COMPUTING RESEARCH NEWS

Serving the Computing Research Community Since 1972

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$85.3 Billion Requested for R&D in FY 2001 Budget

By Lisa Thompson

The Administration's FY 2001 budget proposal, introduced on February 7, 2000, contains a wealth of new spending on health, human resources, access to technology, environment, infrastructure, and R&D initiatives and programs—an expansion of the federal sector designed to secure the President's historical legacy. As the budget would exceed the caps currently imposed on discretionary spending, the President is expected to submit proposed legislation to remove those caps, a move that no longer entails the political risks it did in previous budget cycles. Reaction from the more vocal Republicans on Capitol Hill was predictable: "Too much spending, not enough tax relief."

Overall Research and Development

The request features $85.3 billion for research and development, including facilities and equipment. This figure is about 3 percent above the estimated R&D spending in FY 2000, although civilian basic and applied research would each increase by 7 percent under the plan.

Table 1. R&D Funding by Sector Type
in millions of US dollars

	FY 1999 Actual	FY 2000 Estimate	FY 2001 Proposed	FY 00-01 % change
Civilian				
Basic Research	$16,340	$17,808	$19,054	7%
Applied Research	11,551	12,405	13,274	7%
Development	8,522	8,818	8,981	2%
Defense				
Basic Research	1,128	1,219	1,274	5%
Applied Research	4,364	4,788	4,752	-1%
Development	35,780	35,253	35,340	--
Total				
Basic Research	17,468	19,027	20,328	7%
Applied Research	15,915	17,193	18,026	5%
Development	44,302	44,071	44,321	1%
Facilities & Eqpt.	2,657	2,453	2,658	8%
Total R&D	**$80,342**	**$82,744**	**$85,333**	**3%**

R&D Themes & Crosscuts. When the President talks about his R&D budget, he is more likely to refer to the 21st Century Research Fund, a subset of overall R&D that encompasses the research budgets of the primary science agencies. (Don't be confused by the use of the word "fund"—it is not tied to a particular revenue stream, nor does it entail any additional management structures.) Collectively, the programs included in the fund would total $43 billion in FY 2001, an increase of $2.8 billion (or 7 percent) over the current level; the White House uses the label "Science and Technology Initiative" to refer to the proposed increment.

The R&D budget proposal touts the following highlights and initiatives:

- Information Technology R&D
- National Nanotechnology Initiative
- Promoting Bioenergy and Biobased Products
- Integrated Science for Ecosystem Challenges
- U.S. Global Change Research Program
- Climate Change Technology Initiative
- Partnership for a New Generation of Vehicles
- Interagency Education Research Initiative
- R&D to Defend America Against 21st Century Threats

The nanotechnology and bioenergy initiatives are new thrusts for FY 2001. The theme that covers defense against new threats includes continued funding for the Critical Infrastructure Protection R&D initiative (see related article on page 4).

Information Technology R&D

IT R&D is a new interagency crosscut, although hardly a new theme, that combines the High

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InterTrust's STAR Lab

By J. J. Horning

The second in a series of CRN *articles describing the activities of CRA's industry laboratory members.*

InterTrust Technologies Corporation (http://www.intertrust.com) is a 200-person company in Santa Clara, CA, focusing on digital rights management (DRM) and related electronic commerce systems.

As director of its Strategic Technologies and Architectural Research Laboratory, I am often asked, "How can a small startup like InterTrust afford a substantial research lab?"

Conventional wisdom in Silicon Valley says "Startups can't do research." That is, for a small company to win big, it must take a single idea from somewhere else (a university, government, or large company lab), focus on it obsessively, and run like hell to be first to market. It shouldn't even think about research until it grows large—if ever. Or as David Liddle has said: "The only companies that can afford research labs are too big to be able to profit from the results."

Nonetheless, my short answer to the question is: "InterTrust believes that it cannot afford *not* to have a first-class research lab."

Before I expand on that answer, I need to explain a bit more about InterTrust. In a number of important ways, InterTrust is not a conventional Silicon Valley startup.

First, InterTrust is not actually a "startup." It was founded by Victor Shear in January 1990 (as Electronic Publishing Resources, or EPR). Shear had been awarded basic patents covering techniques for enforcing the rights of owners of intellectual property that was distributed digitally. This area has come to be called digital rights management.

Although he had already been working on the DRM problem for a number of years, Shear realized that the world was not yet ready for—or very interested in—large-scale electronic commerce in digital IP. The Internet was seen as an academic tool, the World Wide Web had not yet been invented, and the cutting-edge commercial digital distribution technology was CD and CD-ROM.

Rather than rushing a product to market, EPR spent its first six years preparing for a market that it believed would eventually be vast. Shear, trained as a sociologist, insisted on taking a broad view of "moving commerce into electronic space," considering the fundamental requirements for a system that would accommodate the needs of all parties in the "value chain" from creative artist to end user. EPR stayed small, built prototypes, and established a formidable patent position. It also developed a business model to give it staying power for the day when other companies, large and small, noticed the opportunity and crowded in.

EPR's model was to make its system ubiquitous by forming long-term partnerships with great global companies—including leading content companies and financial clearinghouses—and with cutting-edge technology companies. Its vision was that EPR would serve as a "utility," providing the common infrastructure for "trusted electronic interactions" among members of value chains. It would give its partners a level playing field on

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Expanding the Pipeline

Gender Differences in Learning to Program

By Janet Carter and Tony Jenkins

The teaching (or, perhaps more accurately, the learning) of programming is a problem that few teachers of programming in higher education would deny. Indeed, most would agree that there is an alarmingly high proportion of graduates who are unable to "program" in any meaningful sense. The experience of the School of Computer Studies at the University of Leeds is no exception. Students often approach their final year project work determined to avoid programming at all costs, presumably because they either cannot program or believe that they cannot.

Our cohort comprises a mixture of novice and experienced students, and approximately 20 percent are female. We have worked, over several sessions, on innovative approaches to supporting the novice students. In the 1997-98 session a particular change was introduced—additional tutorial classes were provided for those students who approached staff and asked for additional support. We insisted that the classes were available only to students who applied; we wanted to keep the class sizes as small as possible. All students were made aware of the classes, and were told to approach a member of the teaching staff if they wished to join; in this way, we hoped to limit the classes to motivated students who were in difficulty.

This additional class was initially seen as a success. The staff saw a significant number of students who had clearly been struggling attend these classes, and eventually achieve creditable, if unspectacular, results. It was apparent, though, that the vast majority of the students attending were women—in the first year, 16 out of 20 were women. This trend continued, and in the 1998-99 session the ratio was 17 to 4. A worrying aspect of this phenomenon was that, in questionnaires circulated at the end of the module, a small minority of (presumably male) students reported that they believed that the staff were only willing to help the female students.

Even though the staff knew that this was certainly not the case, it is not a pleasant comment to read in student feedback. The comments have reappeared since, and have even percolated into students' attitudes in other modules. It was also exasperating to see that many students continued to fail the module—these were students who might well have benefited from the extra classes. It was noticeable that all 14 of the students re-sitting the programming module at the end of the 1997-98 session were men.

