FY 2002 Federal Budget Request for R&D Disappointing

By Lisa Thompson

The federal FY 2002 budget proposal was unveiled by President Bush on April 9, 2001, and the overall treatment of research and development funding is the worst the science community has seen in a long time. The Administration's plans to cut taxes, increase Medicare spending, and pay down the national debt left little new money for discretionary spending. And what new funds were available went mostly to education. Moreover, within the overall R&D budget, medical and defense research are slated for significant increases. As a result, other federal R&D agencies would see their budgets cut under the proposal.

The Congress has reacted strongly to the Administration's plans to reduce science budgets with a variety of letters, reports, and other actions. During its consideration of the budget resolution, the Senate adopted an amendment to increase the general science and space category by $1.44 billion above the Administration's baseline. (This category covers the National Science Foundation, NASA, and the Department of Energy's Office of Science; the category breakdown in the budget resolution differs from the more familiar breakdown used in the appropriations process.) The budget resolution is non-binding, a preliminary step on the road to generating the annual appropriations bills. So it is worth noting that the amendment to provide this significant funding boost was sponsored by key appropriations committee members from both political parties.

Table 1. R&D Funding by Type and Sector
(in millions of US$)

Type	Actual FY 2000	Estimate FY 2001	Proposed FY 2002	Proposed FY01–02 % change
Basic Research	$19,421	$22,018	$23,352	6.1%
Applied Research	18,466	20,734	21,553	4.0%
Development	40,524	42,594	45,954	7.9%
R&D Facilities and Equipment	4,727	4,664	4,394	-5.8%

Sector	Actual FY 2000	Estimate FY 2001	Proposed FY 2002	Proposed FY01–02 % change
Defense R&D	$42,906	$44,946	$48,579	8.1%
Non-defense R&D	40,232	45,064	46,674	3.6%
Total R&D	$83,138	$90,010	$95,253	5.8%

Overall R&D

The total R&D request is a record $95.3 billion, $5.2 billion or 5.8 percent more than the estimated FY 2001 total. But the proposed increases for Department of Defense R&D, $3.6 billion, and the National Institutes of Health (NIH), $2.7 billion, would more than offset the overall increase. In fact, if you take NIH out of the equation, the budgets for non-defense research and basic research would both suffer decreases.

The budget targets only two major multiagency initiatives for increases in FY 2002: funding for the Nanoscale Science, Engineering, and Technology Initiative would grow by about 8 percent to $482 million; and the Networking and Information Technology R&D initiative budget would grow by about 2 percent to $2 billion, a far cry from the 30 percent increase the IT R&D initiative enjoyed in FY 2001.

National Science Foundation

The National Science Foundation's FY 2002 budget request totals $4.47 billion, a proposed increase of $56.1 million, or 1.3 percent, over FY 2001. As the Education and Human Resources directorates would see an even larger increase, the agency's support for research would decline slightly to compensate. NSF Director Rita Colwell barely tried to put a good spin on the numbers, noting that most other R&D agencies didn't even do that well.

Inside CRN

The Evolving Research System

By Diana Hicks

Stunning advances in scientific knowledge and technical innovation have been achieved during the past decade. Over time, areas in which science advances most rapidly undergo change; in recent years, computing and information has been one of the most interesting and fast-moving areas. Most decades seem to bring advances in knowledge in one area of science or another. Recently, however, we have witnessed something new—shifts in what is sometimes referred to as our national system of research and innovation.

Thinking in terms of a national system of research focuses attention on the institutions that perform research and their interrelationships, as well as the relationship between science and technology. During the past decade, parts of this system that once were somewhat distinct and disconnected have drawn closer together. Previously, a simplistic understanding of the system was largely correct. This approach assumed that universities concerned themselves with science, that industry dealt with technology, and that science and technology were different.

Today, university and industry research collaboration is much more frequent; universities have become more concerned with innovating and reaping the rewards of innovation; and technology and science have become intermingled. These broad changes are perhaps strongest in the life sciences, but they also affect research in computing and information.

In this article, bibliometric data are used to explore the evolving networked and overlapping research and technology system. The term 'bibliometric' refers to analysis of databases of patents and scientific papers. The data on patents are drawn from CHI Research's analytical version of the Patent and Trademark Office's database of U.S. patents. The data on scientific papers come from CHI's science literature indicators version of the Science Citation Index (SCI).

To explore changes in the way research and innovation are conducted, I will examine three types of bibliometric evidence: 1) research collaboration between universities and industry; 2) university patenting; and 3) patents that reference scientific papers. Table 1 relates the systemic view to the bibliometric evidence.

Table 1.
Systemic Shifts and Corresponding Bibliometric Indicators

Elements drawing together	Evidence
university—industry	research collaboration
university—technology	university patenting
science—technology	patents referencing papers

Expanding the Pipeline
Women, Engineering, and Community

By Leah H. Jamieson

Many factors have been implicated in the under-representation of women in the fields of computing and engineering. Recurring themes include early socialization, negative reactions to introductory math or science courses or negative lab experiences, eroding confidence, a chilly classroom climate, a dearth of role models, isolation, and work-family issues [Henes et al., 1995; NAE 1999].

In addition to citing personal experiences that women may have as minorities in the field—that is, how we treat our women students and faculty—studies are also pointing to the image of the scientific and engineering disciplines (and of the scientists and engineers who work in them) as contributors to the low numbers. Some approaches to encouraging women in science and engineering are therefore focusing on pedagogy: framing the science in its social context; presenting applications from the outset, rather than teaching several years of theory before addressing how the principles might be used; stressing general educational goals, including communication; emphasizing cooperative, interdisciplinary approaches; and undertaking problems with a "holistic, global scope" [Rosser 1990; Rosser 1995; Henes et al. 1995; Margolis, Fisher, and Miller 2000].

The Engineering Projects in Community Service (EPICS) program at Purdue was not created with an eye towards recruiting or retaining women in engineering. Rather, the goals for EPICS were aimed at addressing some of the perceived shortcomings of engineering education [Dahir 1993; ASEE 1994].

However, since its inception in 1995, the program has attracted a disproportionate number of women students and, in particular, has seen a significantly higher percentage of women students from ECE and CS than are enrolled in the two departments. We therefore hypothesize that the skills and values emphasized in EPICS—multidisciplinary teamwork, communication, and engineering in the context of community involvement—present a picture of engineering and science that is appealing to women students. This article presents an overview of the EPICS program, concluding with a summary of statistics on the participation of women in the EPICS courses.

EPICS (http://epics.ecn.purdue.edu) is an academic program that pairs student teams with local community not-for-profit organizations to develop and implement technology-based solutions in the community. EPICS teams are large (10 to 20 students), vertically integrated (freshmen through seniors on each team), and long-lived (students register for several semesters, earning 1 or 2 credits per semester). This structure results in a slow evolution of the team, allowing multi-year projects of

significant complexity and high potential impact in the community.

The EPICS program emphasizes development of skills in multidisciplinary teamwork, communication, project management, and customer and community awareness, in the context of long-term, start-to-finish design projects. Students work with their partner organization to define the projects they will undertake, and continue to interact with the organization through the development, testing, deployment, and subsequent support of the fielded project. The program is thus addressing two complementary needs: the growing mandate for universities to broaden students' education beyond the traditional technical focus, and the increasing need for community organizations to embrace technology in delivering and improving their services.

EPICS was initiated in ECE at Purdue in fall 1995, with 40 students participating on five project teams. In the 2000-01 academic year, 400 students participated on 20 teams, addressing problems ranging from data management for social services to mitigation of agricultural pollution, and from designing learning centers for local museums to developing custom play environments for children with disabilities. EPICS spans much of Purdue, with a majority of students from ECE, Mechanical Engineering, and CS, but with students enrolled from more than 20 departments. By 1997, EPICS programs were under way at Notre Dame and Iowa State; in 2000-01, programs were initiated at the University of Wisconsin-Madison, Georgia Tech, Case Western, and Penn State.

Two examples illustrate the size, scope, and impact of EPICS projects.

The Purdue EPICS Homelessness Prevention team has developed a secure, distributed database system that allows the agencies serving the county's homeless population to count and characterize their clients, track all services provided to each client, enable case-management that spans all agencies and services, and assemble accurate reports without violating clients' confidentiality. In 2000, the team deployed Version 4.3 of the database system with eight agencies in the greater Lafayette area and with two agencies in Anderson, IN, 80 miles southeast of Lafayette.

The current system includes a common client intake form (the culmination of more than a year of meetings with the participating county agencies), the merging of data across agencies, the elimination of duplicate entries, a private e-mail system for the HPN agencies, and the generation of custom reports and statistics. Automatic connections between the agencies' machines and a central server are made at night, transmitting DES-encrypted data over standard telephone lines to

minimize costs for the agencies. Agencies with very strict confidentiality guidelines can select when and to which other agencies their data will be released.

The team and the Lafayette HPN agencies were awarded a grant from the U.S. Department of Housing and Urban Development that will support their participation in a national study of homelessness data. Lafayette is one of only 19 cities in the United States with a successful Homeless Management Information System.

A second example of an EPICS project is the Children's Clinic at Wabash Center, a not-for-profit organization that provides early intervention programs for disabled or developmentally delayed children. The EPICS CCWC team develops computer, electrical, and mechanical toys to meet objectives specified by the clinic's staff: providing multisensory experiences controllable by the disabled child; allowing the disabled child to interact with the play environment using modalities consistent with the child's abilities; providing experience with cause-and-effect relations; and allowing disabled and normally abled children to play together, with the disabled child in control of some aspects of the play.

Projects delivered by the team include: animated storybooks using multimedia software; animations of songs and nursery rhymes that incorporate images and voices of the children in the clinic; a computer-based sign language tutorial for young children; tutorials on computer use for clinic staff; a "pop box" that speech therapists operate by remote control to encourage correct speech; a custom interface and set of interchangeable handles for a commercial toy record player; a prototype "posture sensor" that interfaces a hat-mounted posture monitoring device with electronic toys; and a finger sensor for activating electronic toys that exercises fine-motor skills and pointing motions.

In addition, there are three rooms of a custom electromechanical dollhouse—a kitchen with electronically controlled refrigerator door, lights, and kitchen sounds; a bathroom with an electronically controlled toilet lid, a swimming/singing rubber duck, lights, and sounds; and a bedroom that includes a ceiling-mounted rotating mobile, a cupboard with electromechanical doors, phone and radio sounds, lights, and (at the request of the clinicians) a vibrating bed, so that the children can feel the motion.

Since 1995, the Purdue EPICS teams have delivered more than 90 completed projects to their community partners.

Extensive evaluation of the program's educational goals has confirmed its success in developing teamwork, communication, project

AAAS/CPST Studies Non-Traditional Pathways into the IT/CS Workforce

By Eleanor Babco and Jolene Kay Jesse

Over the past decade, with the rapid infiltration of information technology (IT) into every segment of society and the economy, demand for workers in IT expanded beyond anyone's predictions. At the same time, the U.S. supply of degreed workers in information technology was on a downward trend.

From 1987-1997, the number of bachelor's degrees awarded in computer science dropped more than 36 percent (from 39,927 to 25,393). However, the number of CS baccalaureates earned by women dropped more than 50 percent (from 13,889 to 6,903).[1] It is not surprising that prognosticators were predicting a major shortfall of workers in this field, and warned that with the declining interest of U.S. students to prepare for opportunities in these fields, it was necessary to bring in talent from outside the country.

The federal government echoed this apprehension about the lack of sufficient workers in IT/CS. In early 2000, a report from the National Science and Technology Council[2] expressed strong concern that the United States might not be able to meet its future science and engineering workforce needs. The report recommended that the nation draw on its full talent pool in order to maintain its position as a world leader in all areas of science and technology. In particular, attracting those parts of the talent pool that had not traditionally participated in science and engineering—women and underrepresented minority groups, for example—should become a national priority.

Meanwhile, private industry was continuing to bemoan the insufficient supply of U.S. talent in information technology, and urged that higher and higher limits be placed on the number of specialized talent that could be brought into the United States to fill positions through a temporary visa program called the H-1B. For some years, industry urged higher and higher limits until, in 2000, Congress raised the limit to 195,000 for 2001-03. After 2003, the limit would scale back to 65,000, the original H-1B ceiling.

The current boom labor market for IT/CS workers is somewhat reminiscent of a similar situation in the 1960s when aerospace/aeronautical engineers were in high demand. Industry couldn't find enough and there were warnings of "doom" if special efforts were not made to encourage more U.S. students to enter the field. Recruitment efforts were successful, but just about the time these graduates started coming out of the educational pipeline as aeronautical/aerospace engineers, national priorities changed and their services were no longer in demand. Stories abounded about aerospace engineers working as taxicab drivers.

So is this a similar kind of situation? Probably not, since IT/CS workers are not concentrated in only one industry but are pervasive throughout all segments of society. In sharp contrast to the aeronautical engineering scenario, where most held at least a bachelor's degree, only slightly more than one-fifth of all IT/CS workers in this country have a college degree.[3] Of those who do have a bachelor's degree, moreover, many hold degrees in fields other than IT/CS, and even outside of science or engineering. At the same time, the number of IT/CS bachelor's degrees awarded has been increasing by approximately 2,100 per year during the past few years.[4]

All these factors led the National Science Foundation (NSF) to initiate a program that would fund research on more effective recruitment strategies to attract more U.S. students, particularly women and minorities, into the IT/CS fields. To date, NSF has funded 18 studies for a total of $5.25 million, and a new call for research proposals went out in December 2000 with the same goal. All of the current studies examine the problem from many different perspectives—by program; by geographic region; by educational institution; by labor-market segment; by employer; by values, attitudes, interests, and goals; and by educational level (high school, college, graduate school, and the informal educational sector). Almost all of these initiatives are using statistics to some degree and most involve interview/survey formats.

