the nearby NASA Langley Research Center and DOE's Continuous Electron Beam Accelerator Facility (CEBAF).

A resume and any supporting documents should be sent to Faculty Search Committee, Department of Computer Science, College of William and Mary, PO Box 8795, Williamsburg, VA 23187-8795. Candidates also should have three letters of recommendation sent to the same address.

E-mail questions to search@cs.wm.edu. Review of candidates will begin on Jan. 15, 1995, and continue until the position is filled.

The College of William and Mary is an equal opportunity/affirmative action university. Members of underrepresented groups (including people of color, persons with disabilities, Vietnam veterans and women) are encouraged to apply

University of Missouri-Rolla
Department of Computer Science

The Department of Computer Science invites applications for a tenure-track position at the level of assistant professor to begin the fall semester of 1995. Qualifications for the position include a Ph.D. in computer science and strong commitments to teaching and to research in the area of software engineering

The department grants the B.S., M.S. and Ph.D. degrees. The Ph.D. program has been active since 1977, and the department has close to 100 graduate students. Departmental research is growing; current funding is more than $500,000 from NSF, DOD and industry sources. Major computing facilities include an Intel Corp. iPSC/860 32 processor multicomputer as well as Sun, SGI and Next workstations for faculty and student use. Disciplinary and interdisciplinary research within the sciences and engineering is active in parallel and distributed computing, scientific computing, formal methods and artificial intelligence. The UMR Intelligent Systems Center also provides interdisciplinary research opportunities. Faculty members in the department may become research investigators in this center

The University of Missouri-Rolla is the primary science and engineering campus of the University of Missouri system. It currently has an enrollment of more than 5,000 students. Rolla is situated in the non-urban environment of the Ozarks equidistant from St. Louis, Columbia and Springfield. Salary is competitive with Big-10 and Big-8 universities.

The committee will begin reviewing applications March 1, 1995. Applications are accepted until the position is filled. Applicants should send a curriculum vitae and a statement of research and teaching interests, and arrange to have three letters of reference sent to Dr. Fikret Ercal, Faculty Search Committee, Department of Computer Science, University of Missouri-Rolla, Rolla, MO 65401. Tel. 314-341-4492; E-mail: csdept@cs.umr.edu.

For additional information about the department, you may access the department's home page via Mosaic at http://www.cs.umr.edu.

UM-Rolla is an equal opportunity/affirmative action employer and especially encourages applications from both minorities and women.

University of Colorado, Boulder
Department of Computer Science

Applications are invited for a faculty position in the area of software and systems. The department is particularly interested in candidates in the areas of databases, distributed systems, networks, operating systems, programming languages and software engineering. Preference will be given to candidates at the assistant professor level.

The Computer Science Department at the University of Colorado has 23 faculty and about 170 graduate students. The department has strong research programs in artificial intelligence, numerical and parallel computation, software and systems, and theoretical computer science. The computing environment includes a multitude of computer workstations and a large variety of parallel computers. The department is the recipient of two consecutive five-year Institutional Infrastructure (formerly CER) grants from the National Science Foundation that support its computing infrastructure and collaborative research among its faculty.

Applicants should send a current curriculum vitae and the names of four references to Professor Robert Schnabel, Chair, Department of Computer Science, Campus Box 430, University of Colorado, Boulder, CO 80309-0430. One-page statements of research and teaching interests also would be appreciated. Review of applications began Jan. 1, 1995, but applications postmarked before March 1 are eligible for consideration. Earlier applications will receive first consideration. Appointment can begin as early as August 1995.

The University of Colorado at Boulder strongly supports the principle of diversity. We are particularly interested in receiving applications from women, ethnic minorities, disabled persons, veterans and veterans of the Vietnam era.