The Study

We planned to run the same classes again in the 1998 session—a reasonable decision since they were clearly of great benefit to the students who attended them. We decided, however, to investigate students' attitudes and approaches to the learning of programming so that we might understand why mainly women attended the classes. This investigation would be complemented by a similar exercise at the University of Kent, where no such additional classes were available. A comparison with a different institution seemed preferable to a comparison with a different module at Leeds. We were particularly interested in how students approached programming, and there was no suitable alternative programming module at Leeds. The study involved a simple questionnaire, which was presented to students in a lecture. The students were presented with a series of seven statements, and were asked to respond on a scale of 1 through 5, where 1 meant "strongly disagree and 5 meant "strongly agree."

The statements used were:

- I find programming easy.
- I prefer to work alone.
- When I get stuck I will always approach a lecturer for help.
- When I get stuck I prefer to ask my friends for help first.
- When I get stuck I prefer to work out the answer myself.
- In general, men are better than women at programming.
- The lecturers are more willing to help female students than male.

The main analysis would be the calculation of average "opinions" and comparisons of the responses from Leeds and Kent. The students were also asked to indicate their gender and whether they were "mature" (which we defined as aged over 21 on entry to the university).

Obviously, our main interest was in the answers to the final question and, in particular, whether students of both genders agreed with this.

Results

The responses were collated, and averages from the Leeds and Kent samples were calculated. The most striking feature of the answers to the first six questions is the closeness of the averages from the students at the two universities. In no case do the differences appear to be significant (at the 5-percent level). There are some apparent differences that can be understood as differences between the cultures of the two departments. The salient difference in the figures is, of course, in the answers to the final crucial question. It is clear that students at Kent (mean 2.0) in no sense agree with this statement, but their counterparts at Leeds (with a mean score of 3.3) are more inclined to. It is also clear that it is the male students under the age of 21 at Leeds that most strongly believe this (a score of 3.9 compared with 2.3 for the Kent males under age 21).

The only obvious difference between the way in which programming teaching is organized at the two universities is that Leeds provides the additional classes that are available only on application. It seems reasonable to suppose that it is these classes that are causing the differences we see. There are, of course, many other possible causes. The possibility that the staff teaching the module are in some way biased towards the female students (perhaps because they are a minority) cannot be discounted, but they would certainly vehemently deny this. It is also possible that news of the usefulness of the classes is spread among friends, and we might expect first year women students to have made more female friends in their first weeks. Another possible issue would be that some men would find the prospect of joining a class that was almost exclusively female rather intimidating. Nevertheless, the key underlying issue is the provision of the extra classes.

A further interesting fact is apparent from the Leeds sample. Responses were received from only 56 students in a class that should have been attended by some 110 (the class takes place on a Friday afternoon—a very unpopular time). Of these 56 students, 20 were women. In the whole class there are 31 women registered, so 65 percent of the women attended. The equivalent attendance figure for the men is 46 percent, which is significantly lower. This seems to point to a difference in motivation between the genders, or perhaps to a difference in the way the genders approach learning.

Research has found that differences between the approaches of male and female students are most strikingly demonstrated when single-sex schools are merged to form a co-educational establishment. Although this is not exactly the case here, it must be noted that a very high proportion of our CS undergraduates previously attended

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Grace Hopper Celebration of Women in Computing 2000

September 14-16, 2000
Sheraton Hotels
Cape Cod, Massachusetts
http://www.sdsc.edu/Hopper

CRA Conference at Snowbird 2000

It's time once again to begin thinking about Snowbird! Mark your calendars for CRA's biennial conference scheduled for **July 9-11, 2000** in Snowbird, Utah.

This is CRA's flagship conference for chairs of Ph.D.-granting departments of computer science and computer engineering, as well as leaders from U.S. industrial and government computing research laboratories. A number of other senior people from research groups, government, academia, and professional societies also attend.

The Snowbird Committee has been working since last fall to put together a strong program to address the conference's major theme—"Computer Science in the New Millennium." What will computer science departments, research, and teaching look like? What are the potential issues that may arise, and how will they be addressed?

The President of the National Academy of Engineering, William A. Wulf, will set the stage by addressing the group on the topic, "Some Challenges for Computer Science as it Enters the 21st Century." Three plenary sessions, two of which are joint industry/academic sessions, include: 1) Important Research Areas for the New Millennium; 2) Impact of the Economic Development Imperative on the Universities; and 3) Educational Challenges for the New Millennium. The program also will offer a workshop for new department chairs, as well as a workshop for deans (new this year).

Industrial research directors will attend regular conference sessions and events, including two joint industry/academic plenary sessions (mentioned above) and one joint workshop, "University Venture Capital/Incubation Initiatives." Other workshops are specifically oriented toward issues of concern to industry, such as: "Using Spin-offs and Venture Capital to Market New Ideas" and "Managing Industrial Research Labs."

The opportunity to network with peers is one of the most valuable aspects of the conference, and it comes around only once every two years. So make your plans to escape to the mountains in July and join the crowd for several days of stimulating discussion about the future of computer science and engineering research.

This year's program committee is co-chaired by Jack Stankovic (University of Virginia) and Frances Allen (IBM T. J. Watson Research Center). Members include: James Foley (Georgia Tech and the Yamacraw Mission); David S. Johnson (AT&T Labs—Research); James Kurose (University of Massachusetts, Amherst); Eric Manning (University of Victoria); and Barbara Ryder (Rutgers University).

For details about the program, accommodations, and registration, please visit the CRA Web site at: http://www.cra.org/.

CRA Industrial Careers, Effective Teaching, and Academic Careers Workshops

June 19-20, 2000
San Diego Marriott Hotel & Marina
San Diego, California

in conjunction with the USENIX Annual Technical Conference June 18-23, 2000

CRA is again offering its highly successful series of workshops for men and women who study or work in computing research. The goal is to provide practical guidance for advanced graduate students and junior faculty as they choose or begin their careers.

New! The **Industrial Careers Workshop** (June 19), organized by Steve Johnson (Transmeta Corp.), is targeted at computing researchers who are considering a career in industry. Topics include the nature and variety of work that can be expected and how to prepare for it, opportunities for conducting research and publishing, and the non-academic skills that are required in industry.

The **Effective Teaching in Computer Science and Engineering Workshop** (June 19), organized by Tim Finin (University of Maryland, Baltimore County), is a highly interactive workshop that includes theoretical material on learning styles and instructional objectives, practical tips on effective lecturing, creative problem-solving, and collaborative learning.

The **Academic Careers Workshop** (June 20), organized by Bobby Schnabel (University of Colorado at Boulder), is targeted at faculty in the beginning years of their careers and senior graduate students contemplating an academic career. Potential topics include time management and family issues, the tenure process, selecting and managing a research project, and getting funding.

Further details about the workshops and registration can be found on the CRA website at http://www.cra.org.