Our own NSF-funded project was sparked by a surprising fact—the number one producer of bachelor's degrees in IT/CS fields in both 1996 and 1997 was not MIT, the University of Illinois, or any other major research university, but Strayer University. Strayer is a private university specializing in information technology and business-oriented education offering undergraduate and graduate programs in Washington, DC, Maryland, and Virginia. Not only was Strayer the number one producer overall, but it was also the number one producer of female and minority graduates in IT/CS fields.[5]

This fact stunned us on many fronts and immediately raised a whole host of questions. Given Strayer's major marketing emphasis on "non-traditional" students, does their market dominance suggest that these students are the dominant consumers of IT/CS education? If so, what does this mean for: 1) area employers; 2) the IT/CS workforce in the area; 3) the women and minorities who choose this path into the IT workforce; and 4) government efforts to adequately invest resources to ensure a strong American IT/CS workforce for the future that includes all segments of the population?

Protecting Personal Information in Academia

By Gene Spafford

Introduction

Personnel actions in academia are often quite sensitive in nature and require the exercise of great discretion. Promotion, tenure, and hiring decisions all require careful deliberation and documentation. They have a tendency to engender controversy—and sometimes litigation—when decisions are contested or involve contradictory information. Thus, it is widely recognized how important it is to treat such information with sensitivity and care.

With that in mind, consider the following scenarios, derived from recent similar events. Could any of these occur in your department?

- A Ph.D. student nearing graduation and interviewing for positions decided to use a WWW search engine to see which pages referenced her thesis work. Upon searching for her name, she found a link to the hiring pages at a university where she had interviewed. By following links to unprotected pages, she was able to read some of the e-mailed, confidential letters of reference written by her advisors, and detailed comments made about her by members of the hiring committee.

- An assistant professor was being considered for tenure and promotion. Because of a typo in the solicitation letter sent out to potential references, replies sent electronically were undeliverable. Not only were those letters returned to the sender, but they were also copied to the staff member acting as "postmaster" at the college—the spouse of the assistant professor, who was thus able to read very sensitive comments about the candidate.

- A prominent research scientist in industry was interviewing for a senior position at a university. For personal and professional reasons, she wanted to interview in confidence, without informing her current employer. However, when one of her current supervisors browsed the WWW pages of the university to get details of her visit, he found a seminar announcement on the main WWW page, very clearly labeling her as a "job candidate."

- Disgruntled students of a senior professor broke into the WWW servers at several universities where they suspected he had applied for a position. At some sites, they completely deleted the electronic records of the professor's application—the only existing copy of his application there. At other sites, they found online copies of reference letters and altered the text to state false and uncomplimentary things about the professor. Finally, at other sites with online application mechanisms, they entered fake applications containing slanderous information.

- A recent Ph.D. was applying to a university for a post-doc position. She was self-conscious about a medical condition and wanted to keep it a secret from the hiring committee as it had no bearing on her application. The personnel committee members at the site where she applied went beyond her submitted application and letters, found her WWW page at an ISP and its links to her role in a medical advocacy group, and linked those into their internal hiring database. This was disclosed when one of the committee members made a passing reference to her activity during the interview.

- Three years after a contentious decision was made on his tenure, a professor obtained a major grant including some significant computing resources. These were located in the department computing facility, to which he was given keys. One evening, while working in the room with the machines, he found stored CD-ROMs containing archival backups of files from faculty machines. Over the next few evenings, he searched through these archives, reading correspondence, reference letters, and other formal documents concerning his tenure case.

Do these sound dramatic? Perhaps, but they are also all too possible, and they are based on real incidents. Some individuals may knowingly violate privacy and confidentiality rules when confronted with temptation; others may be exposed to privileged information via accident or malice. Without proper backups and protection, critical information also may be damaged or lost as a consequence of either chance or unauthorized activity. Controls should be in place to

Summer Workshop for Undergraduate Teachers of CS/CE

Pending financial support from the National Science Foundation, the Computing Research Association will sponsor a workshop in August 2001 for undergraduate teachers of computing-related disciplines. The workshop will examine ways to use history to improve undergraduate teaching. The exact dates and venues are not yet established, but the likely location is the Berkshires resort area in north-western Massachusetts (summer home of the Boston Symphony at Tanglewood, Jacob's Pillow dance theater, Williamstown theater, and much more). The Charles Babbage Institute for the History of Information Processing is working with CRA to organize this workshop.

In a fast-moving, forward-looking field such as computer science (or other computing-related disciplines) where curricular concerns are often focused on cramming in as much technical information as possible, the addition of modest amounts of history into the established curriculum can have highly salutary effects. These include:

- helping to teach introductory students about the nature and uses of computer science;
- motivating interest in the material by showing where it originated;

- demonstrating how the technical material being taught fits into a larger scientific structure;
- giving students a sense of the tremendous progress and pace of development in the field, and what that progress means in social terms;
- offering historical case studies for use in teaching the ethics of computer science;
- providing role models, including ones that enhance diversity; and
- using case studies to help students understand the political, social, and managerial issues they will face when they enter the working world as computer scientists.

The purpose of this workshop is to offer teachers practical advice about how to use history to enhance their current instructional practices. Workshop speakers will be people who have a deep knowledge of the history of computing—in most cases, long-time leaders of the community.

No registration fee will be charged and **scholarships** will be offered to 20 faculty in the form of free dorm rooms and meals. (Additional people will be welcome, but they must pay for their own housing and meals.) Faculty who are interested in attending should send

an e-mail of interest to William Aspray (aspray@cra.org). Details about dates, location, and financial support will be circulated as soon as they are available.

Incomplete speaker list:

- William Aspray (Computing Research Association)
- Mary Croarken (National Maritime Museum, UK)

- John Impagliazzo (Hofstra University)
- John Lee (Virginia Tech)
- Michael Mahoney (Princeton University)
- Arthur Norberg (University of Minnesota)
- James Tomayko (Carnegie Mellon University)
- Michael Williams (University of Calgary) ∎

CRA Outstanding Undergraduate Award Winner

Photo: Jack Carroll, Santa Clara, CA

Award winner Kevin Zatloukal (r), University of Washington, receives his award from CRA board member, Stu Zweben, at the ACM1 conference in San Jose in March.

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prevent incidents involving critical data.

Often, the priority for expediency and economy in our use of computing has replaced careful thought about privacy and security. This becomes a particular concern in academic environments. Many universities and colleges do not have sufficient resources to hire properly trained staff, purchase up-to-date security resources, and keep information properly protected. Worse, academic sites often function using outdated hardware and software, running non-standard configurations, and in an environment where proper security controls are seen as hindering scientific inquiry. However, as can be seen by the examples given above—and many other similar scenarios—the lack of proper controls can also lead to damaged reputations, lost opportunities, hurt feelings, and even legal penalties.

Advice

It is beyond the scope of this article to give a comprehensive tutorial in the issues surrounding the appropriate protection of personnel information. However, the following are worth consideration, both in the general case and specifically for personnel issues:

1. Organizations should have a defined set of policies governing any online forum, WWW

pages, or database of personnel-related information. This should include coverage of procedures and restrictions on the transmission, collection, and use of the data. Users of these systems should be regularly reminded of the policies and the reasons for their existence.
2. Caution should be exercised as to what to put on line instead of remaining paper-based. A software security flaw, network break-in, or virus cannot damage or disclose paper contents.Although it may seem more convenient to use online mechanisms, there is an increased risk of loss—and often that risk and loss are both dramatically more severe than would be the case using well-understood physical mechanisms.
3. Letters with confidential or sensitive content should be encrypted if they must be sent or stored electronically (e.g., using PGP). However, postal mail, courier services, and faxes are still reliable methods of delivery that are far less prone to exposure of material to an unintended audience.
4. Administrative computing should be performed on systems separate from those used for general use and research. These machines should be configured with greater security constraints, and should be

placed behind their own firewalls.
5. Access to sensitive data in WWW pages or databases should require, at a minimum, a password. Use of SSL/TSL on WWW servers, and Kerberos or SSH for interactive connections, should be considered as minimum safeguards.
6. University counsel should be consulted to determine exposures and regulations concerning the placement and dissemination of personnel information. In particular, careful consideration should be given issues regarding the various fair employment and ADA acts, HIPPA (Health Information Privacy Protection Act), and any state laws governing public records ("sunshine laws"—note that online discussions in a list may constitute a "meeting" under some laws, and thus eligible to be made available to the press and public). Systems with student information may also be covered by FERPA (Family Educational Right to Privacy Act).
7. Management should ensure that the staff maintaining the systems are competent and well trained. Security and maintenance functions should be adequately funded, rather than covered as a secondary issue—if at all. It is almost

always unwise to have students or faculty charged with maintaining machines that may contain sensitive information about them or their peers.
8. All critical systems and files should be backed up regularly. The backups should be tested periodically to ensure that they work properly. Access to the backups should be regulated, now and in the future (and possibly encrypted to prevent access if they fall into the wrong hands). A defined procedure should be in place to govern safe disposal of the backups when they are no longer used.
9. A great deal of software currently in use has not been designed with good security practices in mind. Furthermore, much of the software in widespread use today has continued to evolve for additional functionality, but with insufficient care given to meaningful quality assurance. Thus, it is important to stay current with the latest patches and advisories, and to design defense-in-depth strategies to protect against flaws as yet unreported that may lead to compromises.
10. Sending (or accepting) documents in formats that readily support the spread of

Research Collaboration

I begin by looking at research collaboration between universities and industry, using co-authored papers as an indicator. For this purpose, papers are counted as co-authored if the addresses of more than one institution are listed. Of course, simply counting the number of addresses on papers will not produce an accurate indicator here because, for example, different departments of one institution will appear as separate addresses. To overcome this, CHI has examined the addresses listed on all U.S.-authored papers indexed in the SCI to unify departments to single institutions and to identify address variants with known institutions. Institutions are also classified into sectors, and the graphs report numbers at the sectoral level.

Figure 1 plots the number of papers that list both universities and companies in the authors' addresses to determine the number of university-industry collaborative papers. The number of papers rose steadily between 1988 and 1996, with a slight downturn in 1997. This downturn reflects a larger phenomenon that is not specific to collaborative papers. The figure reflects quite strong growth in university-industry collaboration.

How important are collaborative papers to universities and to companies? Figure 2 plots collaborative papers as a share of both university and industry papers. For universities, the collaborative papers have increased from 4 percent to 6 percent of their output. This is a real increase, but perhaps is not as large as one might expect given all the discussion of university-industry collaboration. On the other hand, from the perspective of industry, the number of papers involving collaboration with universities has risen from 31 percent to 44 percent of their output. Of course, from industry's perspective their output of papers is nowhere near as significant as their output of patents. No doubt the share of collaborative work is higher for industry because university researchers, operating under strong incentives to publish, publish everything they can. Industry researchers tend to have less time to write and are more likely to publish if a university collaborator writes the paper.

However, collaboration between researchers working in universities and companies is only part of the story of increased networking in research. Figure 3 broadens our perspective by plotting the share of papers produced collaboratively among researchers at different institutions. The percentage shares of both company and university papers are plotted. At one time the rate at which university researchers collaborated exceeded the rate at which corporate researchers collaborated on published research. That changed in the 1990s as corporate researchers increased their collaborative activity

more rapidly. Currently the rate at which company researchers collaborate substantially exceeds the rate of collaboration for university researchers.

It is clear that by 1988 more than half of both company- and university-authored papers were produced by researchers collaborating across institutional boundaries, and collaboration has only increased since then. The 50-percent mark is quite significant in a way. When that point was passed, inter-institutional research collaboration became the rule, not the exception. The idea of the lone researcher has long been unrealistic in most fields; now the idea of the research group, working at a single institution, is less and less fundamental. Rather, one should increasingly think of the productive unit of research as the cross-institutional network, bringing to bear skills and resources from more than one institution to advance the frontiers of knowledge. Of course, the rate of collaboration varies across fields, and in some areas institutional collaboration may not yet exceed 50 percent of papers. However, the trend is always the same—toward increased collaboration and greater team size. Thus, at some point in the not-too-distant future, most areas will pass the 50-percent mark.

How does collaboration with industry affect the quality and nature of university research? Figures 4, 5, and 6 address this issue. Figures 4 and 5 use citation counts as a partial indicator of the impact of research, and compare university-*industry* collaborative papers with university-*university* collaborative papers and with single university papers. Citations to papers were counted in the second to fifth years following publication for papers published between 1981 and 1992.

Figure 4 plots the average citations per paper. Between 1981 and 1992, university-industry collaborative papers were, on average, cited more often than were collaborations between researchers at different universities; the latter, in turn, were cited more often than papers produced by researchers working at single universities. This suggests that for a university research group, whose goal is to maximize the citation impact of their research, choosing to work with an industry researcher would be better than working with another university group or working alone.