University of Delaware
Department of Computer and Information Sciences

The University of Delaware, centrally located on the East Coast, within day-trip distance of New York, Philadelphia, Baltimore and Washington, DC, invites applications for one tenure-track assistant professor position in the Department of Computer and Information Sciences beginning Sept. 1, 1995. Excellent candidates are sought in system-related areas including operating systems, parallel and distributed computing, computer architecture and compilers. Responsibilities of the position

Wayne State
.5 pt rules print

Professional Opportunities

include research, pursuit of external funding, supervision of graduate student research, and graduate and undergraduate teaching. A Ph.D. degree or its equivalent is required.

The department offers bachelor's, master's and doctoral degrees. It has 15 tenure-track faculty, three visiting faculty and five research faculty, along with about 100 graduate students, a majority of whom are pursuing a Ph.D. The department has excellent research computing facilities and is well connected with gateways to major networks.

Candidates should send a curriculum vitae to Dr. Adarsh Sethi, Chair, Faculty Search Committee, Department of Computer and Information Sciences, University of Delaware, Newark, DE 19716. In addition, candidates should have three confidential letters of reference sent directly to the above address or by e-mail to csfacsch@cis.udel.edu. All applications received by Feb. 10, 1995, will be considered.

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

Princeton University
Department of Computer Science

The Department of Computer Science at Princeton University invites applications for faculty positions at all ranks in all areas of computer science.

Assistant professor applicants must demonstrate superior research and scholarship potential as well as teaching ability. A Ph.D. or equivalent in computer science or a related area is required. Applicants for senior positions must have an exceptional record of research achievement. Successful candidates at all ranks are expected to pursue an active research program and to contribute significantly to the teaching programs of the department.

Applications should include a resume and the names of at least three people who can comment on the applicant's professional qualifications. Applications should be sent to Chair, Search Committee, Department of Computer Science, Princeton University, 35 Olden St., Princeton, NJ 08544-2087.

The committee will begin considering applications in February 1995.

Princeton University is an equal opportunity, affirmative action employer

University of Florida
Department of Computer and Information Sciences

The Department of Computer and Information Sciences invites applications for tenured or tenure-track faculty positions at the assistant, associate and full professor ranks in all areas of computer science and engineering. Applicants must possess a doctoral degree in computer science or computer engineering or equivalent and show a strong record and commitment to teaching and research in these areas. The positions are available in the 1995-96 academic year.

Applicants should send their resumes and the names and addresses of at least four references to Professor Sartaj Sahni, Chair, Faculty Search and Screening Committee, Computer and Information Sciences Department, 301 CSE, University of Florida, PO Box 116120, Gainesville, FL 32611-6120. Tel. 904-392-1200; E-mail: sahni@cis.ufl.edu. The closing date is Jan. 23, 1995, or until positions are filled.

The University of Florida is an equal opportunity, affirmative action employer. This faculty search will be conducted in compliance with the "Florida Government in the Sunshine Law."

Johns Hopkins University
Department of Computer Science

The Johns Hopkins University invites applications for a faculty position in the Department of Computer Science. Appointments at all ranks will be considered. We particularly, but not exclusively, seeking candidates with interests in research and teaching in experimental aspects of the following areas: databases, computer graphics and visualization, and networking. The ability to integrate experimental and analytical approaches is highly desirable.

All applicants are expected to have an outstanding research record, commitment to quality teaching and the ability and willingness to develop a research program of the highest quality.

Applicants should send a comprehensive curriculum vitae and the names of at least three references to: Faculty Search Committee, Department of Computer Science, Room 224 New Engineering Building, Johns Hopkins University, Baltimore, MD 21218-2694. Fax: 410-516-6134; E-mail: faculty_position@cs.jhu.edu.

The Johns Hopkins University is an equal opportunity, affirmative action employer

Yale University
Department of Computer Science

We expect to have one or more junior faculty positions available for the 1995-96 academic year. We are particularly interested in applicants in the areas of programming languages and systems, artificial intelligence and numerical analysis. Applications should be submitted before March 15, 1995.

Duties will include teaching graduate and undergraduate courses. Applicants are expected to engage in a vigorous research program. Candidates should hold a Ph.D. in computer science or related discipline.