Ph.D. in Software Engineering: A New Degree Program at Carnegie Mellon

By David Garlan, Phil Koopman, William Scherlis, and Mary Shaw

Introduction

The School of Computer Science at Carnegie Mellon University (CMU) has recently announced the inauguration of a new Ph.D. program in software engineering. The program is associated with the newly created Institute for Software Research International (ISRI). ISRI is the principal locus for software engineering research and education at Carnegie Mellon, and currently has 23 affiliated faculty members.

As one of its founding principles, ISRI adopts that both research and education in software engineering must rely on an intellectual base that includes not only *core* computer science *topics*, but also engineering methods and process, organizations and collaboration, information management, and legal and policy issues. ISRI faculty are involved in research projects in embedded systems, dependability, pervasive computing, software architecture, software adaptation and assurance, collaboration technology, digital libraries, distance education, distributed resource management, and other areas.

With the start of the new millennium, software has become an essential building material for systems of all kinds, affecting business and everyday living throughout the emerging global economy. As software becomes ubiquitous, the relation between end users and software development is undergoing fundamental changes. Rarely is software produced from scratch by a team of experts and delivered to clients. Increasingly:

- Software is developed by adapting and integrating existing components and services;
- The Internet and other forms of interconnection provide broad access to computation and information resources that are independently created and managed;
- Software systems must be designed and fielded under complex economic and legal constraints;
- Systems are being built in which unreliable and unstable software cannot be tolerated;
- Clients are intimately involved in the development and configuration of systems; and
- Requirements for those systems often emerge only as clients better understand both the technology and

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Administration Proposes New Information Security R&D Funding

On January 7, 2000 President Clinton launched a National Plan for Information Systems Protection, and announced new budget proposals for initiatives to strengthen America's defenses against the emerging threats posed to critical infrastructure, computer systems, and networks.

The FY 2001 budget request features a Critical Infrastructure Protection R&D initiative in which 10 agencies participate. Its funding would grow from $461 million to $606 million in FY 2001, a 31 percent increase.

The plan includes beefing up federal R&D and workforce activities:

- Building on the work of a science advisory panel, the Administration proposes to create a $50 million Information Infrastructure Institute that would combine federal and private sector efforts to fill the gaps in critical infrastructure R&D that are not currently being filled by the private sector or the Department of Defense. It would also provide demonstration and development support in key areas like benchmarks and standards and curriculum development. The institute would be funded through the National Institute for Standards and Technology.
- The plan also calls for improved recruitment, training, and retention of federal IT experts. The FY 2001 budget request will include $25 million for a Federal Cyber Services Training and Education initiative comprising two elements: an ROTC-like program in which the government pays for IT education (at the BS and MS levels) in exchange for federal service; and a program to establish competencies and certify the existing IT workforce. The initiative would be led by the Office of Personnel Management and the National Science Foundation.

Commerce Announces Streamlined Encryption Export Regulations

On January 14, 2000, the U.S. Department of Commerce Bureau of Export Administration (BXA) issued new encryption export regulations that implement the new approach announced by the Clinton Administration in September 1999.

The new approach permits U.S. companies to export any encryption product around the world to commercial firms, individuals, and other non-government end-users under a license exception (i.e., without a license). In addition, "retail" encryption products that are widely available in the market can now be exported to any end-user, including foreign governments. In most cases, a one-time product review by BXA continues to be required. Post-reporting requirements are reduced to track industry business models.

"This policy helps business and promotes e-commerce by adjusting our regulations to marketplace realities that U.S. companies face when they try to sell their products overseas. We've also worked very hard to address privacy concerns and to ensure that our law enforcement and national security concerns are met," said Commerce Secretary William M. Daley at the press conference announcing the change.

For source code, the regulation reduces controls further than announced in September 1999. Commercial encryption source code, encryption toolkits, and components can now be exported under license exception to businesses and non-government end-users for internal use and customization and for the development of new products. In addition, the regulations relax restrictions on publicly available encryption source code, including by posting on the Internet.

The regulation further streamlines requirements for U.S. companies by permitting exports of any encryption item to their foreign subsidiaries without a prior review. Foreign employees of U.S. companies working in the United States no longer need an export license to work on encryption.

The guidelines also implement agreements reached by the Wassenaar Arrangement in December 1998 by decontrolling 64-bit mass market products, 56-bit encryption items, and 512-bit key management products. The changes do not affect restrictions on terrorist-supporting states (Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria), their nationals, and other sanctioned entities.

In developing this regulation, the Administration worked closely with stakeholders to continue a balanced approach. The government will review the workability of the regulation, receiving public comments for 120 days. A final revised rule will be issued shortly thereafter.

The regulations obviate the need for new legislation. Two encryption bills are pending in Congress—the Security and Freedom through Encryption (SAFE) Act (H.R. 850) and the Promote Reliable On-Line Transactions to Encourage Commerce and Trade (PROTECT) Act (S. 798). But the congressional leadership says these bills will be put in abeyance, given the Administration's policy switch.

Note to Department Chairs:

Watch for the arrival of CRAís second Departmental Profiles Survey in early March

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the opportunities in their own settings.

CMU established the ISRI as a center for long-term interdisciplinary fundamental research, apprenticeship-based education, and international collaborations to address the challenge of designing, developing, integrating, validating, and maintaining practical, large-scale, high-quality, software-intensive systems. ISRI's creation is a natural extension of Carnegie Mellon's long-standing commitment to research in software systems.

By creating a new Ph.D. program in software engineering, we are able to train researchers who can address challenging problems related to practical issues of developing product-quality, software-intensive systems.

ISRI research activities employ a variety of approaches, including experimental prototyping, empirical modeling, codification of experience, formal analysis, creating design/development strategies for modern software, and developing public policy positions. Educational activities are tightly integrated with research and demonstration projects. The ISRI faculty is drawn from computer science, computer engineering, public policy, and other areas. The ISRI also maintains close ties with the CMU Software Engineering Institute.

An important emphasis in ISRI activities is employing a broad view of design. The approach to performing design in practice typically follows a progression of increasing maturity over time, starting as artisanship and leading to a scientifically-based, routinized engineering discipline. This frontier advances at different rates in different subdisciplines. Aspects for which generic design principles are not yet well articulated must be taught as art; aspects that can be taught via an artisanship approach must be taught in an apprenticeship format; aspects that can be reduced to heuristics and empirical models can be taught as an engineering discipline; and aspects that can be related to a theoretical foundation may best be taught as science. For this reason, ISRI adopts a flexible approach to teaching topic areas, attempting to identify and teach the right topics rather than just focusing in areas that are easy to teach. Additionally, ISRI seeks to advance the understanding of various areas to increase the level of scientific maturity.

Expectations for Graduates

Graduates will be prepared for faculty positions in software engineering, research positions in industrial laboratories, and leadership positions in the computer industry. As faculty, they will be distinguished by their understanding of software design and development issues, and the way this shapes their selection of research problems and evaluation of research results. As industrial developers, they will understand the interplay of academic research issues with engineering constraints that arise from public policy, economic, regulatory, and market issues. As senior software system developers, they will have a perspective that enables them to address specific problems in the context of the principles and results of the field. Graduates will understand practical issues of software design and development, from requirements acquisition to product support. They will be prepared to enter research or advanced development positions in application areas, distributed networks, embedded/critical systems, and other specialties, as well as conventional software system development.