But surely this cannot be true. It must be different for the really important papers, the most highly cited work. Figure 5 examines this question by counting the number of papers among the most cited 1,000 papers in each year from 1981 to 1992, and normalizing for the size of the publishing pool. The results indicate that more than three of every 1,000 university-industry collaborative papers were found among the most-cited 1,000, while less than two of every 1,000 single university papers were so well cited. This suggests that, indeed, working with an industry partner
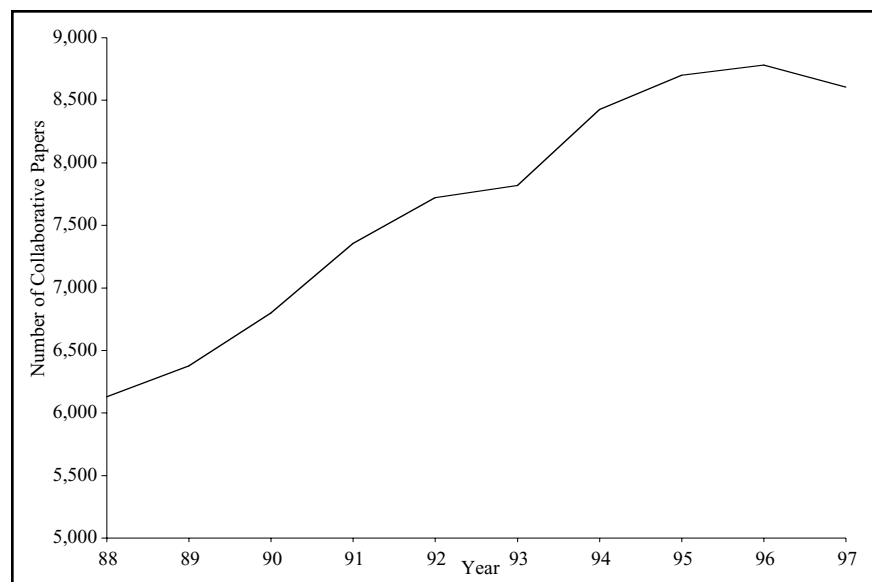
Figure 1. Growth of University-Industry Collaboration 1988-1997
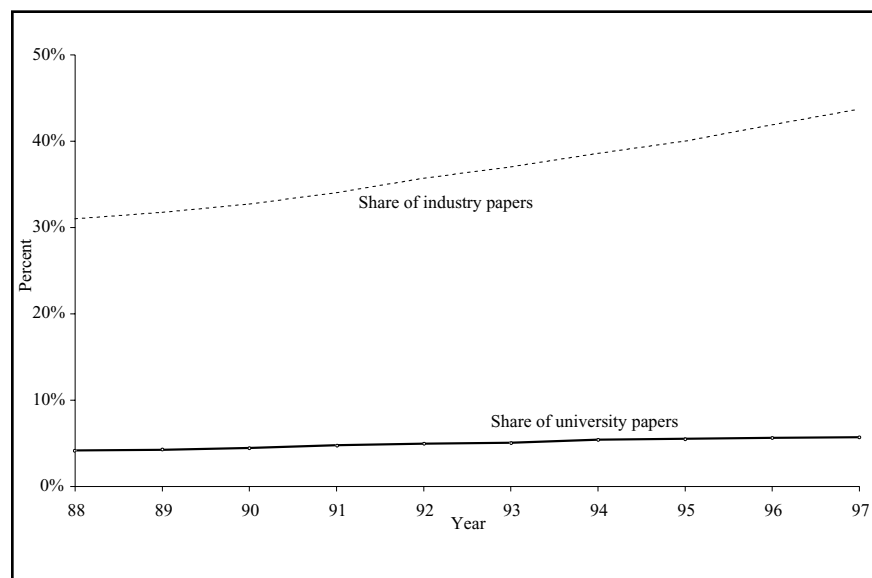

Figure 2. Collaborative Papers As a Share of University and Industry Papers 1988-1997
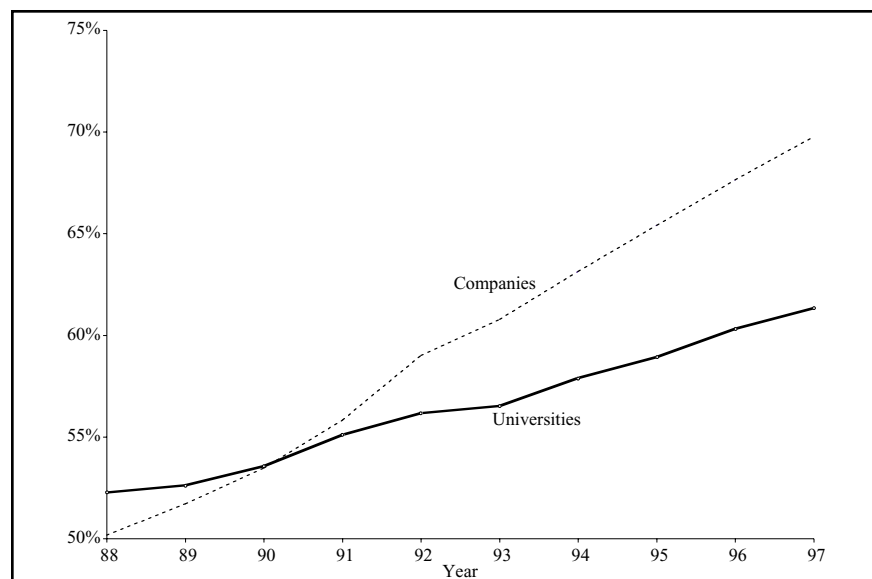

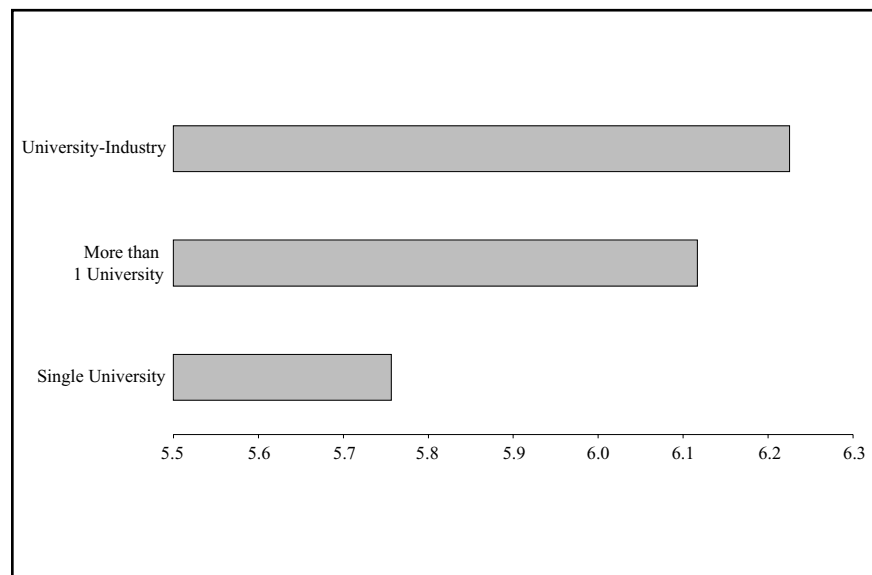Figure 3. Share of Papers Produced Collaboratively at Different Institutions 1988-1997

Figure 4. Average Citations Per Paper 1981-1992, 4-Year Lagged Window

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Budget from Page 1

Over the past month, Congress has reacted strongly to the lack of an appropriate increase in the NSF budget proposal. As a result, the Administration has begun a review of NSF's needs and opportunities to determine whether significant increases are warranted in the future. The review will also look at ways to ensure that funds are managed well. The review is expected to be available in time for its results to be considered for the FY 2003 budget proposal.

NSF Research. NSF's total support for research would shrink by about one-half a percent in FY 2002. Nearly every program within the research directorates would suffer cuts. Notable exceptions include two programs within the Mathematical and Physical Sciences directorate that would see double-digit increases: materials research facilities and mathematical sciences, which is the subject of a new NSF initiative in FY 2002.

Computer and Information Science and Engineering. The total CISE budget request is $470 million, a decrease of about $7 million, or -1.6

percent, below estimated FY 2001 spending. All major activities of the CISE Directorate would suffer at least slight decreases in their budgets for FY 2002, except for the Information Technology Research category, which would be held flat.

FY 2002 plans for the ITR initiative include research enabling the next generation of Cyber Infrastructure to build on successes in high-performance computing and communications. The NSF budget documentation says this line of research "will make possible the full integration of high-volume data resources, high capacity storage, and new techniques enabling users to use and understand information… (and) will create technologies for advances in computational science, education, universal access to cultural resources, and other uses." Focus areas include human augmentation research, research at the interface of biology and information technology, and security and reliability for computer, communication, and information systems.

Figures and analysis for additional agencies will appear on CRA's website when available (http://www.cra.org/govaffairs/budget/). ∎

Transitions and Announcements

CRA board member, **Sandra Johnson Baylor,** Manager of IBM's WebSphere Database Development at its Silicon Valley Laboratory, was featured on the March 2001 cover of *Black Enterprise.* Dr. Baylor is a research division master inventor at IBM and was part of the design team that developed the prototype for IBM's Deep Blue.

Francine Berman was appointed director of the San Diego Supercomputer Center and the National Partnership for Advanced Computational Infrastructure (NPACI), effective February 23, 2001. Dr. Berman, a professor of computer science and engineering at UCSD since 1984, has worked in high-performance computing for 20 years and was involved in the early development of both SDSC and NPACI. She is a long-time member of CRA's Committee on the Status of Women in Computing Research (CRA-W).

Sid Karin, former director of SDSC and NPACI, will serve as a strategic advisor to the SDSC director and as a consultant to the chancellor on computing and communications issues. He will continue as a professor of computer science and engineering at UCSD. Dr. Karin was honored on March 29, 2001 as "Entrepreneurial Supporter of the Year" at STARCOM 2001 as the founding director of SDSC and for the far-reaching economic, educational, and scientific benefits that have flowed to the region as a result of his efforts.

Daniel A. Reed, director of the National Center for Supercomputing Applications (NCSA) and the National Computational Science Alliance has been named a recipient of the Gutgsell Professorship by the University of Illinois at Urbana-Champaign. The professorship was established in 1998 to recognize some of the most distinguished senior faculty members on the Urbana-Champaign campus. Reed, who chairs the Department of Computer Science at UIUC, is a CRA board member and chairs its government affairs committee.

The Ohio State University has announced that **Joel H. Saltz** has been appointed chair of its new Department of Medical Informatics. Dr. Saltz has an M.D. in pathology and a Ph.D in computer science, both from Duke University. Saltz holds a dual appointment as senior fellow at the Ohio Supercomputer Center, and appointments in the Department of Pathology and Department of Computer and Information Science. He also will serve as chief information officer and associate vice president for health sciences, and will also continue in his role as leader of NPACI's Programming Tools and Environments thrust area.

William A. Wulf has been re-elected President of the National Academy of Engineering, a position he has held since 1997. His six-year term will begin July 1, 2001. Dr. Wulf is on leave from the University of Virginia where he holds the AT&T Chair in Engineering and Applied Sciences. A distinguished computer scientist, Wulf has been assistant director of the National Science Foundation; chair and chief executive officer of Tartan Laboratories Inc., Pittsburgh; and professor of computer science at Carnegie Mellon. ∎

CRA Workshop

The next **CRA *Effective Teaching and Academic Careers Workshop*,** designed to aid graduate students and junior faculty as they choose or begin their careers, is tentatively scheduled for **February 10-12, 2002 in Arlington, Virginia**

Table 2. Total NSF Funding by Major Category
(in millions of US$)

Category	Estimate FY 2001	Proposed FY 2002	Proposed FY01–02 % change
Research and Related Activities	$3,342.63	$3,326.98	-0.5%
Education and Human Resources	785.62	872.41	11.0%
Major Research Equipment	121.33	96.30	-20.6%
Administrative Expenses	166.81	176.80	6.0%
Total NSF	**$4,416.39**	**$4,472.49**	**1.3%**

Table 3. NSF Funding by Initiative
(in millions of US$)

Initiative	Estimate FY 2001	Proposed FY 2002	Proposed FY01–02 % change
Biocomplexity in the Environment	$54.88	$58.10	5.9%
Information Technology Research	259.43	272.53	5.0%
Nanoscale Science and Engineering	149.68	173.71	16.1%
Learning for the 21st Century	121.46	125.51	3.3%

Table 4. Research Funding by NSF Directorate
(in millions of US$)

Directorate	Actual FY 2000	Estimate FY 2001	Proposed FY 2002	Proposed FY01–02 % change
Biological Sciences	$418.3	$485.4	$483.1	-0.5%
Computer & Information S&E	388.6	477.9	470.4	-1.6%
Engineering	379.8	430.8	431.0	0.0%
Geosciences	487.6	562.2	558.5	-0.6%
Math & Physical Sciences	755.9	850.8	863.6	1.5%
Social, Behavioral, & Economic Sciences	162.1	164.4	163.2	-0.8%
Integrative Activities	129.3	97.75	80.6	-17.5%

Table 5. NSF Computer and Information Science & Engineering Budgets
(in millions of US$)

Division	Actual FY 2000	Estimate FY 2001	Proposed FY 2002	Proposed FY01–02 % change
Computer-Communications Research	$60.24	$65.49	$64.39	-1.7%
Information and Intelligent Systems	41.43	48.84	48.02	-1.7%
Experimental and Integrative Activities	57.84	60.95	57.81	-5.2%
Advanced Computational Infrastructure and Research	78.01	81.60	80.22	-1.7%
Advanced Networking Infrastructure and Research	60.66	65.55	64.44	-1.7%
Information Technology Research	90.39	155.48	155.48	0.0%
Total CISE	**$388.57**	**$477.90**	**$470.36**	**-1.6%**

Distributed Mentor Project Students Announced

CRA's Committee on the Status of Women in Computing Research (CRA-W) has announced that 29 students have been selected to participate in the 2001 Distributed Mentor Project (DMP).

The DMP project (www.cra.org/craw/dmp), which receives funding from NSF, is a mentoring program for undergraduate women in computer science. Its objective is to increase the number of women entering graduate school in computer science and computer engineering. The project brings together undergraduates and professors for a summer of research at the mentor's research institution. Students are involved in research, learning how a research university operates, interacting with graduate students and professors, and working with successful researchers. Since its inception in 1994, this project has reached more than 140 women, and more than 53 percent of the participants have enrolled in graduate school.

Students selected include: Heballa Al-Zahawi (Utah), Roksolana Antonyuk (Clarke), Jennifer Bedell (Duke), Emily Chung (UC Berkeley), Danielle Dees (Georgia Tech), Julia Farago (Harvard), Rachel Fithian (Princeton), Rebecca Flannery (Texas A&M), Lauren Foutz (RPI), Christine Groce (Clarke), Esther Gubbrud (Carleton), Alice Hagens (Dartmouth), Rebecca Hutchinson (Bucknell), Krista Janssen (Bethel), Kristen LeFevre (Dartmouth), Susan Lin (UC Berkeley), Victoria Manfredi (Smith), Cynthia Mattingly (St. Mary's-of-the-Woods), Laura McGlade (Delaware), Shawna Miller (Texas A&M), Jean Mohammadi-Aragh (Mississippi State), Jessamy Ofcarcik (Greenville), Sarah Osentoski (Nebraska, Lincoln), Angela Reese (Dayton), Kathleen Repine (Rose-Hulman), Sandy Roberts (Beloit College), Laura Slaybaugh (Rose-Hulman), Beth Tsai (Swarthmore), and Clarissa Tuttle (Utah).