Send curriculum vitae and have at least three letters of reference sent to: Faculty Recruiting Committee, Department of Computer Science, Yale University, PO Box 208285, Yale Station, New Haven, CT 06520-8285.

Qualified women and minority candidates are encouraged to apply. Yale is an affirmative action, equal opportunity employer

University of California, Riverside
College of Engineering

The Marlan and Rosemary Bourns College of Engineering at the University of California at Riverside is conducting a worldwide search to attract an outstanding scholar for the Johnson Chair in Intelligent Systems. Applications and nominations are solicited in all areas related to robotics, machine vision, neural networks, artificial intelligence, computational logic, natural language processing, pattern recognition and cognitive science. The college is searching for candidates with established international prominence and interest in developing a strong research focus in intelligent systems within the college.

Candidates for the chair should have qualifications commensurate with the academic rank of full professor at the University of California. In particular, the candidate should possess:

• research ability—demonstrated by major and internationally recognized contributions in an area of intelligent systems;

• leadership capabilities—an interest in creating and leading an active research group and interacting effectively with other groups and institutions; and

• a commitment to teaching—demonstrated by an interest and ability in providing high-quality instruction.

Candidates should submit a resume, a complete list of publications, a written statement on research and teaching objectives and names of at least three individuals willing to write letters of reference to: Chair, Johnson Chair in Intelligent Systems, College of Engineering, University of California, Riverside, CA 92521-0425. Applications will be accepted until Feb. 1, 1995. Late applications may be accepted until the position is filled.

The University of California at Riverside is an equal opportunity, affirmative action employer

University of Pennsylvania
Department of Computer and Information Science

The University of Pennsylvania invites outstanding applicants for two tenure-track assistant professorships, with appointments to start July 1, 1995. Applicants are sought in the areas of artificial intelligence and software systems, but attention will be given to excellent candidates in other areas of computer science.

Faculty duties include undergraduate and graduate teaching, as well as research. As in previous years, we will be looking for applicants whose research would be enhanced by the department's existing strengths in computational biology, computer graphics and animation, computer vision and robotics, gigabyte networks, logic and computation, and natural language processing.

Applications (including the names of at least three references) should be sent to: Chair, Faculty Search Committee, Department of Computer and Information Science, University of Pennsylvania, 200 S. 33rd St., Philadelphia, PA 19104-6389.

Applications must be received on or prior to Feb. 1, 1995, to be assured full consideration.

Address questions to e-mail: bonnie@central.cis.upenn.edu. However, please do not send applications by e-mail.

The University of Pennsylvania is an affirmative action, equal opportunity employer

University of Wisconsin, Madison
Department of Computer Sciences

Applications are invited for a tenure-track assistant professor position beginning August 1995. Applicants should have a Ph.D. in computer science or in a closely related field with a demonstrated ability in relevant scholarly research. Of particular interest are applicants whose research interests lie in the areas of operating systems, networks, parallel and distributed systems or artificial intelligence.

The Computer Sciences Department at the University of Wisconsin at Madison has active research projects in a broad number of areas including artificial intelligence, computer architectures and VLSI, database systems, mathematical programming, modeling and analysis of computer systems, networking and distributed systems, numerical analysis, operating systems, parallel processing, program development environments and the theory of computing.

The department has received three NSF Coordinated Experimental Research (Institutional Infrastructure) grants. The previous two projects emphasized loosely and tightly coupled parallel computing. Our current project, PRISM, addresses parallel processing on machines that offer credible paths to teraflop computing.

Research computing equipment is plentiful. The department has 400 DEC, HP and Sun workstations, 70 PCs, plus numerous file servers and special-purpose devices for computer vision and computer architecture. Equipment for research in parallel computing currently includes a 64-processor Thinking Machines CM-5 and the Wisconsin COW (Cluster of Workstations). COW is a parallel computer constructed from 40 two-way multiprocessor Sun SparcStation 20 workstations (with an ATM interconnect coming in early 1995).