Admission Criteria

Applicants to the program should have proficiency in computer science at least at an undergraduate level, with emphasis on development of software or hardware systems. They should also have evidence of intellectual ability to succeed in an intellectually rigorous doctoral program, demonstrated through transcripts, GREs, and other means.

Prior experience in developing industrial software, especially

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1998-1999 Taulbee Survey

Ph.D. Enrollment Levels Off; M.S. and Undergrad Continue to Rise

By Mary Jane Irwin and Frank Friedman

Figure 1. Number of Respondents to Faculty Salary Questions

Year	US CS Depts.	US CE Depts.	Canadian	Total
1995	110/133 (83%)	9/13 (69%)	11/16 (69%)	130/162 (80%)
1996	98/131 (75%)	8/13 (62%)	9/16 (56%)	115/160 (72%)
1997	111/133 (83%)	6/13 (46%)	13/17 (76%)	130/163 (80%)
1998	122/145 (84%)	7/19 (37%)	12/18 (67%)	141/182 (77%)
1999	132/156 (85%)	5/24 (21%)	19/23 (83%)	156/203 (77%)

This article and the accompanying tables and figures present the results of the 29th annual CRA Taulbee Survey[1] of Ph.D.-granting departments of computer science (CS) and computer engineering (CE) in the United States and Canada. This survey is conducted annually by the Computing Research Association to document trends in student enrollment, employment of graduates, and faculty salaries.

Information is gathered during the fall and early winter. The period the data covers varies from table to table. Degree production (Ph.D., Master's, and Bachelor's) and total Ph.D. enrollments refer to the previous academic year (1998-99). Data for new students in all categories and total enrollments for Master's and Bachelor's refer to the current academic year (1999-2000). Projected student production and information on faculty salaries and demographics also refer to the current academic year. Faculty salaries are those effective January 1, 2000. Responses received by January 14, 2000 are included in the tables.

The survey results are from Ph.D.-granting departments only. Two hundred and three departments were surveyed, compared with 182 departments last year. This increase was due to wider canvassing by CRA staff to get a more complete picture of the set of schools awarding CS and CE doctorates, and the addition of a few newly formed departments. Through last-minute telephone calls to departments that had not responded to the survey, we were able to obtain Ph.D. production numbers from 84% of the schools (compared with 77% last year). Overall, 156 departments out of 203 departments returned their survey forms. We thank all respondents who completed this year's questionnaire. Departments that participated are listed at the end of this article.

Respondents provided answers to most questions, but in some cases questions were left unanswered. Participation rates for individual questions varied from 75% to 80%. The overall response rate was 77%, about the same as last year. Figure 1 shows the number of departments that responded to the survey/number of schools polled for the faculty section of the survey from 1995 to 1999.

This article presents the most significant results of the survey, with particular attention to those that differ markedly from last year or that appear to indicate long-term trends. The continued low response rate for CE departments (21% this year, 37% last year) makes trend analysis for CE risky. Overall, the set of schools that responded this year was very similar to last, and the response rate was essentially the same. The high rate of return this year for Canadian schools (83% compared with 67% last year) must be considered when trying to determine trends with respect to Canadian data.

The survey form itself is modified slightly each year to ensure as high a rate of return as possible (by simplifying and clarifying), while continuing to capture the data necessary to understand trends in the discipline and also reflect changing concerns of the computing research community.

This year two questions were dropped from the survey. One question, added just last year, asked how many years it takes a student to complete the Ph.D. program (5.014 years reported last year). The information provided by this question, compared with the difficulty of collecting the data, suggests that this question only needs to be asked periodically. Another question that was dropped was how many new Ph.D. students had Bachelor's degrees in CS or CE. The data had not changed significantly in several years and, once again, proved difficult for departments to collect.

The question asking for projected faculty sizes was reduced from a five-year to a two-year window, since data further out than two years is probably unreliable.

One question was added on the number of students passing the Ph.D. preliminary/comprehensive (thesis proposal) exam. This was an attempt to fill in the gap in the Ph.D. production pipeline between passing the Ph.D. qualifying exam and graduation, in the hope that we could learn more about when students are leaving their graduate degree programs. The question on the number of Bachelor's students enrolled was expanded to capture both the number of majors and premajors (those students who have declared, but have not yet been officially admitted into the department), in the hope of forecasting future undergraduate loads more accurately.

This year, the faculty demographic and salary data on Instructors and Lecturers was combined into one category—non-tenure-track teaching faculty. As in previous surveys, differentiating between CS and CE counts for graduate students for those departments with combined programs (CSE) continued to be a problem this year.

Degree Production *(Tables 1-6)*

As shown in Table 1, a total of 944 Ph.D. degrees were awarded in 1999 by the 171 (84%) responding departments.

While this is a small increase from the 933 degrees awarded in 1998, only 144 departments (77%) responded last year. In both years, virtually all of the departments producing large numbers of doctorates were included in the survey data; the additional schools responding this year added only marginally to the total. Figure 2 shows the Ph.D. production rate from 1989 to 1999.

The prediction from last year's survey that 1,128 Ph.D. degrees would be awarded in 1999 was, as usual, overly optimistic. Using the same "optimism factor" of 0.85 as we used last year, the prediction for next year of 1,167 translates to 922 new Ph.D.s in 2000. One cause for concern is that the number of students passing the Ph.D. qualifier is down by 150 (or 14%) from last year.

Table 4 shows area of specialization versus types of first ap-

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Figure 2. Ph.D. Production 1989-1999

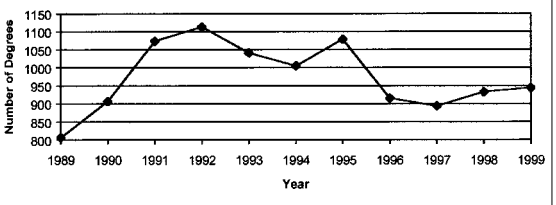

Table 1. Ph.D. Production by Department Type and Rank

Department, Rank	Ph.D.s Produced	Ave. per Dept.	Ph.D.s Next Year	Ave. per Dept.	Passed Qualifier	Ave. per Dept.	Passed Thesis Exam	Ave. per Dept.
US CS 1-12	200	16.7	241	20.1	180	15.0	177	14.8
US CS 13-24	142	11.8	170	14.2	176	14.7	144	12.0
US CS 25-36	65	5.9	111	10.1	117	10.6	112	10.2
US CS Other	445	4.0	508	5.5	369	4.0	245	2.7
Canadian	65	3.4	99	5.2	60	3.2	62	3.3
US CE	27	3.9	38	5.4	28	4.0	30	4.3
Total	**944**	**5.5**	**1,167**	**7.6**	**930**	**6.1**	**770**	**5.0**

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pointments for Ph.D. recipients in 1999. While similar to 1998, there was a small increase (from 35% to 38%) this year in the percentage of recipients taking positions in Ph.D.-granting departments. This increase came at the expense of recipients taking positions in government, industry, and abroad.