Active CRA Programs for Labs and Centers

Although many of CRA's programs are of interest to industrial members, we have a specific set of activities directed toward this group and others interested in what is going on in industry. This article summarizes activities currently underway or planned in the future.

Industrial salary survey. Each fall, CRA collects salary data for researchers at industrial and government laboratories and research centers. The survey includes data about salaries for new employees and those at five-year intervals of experience. Complete results are made available to the survey participants in January. Summaries and comparisons with faculty salaries are published in the following November's issue of *Computing Research News*, and are posted on CRA's website at www.cra.org/statistics/industrial/.

Company profiles. *Computing Research News* publishes an ongoing series of articles, each profiling one of CRA's industrial or government lab members. These articles are also posted on the CRA website at www.cra.org/reports/labs/. They highlight the programs, people, and accomplishments of the labs. Seven have appeared over the past eighteen months. In the fall, articles will appear featuring Fraunhofer CRCG and Panasonic.

Snowbird meeting. The CRA Conferences at Snowbird, Utah have been held every other summer since 1972 for department chairs, laboratory directors, and other leaders from the computing research community in North America. For the past decade, there has been a track of plenary and breakout sessions directed at the interests of industrial-based researchers. The next Snowbird meeting will be held in July 2002.

Regional lab director meetings. In an effort to build the research community and to give lab managers a chance to meet and learn how other lab managers conduct their business, CRA has helped to develop regional meetings of lab directors. Groups meet every several months in San Francisco/San Jose, Boston, and New Jersey/New York. In April 2001, the Boston and New Jersey groups held a joint meeting at the Philips research labs in Briarcliff Manor, New York, with a lab tour, social program, and lecture by former Presidential Science Advisor Dr. Edward David.

Academic-industry agreements. Because of concern in both the academic and industrial sectors about the widely varying types of contracts used to regulate typical academic-industrial interaction in computing research, CRA has collected a set of agreements. A CRA committee with managers from both industry and academia has been formed to draft model agreements. These model agreements will cover such typical issues as sponsored research, faculty members consulting in industry, and student internships.

Industrial career workshops. Over the past few years, CRA and its women's organization (CRA-W) have held a series of well-received and well-attended career workshops for advanced graduate students and recently hired faculty. The workshops

> CRA is pleased to welcome
>
> **Avaya**
>
> as an industry lab member

With this research effort, we seek to explore the role that non-traditional educational pathways play in the education of IT professionals in general, and in particular in preparing underrepresented minorities and women for IT careers. When we refer to non-traditional pathways, we are referring to the choices that students make in their pursuit of an IT/CS bachelor's degree. Have they chosen the most traditional route of entering college right out of high school, attending full time for four or five years, and graduating with a B.A. or B.S. at 22 to 24 years of age? Or have they instead begun their education later in life (after age 20) and taken longer to finish (6+ years)? There are many other concepts we might want to add to this when defining a non-traditional student or pathway—such as distance learners, weekend learners, second degrees, etc.—but as a starting point we begin with this definition.

The study concentrates on a specific region (the Maryland, DC, Virginia triangle). It proposes to survey recent IT/CS bachelor's degree graduates, the top producers of IT/CS bachelor's degrees in the area (26), and area employers of IT/CS workers (25). Data gathering for this study will be undertaken in three parts. The first is a longitudinal survey of May 2000 IT/CS bachelor's degree recipients. The survey will track these graduates over a three-year period and will ask them questions about their experiences before and while pursuing their bachelor's degree, and their employment status after receiving their degree. The second part will involve onsite visits to the degree-granting institutions for in-depth interviews with faculty and students. Finally, a third data-gathering activity requires onsite interviews with local area employers and employees.

At this point we have many more questions than answers and so, in lieu of answers, we share some of these questions with you here.

1. Are women and minorities more likely to choose less traditional educational pathways to an IT/CS degree, and if so, why?
   - Are they simply looking for formal educational credentials to enhance employment experience?
   - Are they attempting a career change that will take advantage of a perceived higher-wage labor market?
   - Do they have a burning personal interest in IT, but were unable to pursue it under more "traditional" circumstances?
   - Did or do life situations make traditional educational options out of reach, or out of the question?
   - How do they perceive their education in their chosen institutions? What attracted them in the first place? Do they have the same goals and expectations as students who pursue degrees along traditional pathways?
2. What will this choice mean for their futures?
   - Will they succeed in turning their education into high-paying, high-responsibility IT/CS jobs?
   - Will their degrees be valued by their employer or future employers the same as the degrees of more "traditional" students?
   - Will the women and minorities who choose non-traditional degree pathways remain in the most vulnerable sectors of the job market? Will they be the first to be laid off or to become obsolete as the field and the market change?
   - Will they be prepared to participate in lifelong learning as technology changes?
3. What are the differences in program and educational experiences between non-traditional and traditional students? Are students getting the same "product" or the same outcome?
4. Given the educational market dominance of educational institutions that cater to non-traditional students, have more traditional universities changed or adapted their foci in response? Should they?
5. To what extent have industry and IT/CS employers attempted to influence the output of educational institutions? Have they been involved in curriculum decisions?
6. Do employers discriminate between students who have chosen a non-traditional degree pathway and more traditional degreed students? If so, in what way?

Clearly there are many more questions, and at this point we are trying to incorporate all of them into our survey and interview instruments. We have also included in our research design significant avenues for the stakeholders to contribute to the design of our surveys and the interpretation of our results. It is of utmost importance that this is an interactive experience for all involved in order to produce meaningful results and policy recommendations.

Recent waves of downsizing in the IT/CS sector in the Washington, DC/Baltimore area have resulted in the layoff of 6,500 workers in the past five months, according to Washtech.com. Most recently, America Online downsized 7 percent of its workforce in the Northern Virginia area and WorldCom cut 8 percent of its workforce, including 400 jobs in the Washington, DC area. At this point, we don't have any idea what types of workers these companies are laying off—whether they are computer programmers or data managers, for example. Nor do we know if these layoffs portend a general decline in the IT/CS job market or if the current general weakening of the economy is having an inordinate impact on IT workers.

Our study will attempt to investigate current labor market trends, employer attitudes and needs, the adaptability of educational institutions to market trends, and the experiences of women and minorities with IT/CS bachelor's degrees from the various colleges and universities in the Washington, DC, Maryland, and Virginia areas. The goal of this project is to develop meaningful policy recommendations that will help government target those institutions and services that will most significantly impact women and minorities, and contribute to their increased participation in the IT/CS workforce.

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[5] National Science Foundation, WebCASPAR Database.

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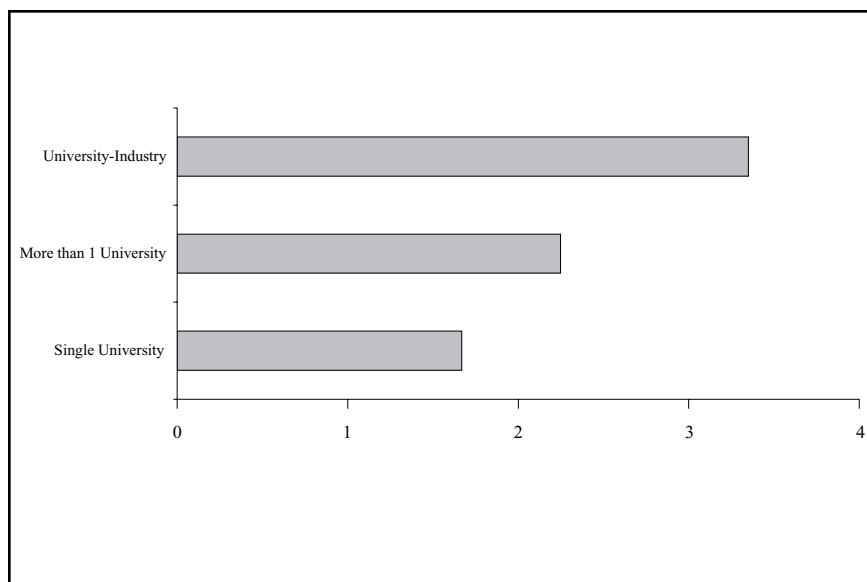|	
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Figure 5. No. of Papers Among the Most-Cited Thousand Papers
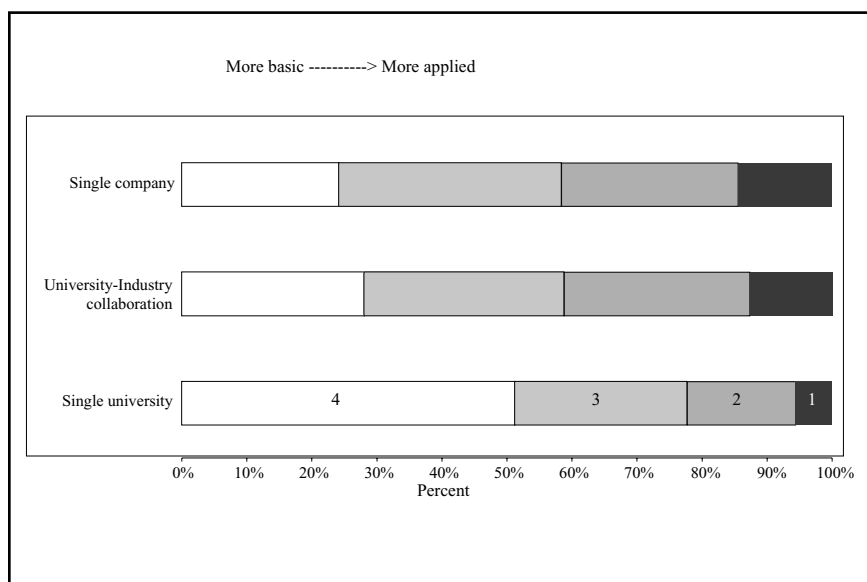Per Thousand Published
1981-1992
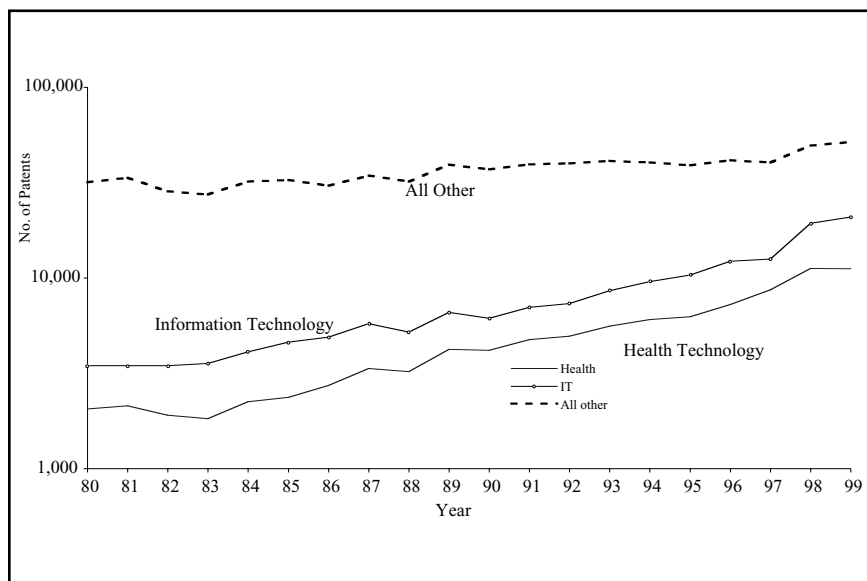

Figure 6. Basic vs. Applied Collaborative Research

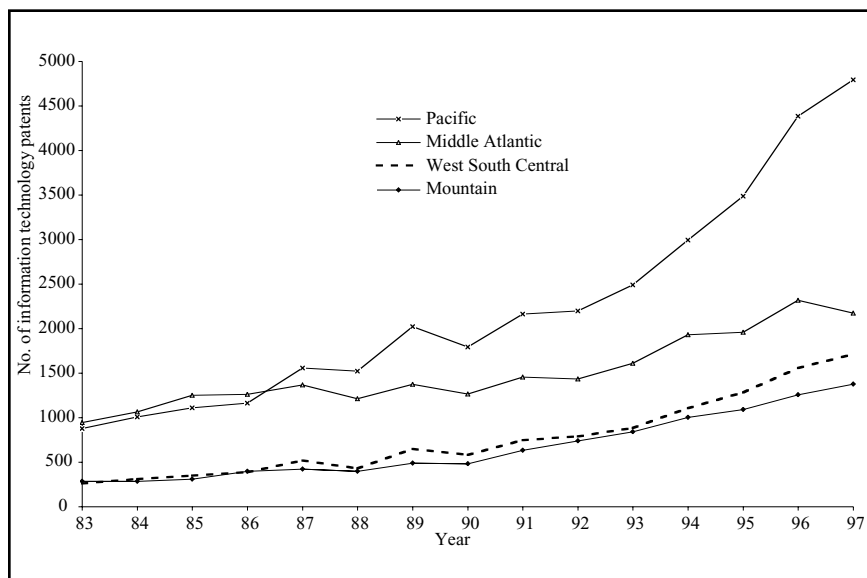Figure 7. Growth of Patenting in Information and Health Technologies
1980-1999

Figure 8. Number of Patents by Census Division
1983-1997

increases the chances that a paper will be highly cited.