Applicants should submit a curriculum vitae and the names of at least three references to: Chair, Faculty Recruiting Committee, Computer Sciences Department, University of Wisconsin-Madison, 1210 W. Dayton St., Madison, WI 53706. The deadline for applications is March 31, 1995.

The university is an equal opportunity, affirmative action employer and encourages women and minorities to apply. Unless confidentiality is requested in writing, information regarding the applicants must be released on request. Finalists cannot be guaranteed confidentiality.

Governors State University
Division of Science

Applications are invited for one or more positions in computer science to contribute to B.S. and M.S. programs in computer science. Applicants should have a Ph.D. prior to Sept. 1, 1995; a degree in computer science is preferred. The 100 junior and senior students and 50 graduate students currently are served by eight full-time faculty.

The university seeks faculty with research potential and a strong commitment to teaching. Applicants from the areas of data communications and computer networks, database systems, and object-oriented programming and design are encouraged to apply. The candidate's emphasis should be in the applied and pragmatic part of computer science. Duties include teaching, research and service. Salaries are competitive. Screening begins March 1, 1995, and the starting date is Sept. 1, 1995.

Governors State University is located in a suburban area 35 miles south of downtown Chicago. The university has an enrollment of 5,600 students in four colleges.

Please send a curriculum vitae, including identification of teaching and research specialties, and three letters of reference to: Professor R.W. Hakala, Chair, Computer Science Search Committee, Division of Science, Governors State University, University Park, IL 60466.

Governors State University is an affirmative action, equal opportunity university seeking to maintain a diverse faculty and encourages applications from African-Americans, Hispanics, Native Americans and women.

Polytechnic University
Department of Computer Science

Faculty positions are open at all levels. Preference will be given to candidates working in the areas of databases, software engineering, computer architecture, parallel and distributed systems, compilers and programming languages or computational biology.

Candidates should have a Ph.D. in computer science or in a closely related field, and a strong research record. Faculty candidates at the full professor level will be expected to help develop, in concert with current faculty, an active and strong group in one of the above areas and to have the demonstrated ability to secure substantial external funding through grants or contracts.

The Department of Computer Science, which offers B.S., M.S. and Ph.D. degrees, currently has 15 regular faculty members. Areas of active research include parallel and distributed systems, architectures and algorithms; large distributed databases; software reliability and testing; network management; image analysis and understanding; pattern recognition; computational biology; and computational geometry.

The department's active research program is supported in part by faculty grants from NSF and other agencies, industry, the Polytechnic's New York State Center for Advanced Technology in Telecommunications and the Center for Applied Large-Scale Computing, which participates in the Consortium for International Earth Sciences Information Network. The department recently moved into a new university building in Brooklyn that is part of the 16-acre MetroTech Center for academic, research and commercial activities. As a result of the university's favorable location, faculty and students enjoy close interactions with major companies in the financial, telecommunications and computer industries.

Polytechnic University (formerly known as Brooklyn Poly) is a private technological urban university established in 1854. It is located on three campuses in the New York City metropolitan area. The main campus is in downtown Brooklyn adjacent to Brooklyn Heights, one of New York's desirable residential communities. Two suburban campuses are located in Farmingdale, Long Island, and in Hawthorne, Westchester County. The university has an enrollment of approximately 3,500 students.

Qualified applicants should send their curriculum vitae to the Chair of the Search Committee, Professor Richard V. Slyke, Department of Computer Science, Polytechnic University, Six MetroTech Center, Brooklyn, NY 11201. Tel. 718-260-3186; E-mail: rvslyke@photon.poly.edu. Evaluation of candidates will begin immediately and continue until the search is complete.

Polytechnic is an equal opportunity employer. Applications from women and underrepresented minorities are strongly encouraged.