The number of Master's degrees awarded (Tables 5 and 6, CS plus CE), which increased by 4.3% in 1997 with 130 (80%) departments reporting, and by 11.1% in 1998 with 141 (77%) departments reporting, was up again by 13.1% in 1999 with 156 (77%) departments reporting.

The significant increase in Master's degrees in 1999 probably explains the decrease in the number of students taking the Ph.D. qualifier. Due to the excellent job market and companies that are now willing to hire Master's graduates with H1-B visas, students who originally planned to pursue a Ph.D. are leaving academia with only a Master's degree. The number of Master's degrees for 1999-2000 is projected to be up an additional 3%.

The growth in undergraduate enrollments over the past few years continues to translate into significant increases in the number of Bachelor's degrees awarded (see Tables 5 and 6). Historically, the Ph.D.-granting departments have awarded approximately one-third of the nation's Bachelor's degrees in CS and CE. There were 12,692 awarded in 1999 by the 150 (74%) responding departments, up 25% from the 10,161 awarded in 1998 by the 138 (76%) responding departments. It is projected that 13,883 Bachelor's degrees will be

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Table 2. Gender of Ph.D. Recipients by Type of Degree

	CS	CE	CS & CE
Male	642 (85%)	86 (91%)	728 (85%)
Female	115 (15%)	9 (9%)	124 (15%)
Total have Gender Data for	**757**	**95**	**852**

Table 3. Ethnicity of Ph.D. Recipients by Type of Degree

	CS	CE	CS & CE
Nonresident Alien	300 (41%)	44 (56%)	344 (42%)
African American, Non-Hispanic	15 (2%)	2 (3%)	17 (2%)
Native American or Alaskan Native	0 (0%)	1 (0%)	1 (0%)
Asian or Pacific Islander	66 (9%)	9 (7%)	75 (9%)
Hispanic	14 (2%)	4 (1%)	18 (2%)
White, Non-Hispanic	324 (44%)	20 (33%)	344 (42%)
Other/Not Listed	16 (2%)	3 (0%)	19 (2%)
Total have Ethnicity Data for	**735**	**83**	**818**
Ethnicity/Residency Unknown	22	12	34
Total	**757**	**95**	**852**

Figure 3. B.S. Production 1995-2000

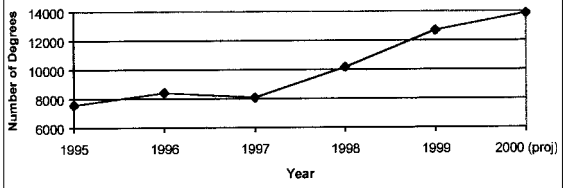

Table 4. Employment of New Ph.D. Recipients by Specialty

New Ph.D.s in Ph.D. Granting Depts.	Artificial Intelligence/ Robotics	Hardware/Architecture	Numerical Analysis/ Scientific Computing	Programming Languages/ Compilers	OS/Networks	Software Engineering	Theory/Algorithms	Graphics/ Human Interfaces	Databases/ Information Systems	Other/Unknown	Total	
Tenure-Track	30	17	4	15	22	21	18	16	12	17	**172**	**(22%)**
Researchers	7	11	3	6	3	2	3	5	4	3	**47**	**(6%)**
Postdocs	16	2	2	1	4	2	8	3	2	5	**45**	**(6%)**
Teaching Faculty	7	2	1	2	3	1	5	1	2	5	**29**	**(4%)**
New Ph.D.s, Other Categories												
Other CS/CE Dept.	7	2	3	2	2	2	2	3	2	0	**25**	**(3%)**
Non-CS/CE Dept.	1	0	0	0	0	1	0	0	0	0	**2**	**(0%)**
Industry	66	48	14	17	58	25	16	36	34	64	**378**	**(49%)**
Government	5	1	0	1	1	3	3	3	1	1	**19**	**(2%)**
Self-Employed	5	0	0	2	3	2	0	0	2	10	**24**	**(3%)**
Employed Abroad	7	2	0	2	3	1	1	1	1	5	**23**	**(3%)**
Unemployed	2	1	0	0	1	0	0	0	0	6	**10**	**(1%)**
Total have Employment Data for	**153**	**86**	**27**	**48**	**100**	**60**	**56**	**68**	**60**	**116**	**774**	**(100%)**
Unknown	13	3	2	1	7	4	1	0	7	40	**78**	
Total	**166**	**89**	**29**	**49**	**107**	**64**	**57**	**68**	**67**	**156**	**852**	

Table 5. Gender of Bachelor's and Master's Recipients

	Bachelor's			Master's		
	CS	CE	Total	CS	CE	Total
Male	7,999 (82%)	1,510 (88%)	9,509 (83%)	3,641 (74%)	468 (75%)	4,109 (74%)
Female	1,745 (18%)	207 (12%)	1,952 (17%)	1,311 (26%)	156 (25%)	1,467 (26%)
Total have Gender Data for	**9,744**	**1,717**	**11,461**	**4,952**	**624**	**5,576**
Unknown	1,065	166	1,231	3	0	3
Total	**10,809**	**1,883**	**12,692**	**4,955**	**624**	**5,579**

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Table 6. Ethnicity of Bachelor's and Master's Recipients

	Bachelor's			Master's		
	CS	CE	Total	CS	CE	Total
Nonresident Alien	623 (9%)	81 (6%)	704 (8%)	2,032 (45%)	370 (65%)	2,402 (47%)
African American, Non-Hispanic	257 (4%)	70 (5%)	327 (4%)	61 (1%)	3 (1%)	64 (1%)
Native American or Alaskan Native	23 (0%)	6 (0%)	29 (0%)	13 (0%)	- (0%)	13 (0%)
Asian or Pacific Islander	1,580 (22%)	275 (19%)	1,855 (21%)	792 (18%)	75 (13%)	867 (17%)
Hispanic	295 (4%)	87 (6%)	382 (4%)	47 (1%)	3 (1%)	50 (1%)
White, Non-Hispanic	4,286 (59%)	885 (61%)	5,171 (60%)	1,341 (30%)	118 (21%)	1,459 (29%)
Other/Not Listed	156 (2%)	56 (4%)	212 (2%)	223 (5%)	4 (1%)	227 (4%)
Total have Ethnicity Data for	**7,220**	**1,460**	**8,680**	**4,509**	**573**	**5,082**
Ethnicity/Residency Unknown	3,589	423	4,012	446	51	497
Total	**10,809**	**1,883**	**12,692**	**4,955**	**624**	**5,579**

Table 7. New Undergraduate Students in Fall 1999 by Department Type and Rank

	CS			CE			CS & CE Majors	
Department, Rank	Premajor	Major	Ave. Major per Dept.	Premajor	Major	Ave. Major per Dept	Total	Ave. Major per Dept
US CS Ranked 1-12	-	1,604	146	205	66	6	1,670	151.8
US CS Ranked 13-24	-	1,655	138	-	399	33	2,054	171.2
US CS Ranked 25-36	174	1,203	109	20	-	-	1,203	109.4
US CS Other	474	9,191	103	-	1,732	19	10,923	122.7
Canadian CS	2,149	3,773	199	583	409	22	4,182	220.1
US CE	1,434	283	40	-	472	67	755	107.9
Total	**4,231**	**17,709**	**118.9**	**808**	**3,078**	**20.7**	**20,787**	**139.5**