Another important question is how working with industry affects the character of university research. Figure 6 addresses one aspect of this issue, namely, how basic is the research? CHI Research has classified the journals in the SCI into four levels, where level four represents research that is the most basic and level one includes research that is the most applied. Figure 6 plots the distribution of papers across these levels. University-industry collaborative papers are compared with two "pure" types, single company and single university. The figure suggests that there is a difference between single company and single university papers, in that single university papers are more basic in orientation. University-industry collaborative papers are only slightly different from single company papers in their basic-applied distribution. This suggests that industry shapes the agenda of collaborative work so that university researchers who work with industry undertake more applied work than they might otherwise pursue.

Overall, university researchers are collaborating more with everyone, including corporate researchers. In general, working with industrial researchers seems likely to be beneficial for the citation impact of the work, although it also tends to make the nature of the work more applied. Of course there will be variations in these patterns by field, but these will tend to be matters of degree. The life sciences will likely lead in these trends, with other areas following.

University Patenting

Examining patterns in scientific publishing provides insights into the evolution of how research is conducted. Similarly, examining patterns in patenting is one way to look at the evolution of technological innovation. Of course not all innovations are patented, and the propensity to patent varies by technology and can change over time. Likewise, not all areas of research are well represented by journal articles indexed in the *Science Citation Index*. Software has been an exemplar of both problems. Although patenting of software is increasing, coverage is not comprehensive as it is, for example, in the case of chemical or pharmaceutical innovation, both of which are well represented in the publication and patent databases.

Patenting in information technology is growing rapidly. Figure 7 illustrates this by comparing growth in information technology patenting with growth in patenting in health technologies and in all other technologies. (The scale is logarithmic so that equal rates of growth appear as equal slopes.) Information technology here comprises semiconductors and electronics, computers and telecommunications. Health technology comprises pharmaceuticals, biotechnology, medical electronics, and medical equipment.

This growth in patenting has a distinct geographic component. Figure 8 plots the number of patents by census division for the divisions with the fastest growth in information technology patenting. (The Census Bureau divides the country into nine groups of states called divisions.) The growth in the Pacific region, which seemed to really take off in the late 1980s, is striking. The Middle Atlantic division (New York, New Jersey, and Pennsylvania) is interesting because it used to produce more information technology innovation than the Pacific division (California, Nevada, Oregon, Washington, Alaska, and Hawaii). This was in the heyday of Bell Labs and IBM, of course. The graph illustrates how the center of gravity of information technology innovation has shifted. Two other divisions demonstrate rapid rates of growth in information technology patenting, particularly in more recent years. These are the West South Central division (Texas, Oklahoma, Arkansas, and Louisiana) and the Mountain division (Colorado, New Mexico, Arizona, Utah, Idaho, Wyoming, and Montana). It is possible the West South Central region has by now overtaken the Middle Atlantic.

There is a sectoral component to the growth in patenting as well. Universities are increasing their patenting activities, a fact that has not gone unnoticed by the government and the public. University patenting is concentrated in the health technologies. Has information technology been affected? Figure 9 addresses this question, examining the number of information technology patents, on a logarithmic scale, produced by companies, universities, and government laboratories. University patenting in information technology is growing quickly, but not as quickly as company patenting. And the number of university patents remains two orders of magnitude below the number of company patents.

At the same time, the overall quality of university patents, as measured by citations from other patents, has been dropping. This is illustrated in Figure 10, which plots CHI's Current Impact Index (CII). The CII measures the number of times the previous five years of patents are cited in the current year, relative to all patents in the U.S. patent system. A value of 1.0 represents average citation frequency; a value of 2.0 represents twice-average citation frequency; and 0.25 represents 25 percent of average citation frequency.

The university CII has been steadily dropping, suggesting that perhaps universities are increasing their propensity to patent by patenting more minor innovations than they would have in earlier years. In contrast, industry CII has been rising. Nevertheless, the university CII in information technology remains high and still exceeds the industry CII, which is not true of other areas such as health technology.

Patents Referencing Papers

Scientific research and technological innovation have drawn closer in recent years. One piece of evidence might be the increasing tendency for U.S. patents to reference scientific papers as prior art.[1] The term "scientific papers" refers to papers in scholarly journals. Such referencing has increased markedly in recent years, most especially pharmaceutical and biotechnology patents referencing life sciences papers.[2] However, the growth in referencing to scientific papers is not confined to the life sciences, as Figure 11 shows. Each of the three areas comprising our definition of information technology saw increased referencing from patents to papers. By 1995, a telecommunications patent on average referenced one scientific paper, and semiconductors and computer patents were getting close to averaging two references to scientific journal articles per patent. This suggests that increasingly research may be closely linked to innovation, especially in semiconductors and computers.

This close relationship is especially visible in university patents. Figure 12 plots the average number of references to scientific literature over time and by institutional sector. University patents reference much more scientific literature, on average six papers per patent by the late 1990s compared with the one paper referenced by company patents. University researchers, oriented more towards the literature and advancing general knowledge, no doubt are more aware of literature that can be cited and presumably innovate closer to the scientific frontier.

Conclusions

Many long-term and quite fundamental changes are underway in the scientific and technical enterprise. Research is becoming more collaborative, although institutional boundaries must be overcome and differences between institutions must be resolved along the way. For example, university and industry researchers differ in the emphasis they place on basic research. Their joint research tends to be more oriented to application than university researchers would produce working by themselves. Such compromises seem well worth the effort, judging by the evidence that collaborative papers, and especially papers produced by university and industry partners working together, are more highly cited.

Innovation in information technology has blossomed, along with innovation in health technologies. This has been accompanied by a shift in the innovative center of gravity westward, away from the East Coast and towards the Rocky Mountains and West Coast. At the same time, patenting by universities has increased, although at some cost to the overall quality of their patent portfolios. University patents seem quite reliant on prior art in the scientific literature, although even corporate patents are increasingly referencing papers and now average at least one reference to a journal article.

If there is a unifying theme in all this it is increasing overlap. The blurring of the lines between science and technology, visible in the increasing referencing from technology to science, suggests that there might be increased common ground between university and company researchers and therefore more fruitful opportunities for collaboration. The closeness of science and technology also encourages universities to move more aggressively into patenting, which in turn blurs their traditional role of generating public knowledge. These changes are long term and gradual. While in total they might be viewed as revolutionary, the process moves forward over years or decades and can more appropriately be described as evolutionary.

References:

[1] For a full methodological discussion of this, see D. Hicks, A. Breitzman, K. Hamilton, and F. Narin, "Research Excellence and Patented Innovation," *Science and Public Policy*, 27(5), 310-320, 2000.
[2] Francis Narin, Kimberly S. Hamilton, and Dominic Olivastro, "The Increasing Linkage Between U.S. Technology and Public Science," *Research Policy*, 26 (3), 317-330, 1997.

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The analysis underlying this article was conducted for the National Science Foundation as part of their Science and Engineering Indicators effort. ∎
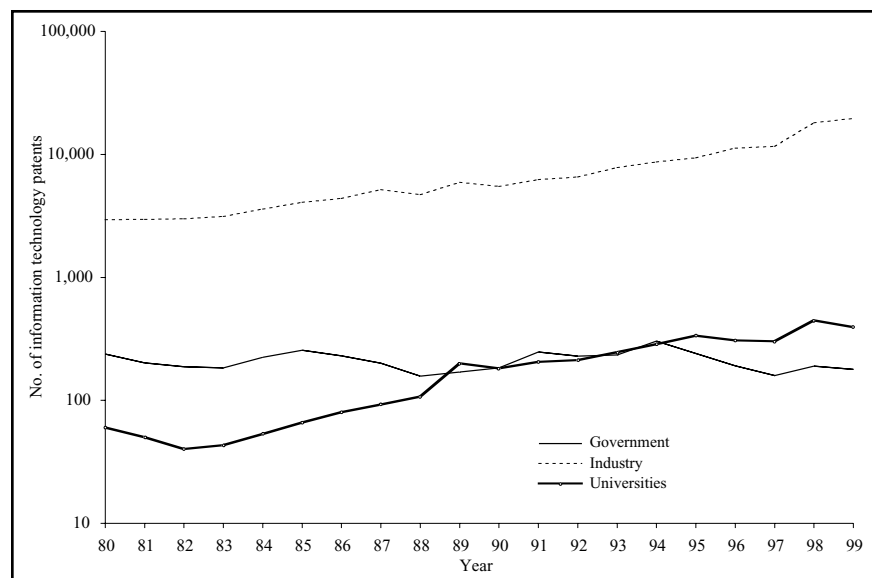

Figure 9. Number of IT Patents Produced by Government, Industry, and Universities 1980-1999
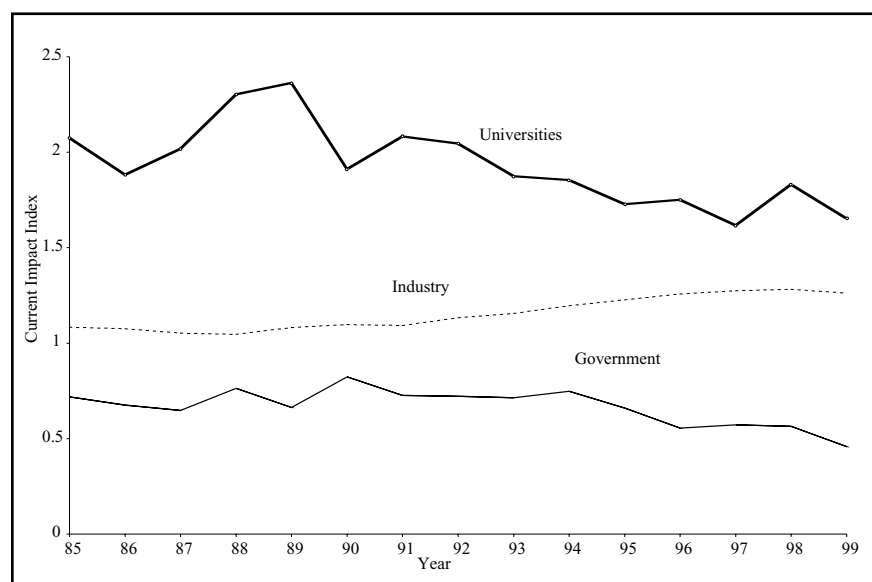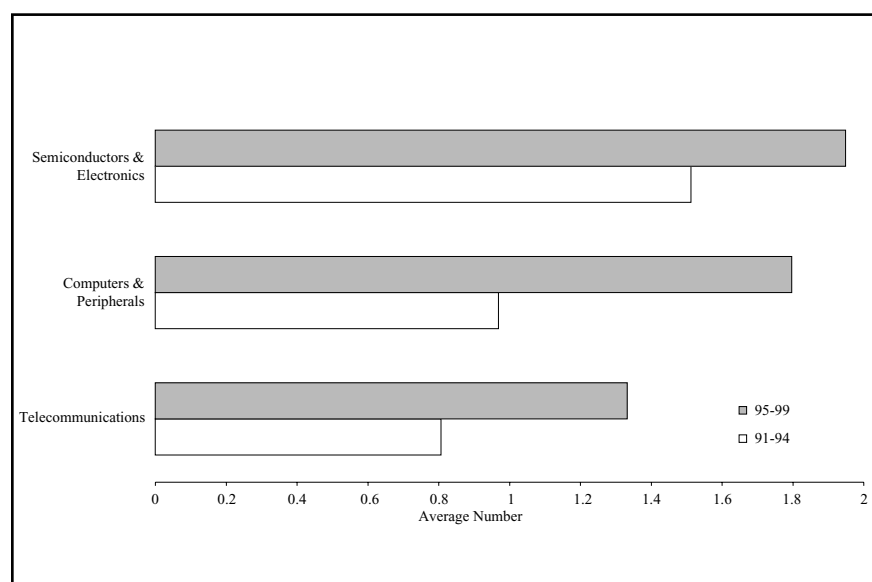

Figure 10. Quality of Patents 1985-1999

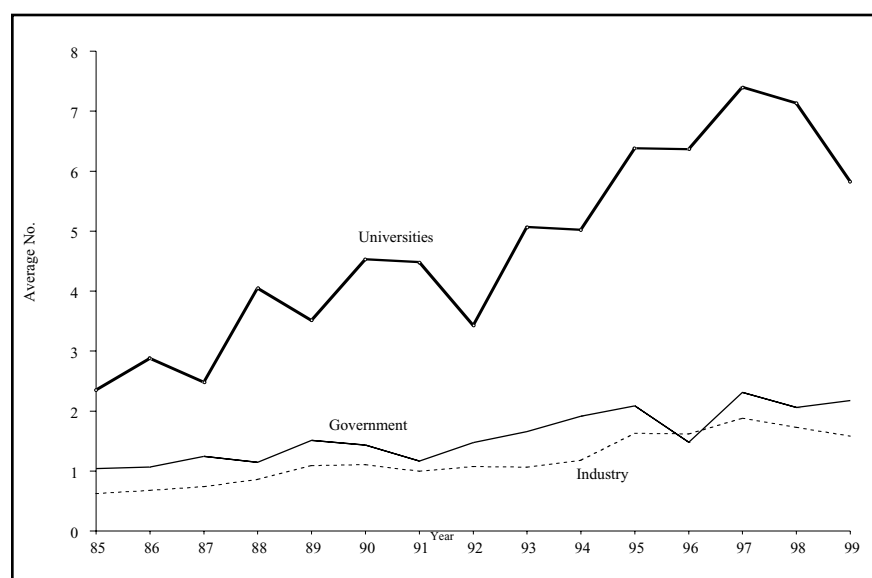Figure 11. Average Number of References to Journal Articles Per Patent 1991-94 and 1995-99

Figure 12. Average Number of References to Scientific Literature 1985-1999

computer viruses is a bad idea, and should be strongly discouraged. Microsoft Word is particularly notorious as a vector of macro viruses; as a conservative practice, Word documents should not be sent nor accepted as an attachment in email. Executables, including files in Visual Basic, should also be discouraged.