Kansas State University
Department of Computing and Information Sciences

The Department of Computing and Information Sciences invites applications for tenure-track positions beginning fall 1995. Applicants should have a Ph.D. in computer science with a research specialty in software engineering, data engineering or related work in parallel systems. The applicant must have a commitment to both teaching and research. Applications should include a description of current research and teaching experience and interests, and several of the applicant's best publications. Non-US citizens must include their visa status. The department offers B.S., M.S. and Ph.D. degrees.

The computing environment in the department is principally X terminals, Sun workstations and PCs network with a multiprocessor scientific cluster, an IBM 3090 and the Internet. Each faculty office is equipped with a workstation on the network.

Please send resumes to Dr. Virgil Wallentine, Head, Department of Computing and Information Sciences, Kansas State University, 234 Nichols Hall, Manhattan, KS 66506. E-mail: virg@cis.ksu.edu. The application deadline is March 1, 1995.

Kansas State University is an affirmative action, equal opportunity employer

Canadian News

Canadian researchers explore privacy issues

By Douglas Powell

As electronic transactions and records become central to everything from commerce and tax records to health care and even basic research, new concerns arise for the security and privacy of networked information. These concerns, if not properly resolved, threaten to limit networking's full potential in terms of participation and usefulness, according to a US Office of Technology Assessment report, *Information Security and Privacy in Network Environments*, released in September. While a vigorous and public debate has developed in the United States, Canada has been relatively quiet, although the same issues challenge the Canadian research community.

However, the nascent electronic privacy debate in Canada has been kick-started by the formation of Electronic Frontiers Canada (EFC) and a recent conference that grappled with the sometimes competing interests of free speech and individual privacy.

Computer science professors David Jones of McMaster University and Jeffrey Shallit of the University of Waterloo formed EFC last January to protect Canadian rights and freedoms on the new electronic frontier. Richard Rosenberg of the University of British Columbia joined the Board of Directors in September.

In November, EFC and several other organizations brought together some of Canada's best-known pundits to weigh the issues and move the debate onto the larger public stage.

Computer users (noticeably more libertarian than the general public) clamor for complete freedom of communication, sometimes without recognizing the accompanying responsibilities, Shallit said. Others have legitimate worries about the new technology exacerbating society's existing inequities. A survey conducted in September of 2,648 Canadians found that the country increasingly is divided into the information haves and have-nots. Computer pornography is spreading and the potential for computer crime and terrorism is increasing. Worse, the Canadian Charter of Rights and Freedoms, enacted in the Constitution Act of 1982, is conflicting with the Internet.

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"Do we control the medium or does the medium control us?" Shallit asked. As noted in the OTA report, appropriate safeguards must account for—and anticipate—technical, institutional and social changes that increasingly shift responsibility for safeguarding information to the end users. Laws currently governing commercial transactions, data privacy and intellectual property largely were developed for a time when telegraphs, typewriters and mimeographs were the commonly used office technologies, and business was conducted with paper documents sent by mail. Technologies and business practices have changed dramatically, but the law has been slower to adapt.

Justice John Sopinka of the Supreme Court of Canada said at the conference the Charter of Rights and Freedoms protects freedom of expression. But he added that there is no specific protection for privacy, although the Supreme Court has hinted several times there should be. Further, the charter applies only to government action, not the private sector, which controls much of the information highway.

"The more that technology affords opportunities to reach wide audiences, the more society may come to resent any attempts to restrict free speech," Sopinka said. "It will not be easy searching for an appropriate middle ground."

Jay Weston, a professor of mass communications at Carleton University and a founder of the Ottawa FreeNet, said that community networks nudge along the process of democratic self-representation, where more groups and individuals gain a public voice.

"Mass media is content-driven, where the Internet is relationship driven," Weston said. He also aimed some barbs at the Canadian Network for the Advancement of Research, Industry and Education (CANARIE), which is establishing itself as the national electronic backbone. "CANARIE, as its name implied, assumed there were no people in Canada," he said.