Table 8. New Master's Students in Fall 1999 by Department Type and Rank

	CS		CE		CS & CE	
Department, Rank	Total	Ave. per Dept.	Total	Ave. per Dept.	Total	Ave. per Dept.
US CS 1-12	631	52.6	0	0.0	631	52.6
US CS 13-24	540	45.0	38	3.2	578	48.2
US CS 25-36	255	23.2	0	0.0	255	23.2
US CS Other	2,799	30.4	267	2.9	3066	33.3
Canadian	442	23.3	37	1.9	479	25.2
US CE	178	25.4	154	22.0	332	47.4
Total	**4,845**	**31.7**	**496**	**3.2**	**5,341**	**34.9**

Table 9. New Ph.D. Students in Fall 1999 by Department Type and Rank

	CS				CE				CS & CE	
Department, Rank	New Admit	MS to Ph.D.	Total	Ave. per Dept.	New Admit	MS to Ph.D.	Total	Ave. per Dept.	Total	Ave. per Dept.
US CS 1-12	340	47	387	32.3	0	0	0	0.0	387	32.3
US CS 13-24	194	25	219	18.3	40	1	41	3.4	260	21.7
US CS 25-36	278	4	282	25.6	0	0	0	0.0	282	25.6
US CS Other	620	117	737	8.0	50	11	61	0.7	798	8.7
Canadian	62	16	78	4.1	3	1	4	0.2	82	4.3
US CE	18	0	17	2.6	45	18	63	9.0	81	11.6
Total	**1,512**	**209**	**1,721**	**11.2**	**138**	**31**	**169**	**1.1**	**1,890**	**12.4**

Table 10. Bachelor's Degree Program Total Enrollment by Department Type and Rank

	CS			CE			CS & CE Majors	
Department, Rank	Premajor	Major	Average Major per Dept.	Premajor	Major	Average Major per Dept	Total	Average Major per Dept
US CS 1-12	-	6,409	582.6	-	201	18.3	6,610	600.9
US CS 13-24	442	5,404	450.3	102	1,521	126.8	6,925	577.1
US CS 25-36	836	4,393	399.4	-	-	0.0	4,393	399.4
US CS Other	5,712	28,848	324.1	1,112	5,857	65.8	34,705	389.9
Canadian	1,626	12,007	631.9	-	1,444	76.0	13,451	707.9
US CE	141	533	76.1	366	1,200	171.4	1,733	247.6
Total	**8,757**	**57,594**	**386.5**	**1,580**	**10,223**	**68.6**	**67,817**	**455.1**

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Table 11. Master's Degree Total Enrollment by Department Type and Rank

Department, Rank	CS		CE	CS & CE
US CS 1-12	1,027	(8%)	0	1,027
US CS 13-24	1,179	(9%)	85	1,264
US CS 25-36	516	(4%)	0	516
US CS Other	8,367	(67%)	696	9,063
Canadian	1,118	(9%)	119	1,237
US CE	225	(2%)	498	723
Total	**12,432**		**1,398**	**13,830**

Table 12. Ph.D. Degree Total Enrollment by Department Type and Rank

Department, Rank	CS		CE		CS & CE	
US CS 1-12	1,432	(22%)	0	(0%)	1,432	(20%)
US CS 13-24	1,019	(15%)	88	(16%)	1,107	(15%)
US CS 25-36	833	(13%)	0	(0%)	833	(12%)
US CS Other	2,858	(43%)	264	(47%)	3,122	(44%)
Canadian	431	(7%)	51	(9%)	482	(7%)
US CE	24	(0%)	160	(28%)	184	(3%)
Total	**6,597**		**563**		**7,160**	

Table 13. Gender of Ph.D. Program Total Enrollment

	CS		CE		CS & CE	
Male	5,418	(83%)	465	(83%)	5,883	(83%)
Female	1,142	(17%)	92	(17%)	1,234	(17%)
Total have Gender Data for	**6,560**		**557**		**7,117**	
Unknown	37		6		43	
Total	**6,597**		**563**		**7,160**	

Table 14. Ethnicity of Ph.D. Program Total Enrollment

	CS		CE		CS & CE	
Nonresident Alien	2,601	(44%)	263	(56%)	2,864	(45%)
African American, Non-Hispanic	125	(2%)	12	(3%)	137	(2%)
Native American or Alaskan Native	3	(0%)	1	(0%)	4	(0%)
Asian or Pacific Islander	593	(10%)	31	(7%)	624	(10%)
Hispanic	93	(2%)	6	(1%)	99	(2%)
White, Non-Hispanic	2,360	(40%)	156	(33%)	2,516	(39%)
Other/Not Listed	127	(2%)	0	(0%)	127	(2%)
Total have Ethnicity Data for	**5,902**		**469**		**6,371**	
Ethnicity/Residency Unknown	695		94		789	
Total	**6,597**		**563**		**7,160**	

Table 15. Bachelor's Degree Candidates for 1999-2000 by Department Type and Rank

Department, Rank	CS		CE		CS & CE	
US CS 1-12	1,727	(15%)	61	(3%)	1,788	(13%)
US CS 13-24	1,182	(10%)	471	(24%)	1,653	(12%)
US CS 25-36	1,198	(10%)	-	(0%)	1,198	(9%)
US CS Other	5,114	(43%)	973	(49%)	6,087	(44%)
Canadian	2,531	(21%)	216	(11%)	2,747	(20%)
US CE	155	(1%)	255	(13%)	410	(3%)
Total	**11,907**		**1,976**		**13,883**	

Table 16. Master's Degree Candidates for 1999-2000 by Department Type and Rank

Department, Rank	CS		CE		CS & CE	
US CS 1-12	682	(13%)	0	(0%)	682	(12%)
US CS 13-24	456	(9%)	52	(9%)	508	(9%)
US CS 25-36	441	(9%)	0	(0%)	441	(8%)
US CS Other	3,151	(61%)	295	(51%)	3,446	(60%)
Canadian	355	(7%)	32	(6%)	387	(7%)
US CE	74	(1%)	194	(34%)	268	(5%)
Total	**5,159**		**573**		**5,732**	

Figure 4. Number of Ph.D.s granted to Three Underrepresented Minorities 1996-1999

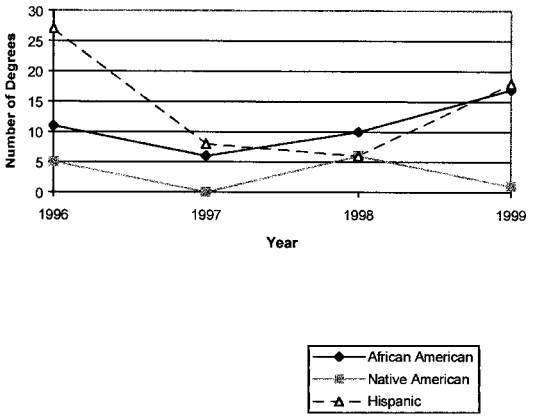
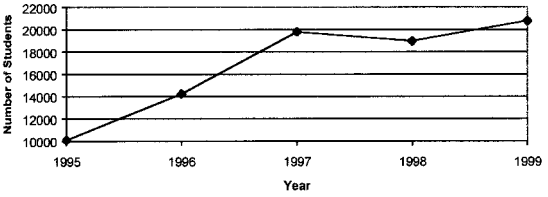


Figure 5. New Undergraduate Enrollment 1995-1999



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awarded in the academic year 2000 (up an additional 9%). Figure 3 shows the B.S. production rate (CS plus CE) from 1995 to 2000. The largest rate of growth, 45%, was in the CE programs. However, this number does include the CE Bachelor's degrees awarded by a number of departments in the CS grouping that offer both CS and CE degrees (e.g., University of Washington, Penn State University, University of Michigan, University of Florida, and Auburn University).