11. Anti-virus software should be installed on critical computers, and the virus definitions

It is beyond the scope of this article to provide detailed instructions on how to secure all web servers or other computing platforms. There are many security measures that should be taken depending on policy, platform, time, and personnel availability. As a start, lists of security tools and practices can be found via the CERT/CC site <http://www.cert.org> or the CERIAS hotlist <http://www.cerias.org/hotlist/>. SANS also offers pointers to useful resources and patches <http://www.sans.org/>.

One good book on security of web servers is *Web Security & Commerce* by Simson Garfinkel and Gene Spafford, published by O'Reilly and Associates, June 1997.

kept up to date. This is especially important for Windows-based systems, which are the target of choice for most known viruses.

Concluding Remarks

No matter the cause of disclosure, the responsibility for protecting sensitive data lies squarely with the people charged with maintaining the data involved. If the data are poorly protected, or handled carelessly, then it is a matter of negligence. A hacker or program fault may be to blame, but the people maintaining the data bear the responsibility. For that reason, it is vital that proper precautions be taken to protect the data in our care. This includes data relating to our students and staff, as well as our faculty and candidates.

It is almost always faster and cheaper in the near term to do things in an unsecure fashion. However, as a profession, we should be setting good examples for others, even if this involves expending more resources and devoting more time to management. Within the CS/CE context, these issues are critical if we wish to maintain our peers' confidence in our ability to execute our administrative functions correctly and fairly within our institutions. Within the broader context of society, they reflect on fundamental issues in the construction of tomorrow's societal infrastructure in a secure and enduring form. As such, we should all be concerned that these systems be built—and used—correctly.

Gene Spafford is Professor of Computer Sciences at Purdue University and an ACM representative on CRA's Board of Directors. ∎

Call for Participation

Richard Tapia Celebration of Diversity in Computing Symposium 2001

October 18-20, 2001
Houston, Texas
www.sdsc.edu/Tapia2001

The Richard Tapia Celebration of Diversity in Computing Symposium 2001 is designed to highlight the technical contributions and career interests of people of color in computing fields. Symposium presenters are leaders in their respective fields, representing academic, industrial, and government communities. Current research on leading-edge topics will be presented by invited speakers and during poster sessions. Tailored panels will focus on the roles of people of color in today's technology fields. Special events will provide networking opportunities. Students and their advisors are strongly encouraged to attend.

Deadlines:

Applications for scholarships to attend: **June 15, 2001**

Poster submissions: **July 15, 2001**

Registration: **August 30, 2001**

CRA Conference at Snowbird
July 14-16, 2002

NAE Elects New Members

The National Academy of Engineering (NAE) has again elected members of the computer science and engineering community to the Academy. NAE President William A. Wulf made the announcement on February 16.

This honor is reserved for those who have made "important contributions to engineering theory and practice, including significant contributions to the literature of engineering theory and practice," and those who have demonstrated "unusual accomplishment in the pioneering of new and developing fields of technology."

This year the Academy elected 74 engineers and eight foreign associates to membership in the Academy. This brings the total U.S. membership to 2,061 and the number of foreign associates to 154.

NAE new members in computer science and engineering and related fields include:

Steven Bellovin, technical leader, AT&T Labs - Research, Florham, N.J. For contributions to network applications and security.

Dimitri P. Bertsekas, professor of electrical engineering and computer science, Massachusetts Institute of Technology, Cambridge. For pioneering contributions to fundamental research, practice, and education of optimization/control theory, and especially its application to data communication networks.

Mark E. Dean, vice president and fellow, systems research, IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y. For innovative and pioneering contributions to personal computer development.

Jack G. Dongarra, distinguished professor, computer science department, University of Tennessee, Knoxville. For contributions to numerical software, parallel and distributed computation, and problem-solving environments.

W. Daniel Hillis, founder, Applied Minds, Glendale, Calif. For advances in parallel computers, parallel software, and parallel storage.

Thomas S. Huang, professor, department of electrical and computer engineering, University of

Illinois, Urbana-Champaign. For contributions to the theory and practice of image compression, retrieval, and analysis.

Barry C. Johnson, senior vice president and chief technology officer, Honeywell International, Morristown, N.J. In recognition of technical and strategic industry leadership in semiconductor devices, processes, and packaging technologies.

Sangtae Kim, vice president and information officer, Eli Lilly and Co., Indianapolis. For contributions to microhydrodynamics, protein dynamics, and drug discovery through the application of high-performance computing.

Raymond C. Kurzweil, founder, chairman, and chief executive officer, Kurzweil Technologies Inc., Wellesley Hills, Mass. For application of technology to improve human-machine communication.

Edward D. Lazowska, professor and chair, department of computer science and engineering, University of Washington, Seattle. For leader-

ship and contributions to computer performance evaluation and distributed systems.

Nancy A. Lynch, NEC Professor of Software Science and Engineering, Massachusetts Institute of Technology, Cambridge. For the development of theoretical foundations for distributed computing.

John K. Ousterhout, chief scientist, Interwoven Inc., Sunnyvale, Calif. For improving our ability to program computers by raising the level of abstraction.

Sosale Shankara Sastry, director, electronics research laboratory, professor, electrical engineering and computer sciences, University of California, Berkeley. For pioneering contributions to the design of hybrid and embedded systems.

Guy Lewis Steele Jr., distinguished engineer, Sun Microsystems, Burlington, Mass. For contributions to the design, specification, and engineering of programming languages. ∎

Professional Opportunities

Bucknell University
Computer Science One-year entry-level visiting assistant professor (one or more)

Applications are invited for one or more one-year entry-level visiting assistant professor positions beginning mid-August, 2001. A Ph.D. in Computer Science or Computer Engineering is preferred, but individuals with substantial progress towards such a degree will be considered. A demonstrated interest in and promise of excellence in teaching is important. All research areas will be considered. Interest and ability to teach one or more of the core courses (computer organization, programming languages, operating systems, CSI, and CSII) should be indicated in the application letter. Salary and fringe benefits are competitive.

The computing environment for instruction, research, and laboratories consists of nearly 70 SUN workstations. For more information on our program visit our web page at www.eg.bucknell.edu/csci.

Applications will be considered as received and recruiting will continue until the position is filled. Candidates should send a resume, transcripts for all graduate work (Xerox copy acceptable), and the name of three references to:

Gary Haggard, Chair
Dept. of Computer Science
Bucknell University
Lewisburg, PA 17837
Bucknell encourages applications from women and members of minority groups (EEO/AA).

DePaul University
School of Computer Science, Telecommunications and Information Systems
Full-time Tenure-track Faculty Positions

The School of Computer Science, Telecommunications and Information Systems (CTI) of DePaul University invites applications for multiple tenure-track positions beginning September 2001. We welcome applications from outstanding applicants in all areas of specialization. CTI is a young and growing school in downtown Chicago, with a wide range of degree programs. B.S. programs include Computer Science, Computer Graphics and Animation, E-Commerce Technology, Human-Computer Interaction, Information Systems, and Network Technology. M.S. programs include Computer Science, Distributed Systems, E-Commerce Technology, Human-Computer Interaction, Information Systems, Management Information Systems, Software Engineering, and Telecommunication Systems. CTI also offers a Ph.D. program in Computer Science.

CTI currently has over 70 full-time faculty and a student body growing at a rate of 30% per year. By bridging faculty from several areas of computing and information technology and by placing them in the Loop — the heart of Chicago's business and financial district — DePaul has established a unique, dynamic, and entrepreneurial school. CTI rewards excellent teaching, provides strong support for research, and encourages creative applied scholarship. Because DePaul draws students of many backgrounds and cultures from a diverse urban setting, CTI is interested in recruiting and maintaining a diverse collection of faculty. Members of all underrepresented groups, women, veterans, and persons with disabilities are invited and encouraged to apply.

Computer Science faculty are actively pursuing research in a wide variety of areas, including artificial intelligence, computational complexity, computer vision, intelligent agents, databases, distributed computing, foundations of programming languages, graphics and human computer interaction, parallel and distributed algorithms, quantum computation, software engineering and software reliability. **Telecommunications** faculty are actively pursuing research in performance analysis of data networks, techniques for providing differentiated quality of service to Internet applications, formal methods in protocol development, simulation tools for network education, and distributed multimedia systems. **Information Systems** faculty are actively pursuing research in electronic commerce, technology-supported learning, group support systems, collaborative systems design, and IT strategy. Candidates should have a Ph.D. in a relevant field by the date of appointment. To apply, *complete the online application form* and send a curriculum vita, a research statement, a teaching statement and at least three letters of reference to:

Michelle Marchant
School of Computer Science
Telecommunications and Information Systems
DePaul University
243 South Wabash Avenue
Chicago, IL 60604-2301
E-mail: faculty_search@cs.depaul.edu
Electronic submission of documents is encouraged. Applications will be accepted until positions are filled.

DePaul University is committed to equality in educational and employment opportunities.

Duke University
Chair Search
Department of Electrical and Computer Engineering

The Department of Electrical and Computer Engineering, in the Pratt School of Engineering at Duke University, is seeking to fill the position of Chair. We are looking for a nationally and internationally recognized researcher and educator with a strategic vision of developing a dynamic department with strong interdisciplinary linkages to both the physical and biomedical sciences, and a strong commitment to promote the department's existing strengths in Computer Engineering, Controls, Electromagnetics, Microelectronics and MicroelectroMechanical Systems (MEMS), Photonics, and Signal Processing. The Department currently consists of 18 Faculty with an annual research budget in excess of 6.5M. The Pratt School of Engineering is committed to three interdisciplinary initiatives in Photonics and Communications, Biologically inspired Materials and Materials Systems, all of which involve faculty from the ECE Department to execute this vision. The Pratt School is planning an approximate 50% increase in faculty size and the construction of two new buildings which will more than double the existing space. Candidates should have experience in strategic research planning, and have the enthusiasm and motivation to lead a distinguished faculty. Enquiries or nominations can be made to the Search Chair. Applications will be reviewed upon receipt until the position is filled. Interested candidates should submit curriculum vitae and a list of three references to:

ECE Chair Search, c/o John Strohbehn
P.O. Box 90291
(for courier use Hudson Hall 130)
Duke University
Durham, NC 27708-0291
Tel. (919) 660-5253
FAX (919) 660-5293
Address email to: mak@ee.duke.edu
Our web address is http://www.ee.duke.edu
Duke University is an Equal Opportunity/Affirmative Action Employer.

Grinnell College
Visiting Assistant or Associate Professor of Computer Science

One- to three-year position as Assistant or Associate Professor of Computer Science in the Department of Mathematics and Computer Science starting Fall, 2001. Appointment can be adapted to meet the needs of faculty on sabbatical leaves. Ph.D. in computer science or a related field is preferred, with academic rank depending on experience (non-Ph.D. considered as Instructor). Department seeks outstanding teacher-scholar, regardless of specialty, with interests in innovative and effective teaching. Grinnell College, a highly selective liberal arts college, is committed to student-faculty research and is generous in its support of scholarship for regular and visiting faculty. Send a curriculum vitae, transcripts (copies acceptable), three letters of recommendation, and a statement describing your interest in teaching and scholarship in an undergraduate liberal arts environment that values diversity and emphasizes close faculty-student interaction. Address applications to:

Computer Science Search Committee
Department of Mathematics and Computer Science
Grinnell College
Grinnell, IA 50112-1690
or fax 641-269-4984
For more information, see http://www.cs.grinnell.edu/2001-cs.html, or send e-mail to cs-search@cs.grinnell.edu. Applications will be reviewed as they are received until the position is filled.

Grinnell College is an equal opportunity/affirmative action employer committed to employing a highly qualified staff which reflects the diversity of the nation. No applicant shall be discriminated against on the basis of race, national or ethnic origin, age, gender, sexual orientation, marital status, religion, creed, or disability.

Indiana University
Computer Science Department

The Indiana University Computer Science Department anticipates filling several tenure-track faculty positions beginning 2001-2002. Areas of interest are operating systems, distributed systems, networking, graphics and databases. In addition our new, privately endowed, IPCRES research center will be hiring several senior positions in the areas of distributed systems, networking, pervasive computing, security and graphics.

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

science related areas such as data mining and search technologies.

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

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

Please send a detailed CV and a list of references to:
Faculty Search Computer Science Department
Indiana University
Lindley Hall 215
Bloomington, IN 47405-7104
email: search@cs.indiana.edu
Indiana University is an Equal Opportunity/Affirmative Action Employer. The Computer Science Department strongly encourages applications from women and minorities.

WESTERN MICHIGAN UNIVERSITY

CHAIRPERSON
COMPUTER SCIENCE

Western Michigan University invites applications and nominations for the position of Chair of the Department of Computer Science. The Department offers Bachelor of Science, Master of Science and doctoral degrees in Computer Science. There are two undergraduate major options including the Theory and Analysis program that is accredited by the CSAB. The department also offers a number of introductory courses and minors in computer science. The department, currently housed in the College of Arts and Sciences, will join the College of Engineering and Applied Sciences in July 2001 and is positioned to move to a new level of excellence in its operations. For more information about the Department of Computer Science, please visit www.cs.wmich.edu and for more information about the College of Engineering and Applied Sciences, please visit www.wmich.edu/engineer.

The successful candidate will have an earned doctorate in computer science or a closely related discipline and possess distinguished record of professional accomplishments sufficient to qualify as a professor with tenure in the department. The successful candidate must have excellent interpersonal skills and have a clear vision of how a computer science department at a major university should be positioned for excellence in light of the computing and software issues and industries in the global environment. Administrative or supervisory experience preferred.

A new 270-acre campus for engineering and applied sciences is under construction. This site will include new college buildings, research facilities, and a Business, Technology and Research Park, which we anticipate will facilitate collaboration with industrial partners.

Western Michigan University enrolls 28,500 students in a broad range of curricula in seven academic colleges. It is one of four universities within Michigan listed nationally as a Carnegie Doctoral Research Extensive institution. WMU is located in Kalamazoo, a community midway between Chicago and Detroit with a metropolitan population of 230,000.