But with more people on the Net, there are more opportunities for electronic tinkering. Henry Spencer, an independent consultant and author who worked for many years as a Unix systems programmer at the University of Toronto, said that although it is increasingly difficult for the government to monitor private conversations (through programs such as PGP—pretty good privacy), most electronic communications are not going to use it and remain exposed.

Spencer, whose system was the first Usenet site in Canada and the first outside the United States, said freedom of the press exists as long as the media does not make the government too angry. "The presumption of innocence is an area where organizations usually blow it," he said in reference to several cases where electronic messages were monitored or confiscated. "Your employer expects more control over you than governments, with a whole lot less in the way of due process."

That view was expanded by Canadian journalist Parker Barass Donham, who said universities, with newsgroup bannings and speech codes, "have become the most censorious institutions in our society." Repeatedly, the discussion returned to newsgroup bannings and other electronic restrictions imposed by university administrators.

Shallit noted the similarities between the banned discussion of details surrounding the Paul Teale and Karla Homolka murder trials and the 100-year-old murder of Reginald Birchall. Banned discussions of the Teale and Homolka trials were easily circumvented using the Internet newsgroups and then listserves. In the Birchall case, an entrepreneur installed a microphone above the judge's bench in the Woodstock, Ontario, courtroom, and the trial proceedings were relayed by telephone to his tavern, where patrons could listen in at the rate of 25 cents an hour.

"As we decide on what policies are best for the communications world of the future," Shallit said, "let us reflect seriously on the mistakes and successes of the past."

Ursula Franklin, professor emeritus at the University of Toronto where she taught in the Department of Metallurgy and Materials Science, proposed a public health model to regulate—in the same way cigarette smoking is regulated in public spaces—when and where potentially offensive material such as pornography could be viewed.

"The information age is an environment," Franklin said. "One that needs regulations and management, like the regular environment."

That suggestion brought a sharp rebuttal from several speakers. "Human expression is not the moral equivalent of smoking and toxic waste," Donham said.

For more information about Electronic Frontiers Canada, send E-mail to efc@graceland.uwaterloo.ca.

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early deadlines (November or December of your senior year), so you should request application materials during the summer but no later than September of your senior year.

Matriculation

A major figure in the life of the graduate student is the research adviser. The relationship you establish with your adviser is one of the most vital aspects of your successful completion of the graduate program. It is of utmost importance that you do your homework when selecting an adviser. There are four basic questions that should serve as a guide. First, ask if the faculty member is in a position to share her or his time and advice. Second, determine if the faculty member has a reputation for producing quality research in a timely manner. Third, determine if the faculty member's current research area is of interest to you and in keeping with your graduate study goals. Fourth, determine if the faculty member is sensitive to the concerns and problems many women face as graduate students.

Many women encounter problems in CS&E graduate school that are unique to their gender. If you do not find a supportive mechanism during your matriculation, it may be difficult for you to complete your degree requirements. Do some research to determine if the department or the graduate school in general provides some means of support and encouragement. For example, there may be a formal women-in-CS program that pairs female faculty, other sensitive faculty members or more advanced graduate students with new graduate students for mentoring or other support. There may be informal programs where female graduate students and faculty meet on a regular basis (for example, lunch once a month) to discuss problems and other issues they encounter and their technical work. Many CS&E departments provide some kind of support for the special needs of female graduate students. If you are not aware of these programs when you arrive, ask about them. If they do not exist in your department, you may want to start an informal group. If there are few women in your department, you may try getting together with women in other technical disciplines such as engineering and the physical sciences.

Conclusion

Earning a graduate degree in computer science and engineering can be an enlightening process. It is possible that the intense intellectual enlightenment associated with this process may not be repeated at any other point in your life. It can be an exciting time. However, it is also a humbling experience that can be extremely stressful. CRA-W's graduate school information kit outlines the graduate school process for women in computer science and engineering. The overview presented here was designed to educate you on this process and highlight some of the advantages and disadvantages of pursuing a graduate degree. Also discussed were some of the formal and informal programs you can use to provide a supportive environment for conducting a successful independent research program while enjoying your life.

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