Once again, the ethnicity and gender statistics for Ph.D., Master's, and Bachelor's degree recipients (Tables 2, 3, 5, and 6) remained relatively static, with a few exceptions. The percentage of Ph.D. CE degrees awarded to women dropped from 17% last year to 9% this year. Once again, this may be a reflection of the low response rate for CE departments. The numbers of Ph.D. recipients for three underrepresented groups for the past four years are depicted in Figure 4.

Student Enrollment *(Tables 7-16)*

New enrollment in Ph.D. programs (Table 9, CS plus CE) is up 6% compared with last year. This is a much smaller increase than last year's growth rate of 24%. Total Ph.D. enrollment (see Table 12) is 7,160, up less than 1% from last year. These two data points together indicate a leveling of Ph.D. enrollments.

New enrollment in M.S. programs (Table 8, CS plus CE) is up 26%, improving on last year's increase of 24%. In particular, the US CE new enrollment increased by 107% with 5 of 24 schools reporting this year, compared with 7 of 19 last year. Also worth noting is that the new enrollments in Canadian M.S. programs (CS plus CE) increased by 79% over last year, with 19 of 23 schools reporting this year compared with 12 of 18 last year. Total M.S. enrollment (Table 11, CS plus CE) increased by 13%; CE alone increased 43%.

Figure 5 shows the trend in new undergraduate enrollments (CS plus CE, excluding premajors) for the period 1996 to 1999 (see also Table 7). The percentage increase this year over last was 10% for CS and 7% for CE. This growth is primarily due to the increase in new CS enrollment for Canadian schools of a whopping 99%.

This is the first year that data on premajors were collected. Some departments surveyed do not accept students as majors until

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Table 17. Anticipated Faculty Size by Position

	1999-2000	2000-2001	2001-2001	Expected Two-Year Growth
Tenure-Track	3,183	3,166	3,388	205 (6%)
Researcher	298	306	345	48 (16%)
Postdoc	250	241	274	24 (9%)
Teaching Faculty	505	496	538	33 (7%)
Other/Not Listed	109	106	122	13 (12%)
Total	**4,344**	**4,315**	**4,667**	**323 (7%)**

Table 18. Anticipated Faculty by Department Type and Rank

Department, Rank	1999-2000	2000-2001	2001-2001	Expected Two-Year Growth
US CS 1-12	582	644	690	108 (19%)
US CS 13-24	435	497	540	104 (24%)
US CS 25-36	390	388	414	25 (6%)
US CS Other	2,130	1,962	2,127	-3 (0%)
Canadian	632	646	721	90 (14%)
US CE	176	178	175	-1 (-1%)
Total	**4,344**	**4,315**	**4,667**	**323 (7%)**

Table 19. Gender of Newly Hired Faculty

	Tenure-Track	Researcher	Postdoc	Teaching Faculty	Other	Total
Male	285 (87%)	44 (92%)	73 (87%)	110 (77%)	9 (75%)	521 (85%)
Female	42 (13%)	4 (8%)	11 (13%)	32 (25%)	3 (25%)	92 (15%)
Total	**327 (53%)**	**48 (8%)**	**84 (14%)**	**142**	**12 (2%)**	**613**

Table 20. Ethnicity of Newly Hired Faculty

	Tenure-Track	Researcher	Postdoc	Teaching Faculty	Other	Total
Nonresident Alien	46 (15%)	9 (19%)	32 (38%)	12 (9%)	1 (8%)	100
African American, Non-Hispanic	3 (1%)	1 (2%)	0 (0%)	5 (4%)	0 (0%)	9
Native American or Alaskan Native	2 (1%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	3
Asian or Pacific Islander	63 (20%)	11 (23%)	13 (15%)	13 (9%)	0 (0%)	100
Hispanic	3 (1%)	2 (4%)	0 (0%)	2 (1%)	0 (0%)	7
White, Non-Hispanic	182 (58%)	14 (30%)	34 (40%)	105 (75%)	9 (75%)	344
Other/Not Listed	14 (4%)	10 (21%)	5 (6%)	2 (1%)	2 (17%)	33
Total have Ethnicity Data for	**313**	**47**	**84**	**140**	**12**	**596**
Ethnicity/Residency Unknown	14	1	0	2	0	17
Total	**327**	**48**	**84**	**142**	**12**	**613**

Table 21. Gender of Current Faculty

	Full	Associate	Assistant	Teaching Faculty	Total
Male	1,321 (92%)	950 (88%)	624 (84%)	428 (75%)	3,323 (87%)
Female	115 (8%)	132 (12%)	120 (16%)	146 (25%)	513 (13%)
Total	**1,436 (37%)**	**1,082 (28%)**	**744 (19%)**	**574 (15%)**	**3,836**

Table 22. Ethnicity of Current Faculty

	Full	Associate	Assistant	Teaching Faculty	Total
Nonresident Alien	34 (2%)	17 (2%)	98 (14%)	27 (5%)	176 (5%)
African American, Non-Hispanic	4 (0%)	5 (0%)	9 (1%)	12 (2%)	30 (1%)
Native American or Alaskan Native	5 (0%)	7 (1%)	8 (1%)	1 (0%)	21 (1%)
Asian or Pacific Islander	231 (17%)	216 (21%)	131 (18%)	49 (9%)	627 (17%)
Hispanic	18 (1%)	14 (1%)	12 (2%)	6 (1%)	50 (1%)
White, Non-Hispanic	1,063 (76%)	744 (71%)	430 (60%)	465 (82%)	2,702 (72%)
Other/Not Listed	35 (3%)	48 (5%)	33 (5%)	8 (1%)	124 (3%)
Subtotal	**1,390**	**1,051**	**721**	**568**	3,730
Ethnicity/Residency Unknown	46	31	23	6	106
Total	**1,436**	**1,082**	**744**	**574**	3,836

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Table 23. Faculty Losses

	Total
Died	5
Retired	53
Took Academic Position Elsewhere	75
Took Nonacademic Position	54
Remained, Changed to Part Time	11
Other	10
Unknown	3
Total	**211**

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the end of their sophomore year. Undoubtedly some departments included such premajors in their major counts in previous survey years. Looking at major counts only, total undergraduate enrollment for CS was down slightly (less than 1%), while total enrollment for CE was up 12% over last year.