Nominations or applications, together with vita and names of three references, should be addressed to:

Professor Michael Atkins
Chair, Computer Science Search Committee
Western Michigan University
College of Engineering and Applied Sciences
2022 Kohrman Hall
Kalamazoo, MI 49008-5314

Review of applications will begin May 15, 2001 and will continue until the position is filled.

WMU is an equal opportunity employer. In addition, it has embarked upon a vigorous affirmative action program and encourages the application of qualified women and members of minority groups.

Professional Opportunities

Knox College
Department of Computer Science

The Department of Computer Science invites applications for a tenure-track position at any level (including instructor) to begin Sept. 1, 2001. We seek candidates with the potential for excellence in teaching and research in a liberal arts institution. While all areas of specialization will be considered, the following areas would be particularly complementary to the current faculty: software engineering, graphics and visualization, theory of computation.

Knox is a highly selective independent liberal arts college with students from 47 states and 41 countries. The college is consistently ranked as one of the "Best Values" among national liberal arts colleges in the *U.S. News & World Report* survey of quality and price in higher education. Small classes, a strong advising system, and an emphasis on independent research foster close student/faculty interaction. Please visit us at www.knox.edu for more information about the College, the department and our facilities.

To apply, please send a curriculum vitae, a letter detailing your interests and goals, and contact information for three references to:
Sahnny Johnson, Chair
Department of Computer Science
Knox College #67
Galesburg, IL 61401-4999
(e-mail: sjohnson@knox.edu).
Review of applications will begin as soon as they are complete and will continue until the position is filled.

Knox College is an affirmative action, equal opportunity employer. In keeping with its 164-year commitment to equal rights, the College particularly welcomes applications from individuals in under-represented groups.

Methodist College
Computer Science Instructor

Methodist College, an Equal Opportunity Employer, is seeking applications for one full-time position in Computer Science (starting in Fall 2001) in the Department of Mathematics and computer Science. Masters Degree in Computer Science required; doctorate preferred. The position is open to all areas of Computer Science. Responsibilities include teaching lower and upper level Computer Science courses. In addition, the candidate is expected to help with various duties including the maintaining of the computer systems within the department. Methodist College, in harmony with its tradition, takes seriously its role in the ethical and moral development of students. Members of populations traditionally underrepresented in higher education are encouraged to apply. Rank and salary are commensurate with credentials and experience. The position is open until filled. To apply send a letter of application including a statement of professional goals and teaching philosophy, full resume, three reference, and graduate transcripts to:
Dr. Shivappa Palled, Head
Department of Mathematics and
Computer Science
Methodist College
5400 Ramsey Street
Fayetteville NC 28311-1420
(910) 630-7133/7125.

Oregon State University
Department of Computer Science Visiting Professor
Visiting Professor Positions

The Department of Computer Science is seeking to fill one or more visiting professor positions for the 2001-2002 academic year. These are nine-month, part-time or full-time appointments with the possibility of renewal for a second year. Applicants should have a Ph.D. in computer science or a closely related field. We encourage applications from faculty on sabbatical leave who are interested in collaborating with one of our research groups. The teaching load is one or two courses per term, depending upon the level of appointment desired.

To apply, send a complete resume and at least three sealed letters of recommendation (email is acceptable) to:
Visiting Professor Search Committee
Dept. of Computer Science
Oregon State University
102 Dearborn Hall
Corvallis, OR 97331
Phone: 541-737-3273
Email: jobs@cs.orst.edu.
For full consideration apply by March 1, 2001. Positions will remain open until filled
OSU is an AA/EEO employer.

Purdue University
School of Electrical and Computer Engineering

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

Send a resumé, including a statement of research and teaching interests and a list of at least three references to:
Head
School of Electrical and Computer
Engineering
Purdue University
1285 EE Building
West Lafayette, IN 47907-1285.
Applications will be considered as they are received. Purdue University is an Equal Opportunity/Affirmative Action employer.

SUNY College at Oneonta
Mathematical Sciences Department
Assistant Professor Position

SUNY College at Oneonta seeks applications for a tenure track position in Mathematical Sciences at the Assistant Professor rank beginning in the Fall 2001 semester. The initial appointment for this position is two years. The expectations for this position include teaching; research; advisement; and college service. Ph.D. or A.B.D. in Computer Science or related field required. Strength in database systems, theory of computation, and/or artificial intelligence; demonstrated collegiate teaching excellence; and ability to teach diverse courses in an undergraduate Computer Science major program preferred. Applicants should send a letter of application, curriculum vitae, graduate transcripts, and arrange to have three letters of reference sent to:
Dr. Leo J. Alex, Search Committee Chair
Mathematical Sciences Department
Box A
SUNY Oneonta
Oneonta, NY 13820
Review of applications will continue until the position is filled.
SUNY Oneonta is an EEO/AA/ADA employer. Women, minorities, veterans, and the disabled are encouraged to apply.

SUNY at Stony Brook
Computer Science Department
Lecturer

Applications are invited for the position of Lecturer in the Department of Computer Science. Applicants must hold a graduate degree in Computer Science or closely related field, and should have a strong commitment to excellence in teaching, and must have experience teaching computer science at the university level. Please send a copy of your resume and the names of three references to:
Professor Steven Skiena
Instructor Search committee
Computer Science Department
SUNY at Stony Brook
Stony Brook, NY 11794-4400
skiena@cs.sunysb.edu
AA/EEO.

University of Alberta
Department of Computing Science

Do you have a commitment to push the frontiers of computing research in one of the most supportive environments in Canada? Join us in a dynamic Computing Science department, known for its collegial atmosphere and collaborative research environment. Our department is in the Faculty of Science at the University of Alberta, in Edmonton, the Capital of Alberta. We are a department on the move, with resources to grow to over fifty faculty. We have ten established research laboratories, including Algorithmics, Artificial Intelligence, Computer Vision and Multimedia Communications, Database Management, Graphics, Networks and Communications, Robotics, Software Engineering, Spatial Computing, and Software Systems.

We have abundant computing facilities, and our department leads broadly-based multidisciplinary research within the Multimedia and Advanced Computational Infrastructure (MACI) project, and the Research Institute for Multimedia Systems (RIMS). In addition to the standard computational research facilities, we also have a large SGI Origin 2000,and a 3D immersive display powered by an SGI Onyx2. We recently moved into a new research laboratory building adjoined to a renovated historical building. This combined space now provides us with consolidated office and research space in the middle of our campus of about 30,000 students.

Computer Science research is well-funded in Alberta, with several provincial programs providing research opportunities that are the envy of everyone in the world, including our multi-university collaborations (e.g., www.maci.ca, www.aserc.ab.ca), research chair programs (e.g., www.icore.ca), and a new billion dollar science and engineering research foundation (www.ahfser.ab.ca). Our current complement of 42 regular faculty work within a department of about 32 support staff, 160 graduate students and 550 undergraduate students. Our consistent performance in ACM World Programming Contests is evidence of our claim to be one of the best undergraduate programs in the country, and our graduate students are successful in industrial and academic research labs around the world.

We are looking for highly-productive eager computing scientists to complement our strengths in all areas listed above. We are especially keen on those who can demonstrate that they are driven by curiosity and interested in collaborative research with existing faculty across the sub-disciplines. Candidates should have, or be at the completion stage of a PhD degree in Computing Science, and a proven research record, and a strong commitment to excellence in teaching. Responsibilities include research as well as teaching at the graduate and undergraduate levels. Most positions will be at the assistant professor level, however, we will consider associate and full professor appointments for outstanding candidates.

We offer an environment that is congenial and supportive of new PhDs, with the challenge to help you be your best, and the support to help you succeed within an academic environment. Our department is part of a full-service university in a province that has the fastest economic growth in the country, and we enjoy strong collaborative ties with local industry. Competition will remain open until suitable candidates are chosen. Find further details about us at www.cs.ualberta.ca and send your curriculum vitae and the names and addresses of three referees to:
Iris Everitt, Administrative Assistant
Department of Computing Science
University of Alberta
Edmonton, Alberta, Canada, T6G 2E8 or
e-mail: everitt@cs.ualberta.ca
The records arising from this competition will be managed in accordance with provisions of the Alberta Freedom of Information and Protection of Privacy Act (FOIPP). The University of Alberta hires on the basis of merit. We are committed to the principle of equity in employment. We welcome diversity and encourage applications from all qualified women and men, including persons with disabilities, members of visible minorities, and Aboriginal persons.

University of Illinois at Urbana-Champaign
Head, Department of Computer Science

The University of Illinois invites applications and nominations for the position of Head of the Department of Computer Science. The Department of Computer Science conducts an outstanding educational and research program, embracing all major technical specialization of the profession. The Department currently has approximately 40 full-time faculty members, and it offers degrees at the bachelors, masters and doctoral level. The Head will have the opportunity to lead the Department through a period of substantial growth in new faculty positions, including filling a number of named chairs. This growth will be facilitated by the completion of the $75M Siebel Center for Computation, construction on which will begin in July, 2001. The Head is a tenured Professor in the Department and must demonstrate the credentials to hold such a position. As the chief executive officer of the Department, the Head must be able to assert the leadership required in a first-rate academic program. Applicants should submit a full resume including a list of publications, a statement of interest and vision regarding the post, and the names and addresses of at least five references. Salary is commensurate with experience. A starting date of September 1, 2001 is desirable. To ensure full consideration applications should be received by June 1, 2001. Interviews may take place prior to the application deadline, however, no final decision will be made until after that date. Send applications and nominations to:
CS Head Search Committee
University of Illinois
306 Engineering Hall
1308 West Green Street
Urbana, IL 61801
(217-333-2152)
Electronic inquiries may be sent to cs-search@cen.uiuc.edu.
The University of Illinois is an Affirmative Action, Equal Opportunity Employer.

University of Maryland
Department of Electrical and Computer Engineering
Tenure Track and Tenured Faculty Positions

The Department of Electrical and Computer Engineering at the University of Maryland, College Park (www.ece.umd.edu) expects to have several openings for tenure-track and tenured faculty positions starting August 2001.

The Department is seeking candidates in Information Technology and Small Smart Systems, two broad research activities selected for expansion by adding distinguished faculty under the University of Maryland Enhancement Initiative. In both areas, we are seeking faculty who can build links between established research programs in systems and devices.

In Information Technology, we are seeking candidates in (i) communication networks, emphasizing hardware implementation, including optical communications and RF communications; (ii) wireless communications, emphasizing the physical layer, including error control coding, modulation, and signal processing for wireless systems; (iii) real-time and embedded computing systems, hardware/software co-design, and VLSI systems; (iv) video processing and multimedia systems; and (v) Circuit design, especially analog, mixed mode, and digital VLSI, and HF and RF circuits, for applications in communications and signal processing, controls or computer systems.

Small Smart Systems refers to distributed, often mobile, physical systems of sensors and actuators, integrated with advanced computational and communications capability. In this area we are seeking candidates in (i) sensors/actuators/control systems, especially MEMS-based; (ii) semiconductor devices and circuits, emphasizing applications to sensors and actuators, novel devices including quantum effect devices and nanostructures, RF and low-power devices, mixed mode circuits and embedded systems.

There are strong possibilities for joint appointments between the Department and the Institute for Systems Research, the Institute for Advanced Computer Studies, and the Department of Computer Science. In addition, candidates in the area of circuits and semiconductor technologies may be eligible for a Ward Professorship in Semiconductor Science and Technology.

Appointments at all ranks will be considered. Prior experience in industry is desirable. Candidates for the rank of Assistant Professor should have a high potential for both teaching and research. Candidates for the ranks of Associate and Full Professor should have distinguished records in research and a strong interest in educational programs.

For best consideration, applications should be received by December 31, 2000. Please send resume, list of publications and the names of at least four references to:
Professor Steven I. Marcus, Acting Chair
Department of Electrical and Computer
Engineering
University of Maryland
College Park, MD 20742
If the resume is available in MS Word, please send a copy on a floppy disk as well.
The University of Maryland is an equal opportunity, affirmative action employer with a strong commitment to the principle of diversity. In that spirit, applications from minority groups and women are especially invited.

University of Massachusetts Boston
Department of Computer Science
1) Alton J. Brann Distinguished Professorship
2) Assistant/Associate Professor (2)
3) Lecturer

The Computer Science program at the University of Massachusetts Boston invites applications for Fall 2001 for the four new faculty positions described below. We are a growing department, offering a BS, an MS with an emphasis on software engineering, and a recently established doctoral program. We seek to strengthen our research program significantly. Current faculty interests include databases, data mining, bio- and ecoinformatics, systems, networking, image and text processing, system modeling, and theoretical computer science.

Our campus overlooks Boston harbor; our faculty and students enjoy professional life in a center of academia and the software industry.

For more information, visit us at http://www.cs.umb.edu.

I. Alton J. Brann Distinguished Professorship (Box# 635)
The Brann professorship is an endowed position for a senior faculty member with a distinguished record of research leadership, preferably in an area that can foster interdisciplinary collaboration, such as bioinformatics, ecoinformatics, computational molecular biology, or computer engineering. Send cover letter, curriculum vitae, and names of three references to the address below.

II. Assistant/Associate Professor (Box# 630) (two openings)
Strong candidates will be considered from any area of Computer Science. Evidence of significant research potential and a PhD in Computer Science or Computer Engineering are required. Applicants should be able to teach all levels of computer science. We offer a competitive salary and a generous start-up package, including summer support and laboratory funds. Send cover letter, curriculum vitae, statements about research and teaching, and three letters of reference to the address below.

III. Lecturer (Box# 640)
Non tenure track faculty position teaching three undergraduate CS courses/semester, advising students, and helping develop curriculum. Experience and keen interest in teaching are required. A Master's in Computer Science and software industry experience are desirable. The initial two-year appointment is renewable.

Send cover letter, curriculum vitae, a statement about your teaching experience and

Professional Opportunities

philosophy, and three letters of reference to the address below.

Chair of the Search Committee (Box 635)
Department of Mathematics and Computer Science
University of Massachusetts Boston
100 Morrissey Blvd., Boston MA 02125

Review of applications has begun and will continue until the positions are filled. The University of Massachusetts is an equal opportunity, affirmative action employer and encourages applications from women and minorities.

University of Pennsylvania
Department of Computer and Information Science
Research Faculty Positions

The Department of Computer and Information Science invites applicants for (non-tenure track) research faculty appointments in both experimental and theoretical computer sciences.

The CIS Department is looking for applicants whose research would be enhanced by the Department's existing strengths in algorithms and computational biology, computer graphics and animation, computer vision and robotics, databases, logic and computation, natural language processing, networks and distributed systems, programming languages, and real-time systems.

Candidates should demonstrate an ability to carry out high quality, independently formulated research and obtain research grants essential for the continuing support of this research position. A Ph.D. Degree in computer science or a related field with appropriate experience is required.

The University of Pennsylvania is an Ivy League University located near the center of Philadelphia - the 5th largest city in the United States. Within walking distance of each other are its Schools of Arts and Sciences, Engineering, Medicine, Nursing, Law, Business, and Fine Arts. The University campus, and its surroundings in Philadelphia, benefit from a rich diversity of cultural opportunities as well as attractive urban and suburban residential neighborhoods.

To apply, please submit an updated Curriculum Vitae, statement of research interests, copies of three most significant publications, and the names of at least six references, and record of research funding to:

Research Faculty Search Committee
Department of Computer and Information Science
University of Pennsylvania
200 South 33rd Street
556A Moore Bldg. (GRW)
Philadelphia, PA 19104-6389

Applications should be received by May 1, 2001 to be assured full consideration. Applications will be excepted until the position (s) is filled. Questions can be addressed to amyd@cis.upenn.edu

The University of Pennsylvania is an Equal Opportunity/Affirmative Action Employer.

University of Virginia
Director of Computer Engineering Faculty Position

Computer Science
www.cs.virginia.edu
Electrical & Computer Engineering
www.ece.virginia.edu

The School of Engineering, University of Virginia, seeks to fill a senior position to lead our Computer Engineering program. The appointee will teach undergraduate and graduate courses in Computer Engineering, contribute significantly to a strong research program and collaborate with existing faculty. Areas of primary interest are: computer architecture, distributed systems, computer networks and areas related to mobile computing and embedded systems.

The CS and ECE Departments offer BS, MS, and Ph.D. degrees in their respective areas and jointly administer an ABET-accredited BS program in Computer Engineering. Both provide graduate instruction and research in Computer Engineering areas. The successful candidate will be jointly appointed in the two departments and serve as faculty leader of the B.S. program in Computer Engineering. The appointment will be made to start September 1, 2001 or sooner, and may include a Chaired Professorship.

Founded in 1819 by Thomas Jefferson, the University of Virginia is widely recognized as one of the nation's leading institutions of higher education. At the heart of the "Academical Village" are the Lawn and Rotunda, designed by Jefferson and now historical landmarks. With about 19,000 students and 2,000 professors, the University remains small among state-supported institutions. The students, two thirds of them Virginians, come from 80 countries and 50 states. The University offers baccalaureate degrees in 56 fields, the master's in 78, the first professional in two, and the doctorate in 68. In survey after survey, Charlottesville ranks as one of the most attractive small cities in the country. Beautiful countryside, vibrant arts

and energetic high-tech communities, and a thriving town center make it an ideal location.

The University of Virginia is an equal opportunity/affirmative action employer. We encourage women, minorities and persons with disabilities to apply for this position. Applications will be received until the position is filled. Please submit a cover letter, curriculum vitae, the names of three references, and a statement of research and teaching interests to:

Computer Engineering Search Committee
Milton Adams, Chair
351 McCormick Road
Thornton Hall A126
The University of Virginia
Charlottesville, VA 22904-4232
804-924-3310
jma@virginia.edu

University of Wisconsin at Green Bay
Information and Computing Sciences

UW-Green Bay invites applications for a lecturer position in Computer Science with potential for a long-term appointment. The successful candidate must be enthusiastic about teaching and have strong interests in curricular development and undergraduate advising. Teaching assignments include a variety of courses dependent, in part, on the qualifications of the individual. Responsibilities also include supervising interns and advising. The normal load is 27 credits per academic year including 24 credits of teaching and 3 credits reassigned for internship supervision and other duties. Additional reassignments are possible.

Qualifications: Masters degree in Computer Science or a related area preferred. Bachelor's degree in Computer Science or related area required; however Bachelor's degree only applicant must have extensive post Baccalaureate experience in software design, database, or similar applications. Teaching/instructional experience required.

Conditions of appointment: Academic year (nine month) appointment as full-time academic staff lecturer with potential for a long-term appointment. Reappointment contingent upon successful performance; annual merit review of teaching. First screen is April 20, 2001; Position open until filled. Submit a letter of application with statement of teaching interests and philosophy, curriculum vita, transcripts (official transcripts required only for finalists), evidence of teaching ability and documented effectiveness of teaching, if available, and three current letters of recommendation (direct from references) to:

Professor William Shay
Chair, Computer Science Search Committee
University of Wisconsin-Green Bay
2420 Nicolet Drive
Green Bay WI 54311-7001
Telephone calls or email are welcome:
Phone: (920) 465-2316/2371
email: shayw@uwgb.edu; URL:
http://www.uwgb.edu/compsci

UWGB is an AA/EEO employer. Names of applicants may be disclosed unless requested otherwise. Names of finalists will be released.

Wake Forest University
Departments of Computer Science and Art

Applications are invited for a Lecturer in Digital Media beginning August 2001. The position is non-tenure track and will be held jointly in the Computer Science and Art Departments. Duties are both instructional and staff related and include team teaching digital media courses in the Computer Science and Art Departments and working with multimedia development for computer-enhanced learning. Applicants should have an advanced degree in an appropriate field plus at least three years experience in multimedia development. Send a letter of application to:

Jennifer Burg
Department of Computer Science
Wake Forest University
P. O. Box 7311
Winston-Salem, NC 27109-7311
AA/EO Employer

Wake Forest University
Department of Computer Science
Visiting Professor of Computer Science

Applications are invited for a visiting professor position in computer science beginning August 2001. Duties include teaching computer science at the undergraduate or graduate level. A PhD in computer science or equivalent is required. The department has nine computer science faculty and offers a B.S. and M.S. in computer science. Send a letter of application to:

Jennifer Burg
Department of Computer Science
Wake Forest University
P.O. Box 7311
Winston-Salem, NC 27109-7311
AA/EO Employer

CRA Undergraduate Awards Presented at ACM1

Photo: Jack Carroll, Santa Clara, CA

Back row (l to r) Ed Lazowska, CRA board chair; Steve Zhang and Kevin Zatloukal, (University of Washington); Ben Carlson (University of Nevada, Reno); Matt Rosencrantz (University of Washington); Matt Bell (Stanford); Bill Aspray, CRA executive director. Front row: (l to r) CRA board member, Stu Zweben, presenter; Kimberly Jackson (Xavier University); Deborah Abel and Russell Cox (Harvard University); and Tal Garfinkel (UC Berkeley). Kevin Zatloukal was the male winner and Russell Cox the male runner-up. Others received Honorary Mention awards.

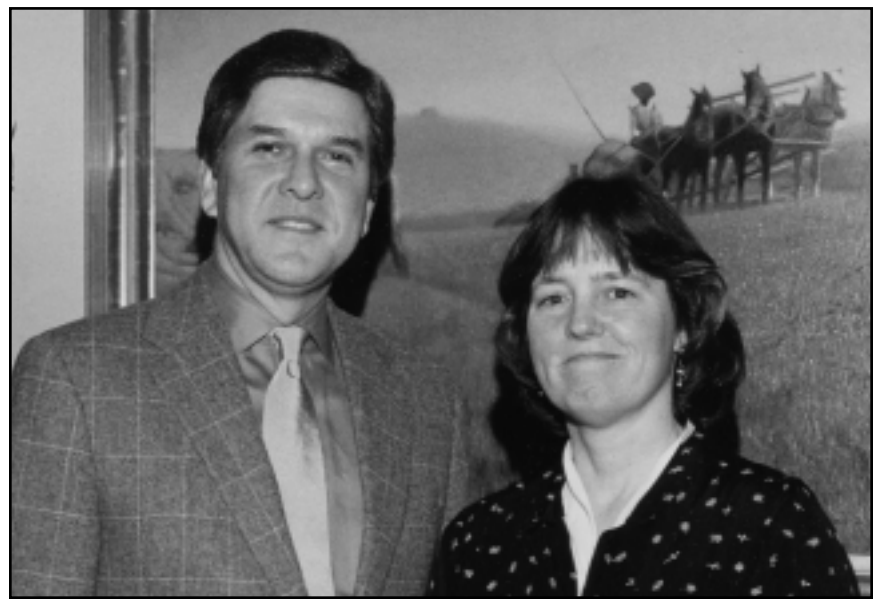## CRA Board Takes to Capitol Hill

Photo: Senate Photo Studio

CRA held a Congressional Visits Day for its Executive Board in February. Ten board members visited about 20 congressional offices to discuss the importance of federal support for computing research and other matters of concern to the computing research community. Every day, legislators meet in Washington with hundreds of constituents to talk about issues and policy. Legislators need this kind of feedback, and participants typically enjoy the opportunity to engage in the political process. Above, CRA board member Jan Cuny meets with Senator Gordon Smith of Oregon.

CRA maintains a variety of resources to facilitate advocacy within the computing research community. Please check <cra.org/govaffairs/advocacy> for further information. ▮

Mentors include: Nancy Amato (Texas A&M), Annie Anton (NC State), Amy Bruckman (Georgia Tech), Lori Clarke (UMass), Elaine Cohen (Utah), Anne Condon (British Columbia), Jan Cuny (Oregon), Maria Gini (Minnesota), Amy Greenwald (Brown), Mary Jean Harrold (Georgia Tech), Adele Howe (Colorado State), Victoria Interrante (Minnesota), Lydia Kavraki (Rice), Sandra Mamrak (Ohio State), Lori Pollock (Delaware), Wanda Pratt (UC Irvine), Linda Shapiro (Washington), Mary Lou Soffa (Pittsburgh), and Jennifer Welch (Texas A&M). ▮

INVITATION FOR PARTICIPATION

CRA-W/Lucent Technologies Distinguished Lecture Program and Graduate School Recruiting Panels

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

See: http://www.cra.org/Activities/craw/projects/dls-application.html

Contact Program Coordinator:
Carla Ellis (carla@cs.duke.edu)

First priority will be given to email messages received
prior to May 15, 2001.

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CRA Electronic Bulletin
Headlines from April 5, 2001 Edition

■ Floyd Kvamme Appointed to Presidential Advisory Committee on S&T

■ Even With Downturn, Most Firms Remain Committed to R&D

■ House Science Committee Response to Bush's FY2002 Budget

■ Intel and 'Virtual Laboratory' Collaborate on Chip Design

■ Sony, Toshiba, and IBM to Develop New Chip

■ CPST Report: 'Scientists and Engineers for the New Millennium'

■ New Women's High-Tech Coalition Formed in DC

■ 2% Growth in U.S. Engineering Undergrads

■ Demand for IT Workers, Though Slowing, Continues to Outstrip Supply

■ Significantly Fewer H1-B Visas Granted

■ Role of High-Tech Exports Continues to Grow as Senate Committee Supports Changes to Export Rules

■ NSF CSEMS Scholarships: May 1 Deadline

Expanding Pipeline from Page 2

management skills, and an understanding of the design process, as well as its role in increasing customer and community awareness [Oakes et al. 2000]. No formal evaluation has focused on the experiences of the women students. However, the statistics about participation are suggestive. The first five years recorded approximately 1,400 semester registrations (slightly more than 700 individual students, with each student registering for an average of two semesters). Women accounted for 355, or 26 percent, of the registrations. Since the mix of disciplines includes students from fields such as environmental engineering as well as liberal arts, which traditionally has more women, it is more enlightening to look at the numbers for students coming from disciplines where women are significantly underrepresented.

Over the five-year window, enrollment of women in ECE and Mechanical Engineering at Purdue ranged between 10 percent and 12 percent, but 20 percent of the ECE and ME students in EPICS were women. Over the first five years, 38 percent of the EPICS CS students have been women; in the current semester, 33 percent of the CS students in EPICS are women, compared with 11.5 percent of the undergraduates in CS. Lastly, in the first three years of the program, when 20 percent of the students in EPICS were women, approximately 30 percent of the team leaders were women. It therefore appears that EPICS, with its focus on engineering in context and strong emphasis on teamwork, communication, personal growth, and commitment, is proving an effective vehicle for encouraging women in engineering and computer science.

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Rosser, S., *Women Friendly Science: Applying Women's Studies Methods and Theories to Attract Students* (New York: Pergamon Press, 1990).

Rosser, S., *Teaching the Majority: Breaking the Gender Barrier in Science, Mathematics, and Engineering* (New York: Teachers College Press, 1995).

Leah Jamieson (lhj@purdue.edu; http://www.ece.purdue.edu/~lhj) is a Professor of Electrical and Computer Engineering at Purdue University and a co-founder and co-director of the EPICS Program. She is a past co-chair of CRA-W and Secretary of the CRA Board of Directors. ∎

CRA Programs from Page 7

focus on how to have an effective career and be a good teacher. CRA is planning to hold a similar series of workshops for advanced graduate students and recently hired industrial and government computing researchers. These workshops will offer guidance on how to have an effective career in a computing research laboratory or center.

Summer internships. In fall 2001, CRA will begin an online clearinghouse that will allow students to seek summer internships in the academic, industrial, and government sectors. The internships that will be advertised on the CRA website will be restricted to those that are research-oriented (and not simply routine programming jobs, for example).

For more information about CRA's programs on and about industry, contact Jay Vegso (jvegso@cra.org), CRA's Manager of Membership and Information Services. ∎