Reversing earlier trends of a slow but steady increase in the percentage of women enrolled in CS Ph.D. programs, the number declined this year to 1,142 (down to 17%, see Table 13), compared with 1,247 last year. There were no significant changes in the ethnicity of CS Ph.D. students (Table 14). The percentage of nonresident alien CE Ph.D. students went up slightly this year from 53% to 56% and the percentage of African Americans jumped from less than 1% to 3%, balanced with a decline in the percentage of Asians and Pacific Islanders from 11% last year to 7% this year.

Faculty Demographics *(Tables 17-23)*

The number of faculty in tenure-track positions (Table 17) increased by 206 (7%) over last year. But the most interesting change in faculty demographics is the large increase in Canadian faculty sizes to 632 (see Table 18), up 65% compared with last year's number of 383. Recall that the response rate for Canadian schools was significantly higher this year compared with last (83% compared with 67%). However, in light of the significant increase in B.S. and M.S. student enrollment in Canada, we hope that this truly reflects an increase in Canadian faculty numbers (at least, for the sake of our Canadian sisters' sanity, we hope this is the case).

For the second year in a row, 13% of the new faculty hired into the tenure-track were women (Table 19), while 15% of the Ph.D. recipients (CS plus CE) were women (Table 2). The number of female professors remained stable at 16% for assistants, 12% for associates, and 8% for full. At this rate, it's going to take a very, very, very long time to attain gender equity. Significant ethnicity changes include a doubling of the number of African American full professors (from 2 to 4) and an increase (from 1 to 8) in the number of Native American assistant professors (see Table 22).

Faculty Salaries *(Tables 24-31)*

Average increases in salary levels at US institutions (CS only) ranged from 2.5% to 6.3%, with the smallest increase at the full professor level and the largest at the assistant professor level (Table 24). The increase at the assistant level is higher than last year, but the increase at the full professor level is slightly lower. Canadian salaries posted larger increases ranging from 5.4% for full professors to 9.6% at the assistant professor level (see Table 29). Salaries reported for US institutions are 9-month salaries reported in US dollars; those for Canadian institutions are 12-month salaries reported in Canadian dollars. The overall mean salaries reported in the center column in Tables 24 through 31 are unweighted means, calculated by averaging the mean salaries reported by each department. They are ***not*** weighted by the number of CS and CE faculty at each institution.

Average salaries for new tenure-track and researcher Ph.D.s in US CS and CE departments rose approximately 6%. On the other hand, average salaries for non-tenure teaching faculty and postdocs dropped 3.2% and 7.3%, respectively.

The salary figures in the first column of Table 25 that appear to be inverted are correct. This phenomenon was also observed last year.

Rankings

For tables that group computer science by rank, the rankings are based on information collected in the 1995 assessment of research and doctorate programs in the United States conducted by the National Research Council.

The top twelve schools in this ranking are: Stanford, Massachusetts Institute of Technology, University of California at Berkeley, Carnegie Mellon, Cornell, Princeton, University of Texas at Austin, University of Illinois at Urbana-Champaign, University of Washington, University of Wisconsin at Madison, Harvard, and California Institute of Technology. All schools in this ranking participated in the survey this year. One department declined to submit faculty salary information.

CS departments ranked 13-24 are: Brown, Yale, University of California at Los Angeles, University of Maryland at College Park, New York University, University of Massachusetts at Amherst, Rice, University of Southern California, University of Michigan, University of California at San Diego, Columbia, and University of Pennsylvania.[2] All schools in this ranking participated in the survey this year.

CS departments ranked 25-36 are: University of Chicago, Purdue, Rutgers, Duke, University of North Carolina at Chapel Hill, University of Rochester, State University of New York at Stony Brook, Georgia Institute of Technology, University of Arizona, University of California at Irvine, University of Virginia, and Indiana. All schools in this ranking participated in the survey this year. One department provided faculty salary data only.

CS departments ranked above 36 or unranked that responded to the survey include: Arizona State, Auburn, Case Western Reserve, City University of New York, Clemson, William and Mary, Colorado School of Mines, Colorado State, Dartmouth, DePaul, Drexel, Florida Atlantic, Florida Institute of Technology, Florida International, Florida State, Iowa State, Johns Hopkins, Kansas State, Kent State, Lehigh, Louisiana State, Michigan State, Michigan Technological, Mississippi State, Naval Postgraduate School, North Carolina State, North Dakota State, Northeastern, Northwestern, Oakland, Ohio State, Oklahoma State, Old Dominion, Oregon Graduate Institute, Oregon State, Pennsylvania State, Rensselaer Polytechnic Institute, Southern Methodist, State University of New York (Albany and Buffalo), Syracuse, Temple, Texas A&M, Texas Tech, Tufts, University of Alabama (Birmingham, Huntsville, and Tuscaloosa), University of California (Davis, Riverside, Santa Barbara, and Santa Cruz), Central Florida, Colorado (Boulder and Colorado Springs), Illinois (Chicago), Maryland (Baltimore Co.), Nebraska (Lincoln), Nevada (Las Vegas), South Florida, Southwestern Louisiana, Tennessee (Knoxville), Texas (Arlington, Dallas, and El Paso), Wisconsin (Milwaukee), Connecticut, Delaware, Denver, Florida, Hawaii, Houston, Idaho, Iowa, Kansas, Kentucky, Maine, Minnesota, Mississippi, New Hampshire, New Mexico, North Texas, Oklahoma, Oregon, Pittsburgh, South Carolina, Utah, Washington, Wyoming, Vanderbilt, Virginia Polytechnic, Wayne State, West Virginia, Western Michigan, Worcester Polytechnic, and Wright State.

Computer Engineering departments participating in the survey this year include: Northwestern, Purdue, Santa Clara, University of Cincinnati, and University of New Mexico.

Canadian departments participating in the survey include: Concordia, Dalhousie, McGill, Memorial, Queen's, Simon Fraser, Western Ontario, Alberta, British Columbia, Calgary, Manitoba, New Brunswick, Ottawa, Saskatchewan, Toronto (CS and ECE), Victoria, Waterloo, and York.

The following 18 departments that did not complete this year's survey did provide the number of Ph.D.s they produced in 1998-99: Boston, Brandeis, George Mason, George Washington, Montana State, New Jersey Institute of Technology, New Mexico State, New Mexico Tech, Polytechnic University, SUNY Binghamton, Stevens Institute of Technology, Tulane, Missouri (Columbia and Rolla), Georgia, Louisville, Tulsa, and Washington State.

Acknowledgments

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Endnotes

[1]The title of the survey honors the late Orrin E. Taulbee of the University of Pittsburgh who conducted these surveys for the Computer Science Board until 1984, with retrospective annual data going back to 1970.

[2]Although the University of Pennsylvania and the University of Chicago were tied in the National Research Council rankings, CRA made the arbitrary decision to place Pennsylvania in the second tier of schools.

All tables with rankings: Statistics sometimes are given according to departmental rank. Schools are ranked only if they offer a CS degree and according to the quality of their CS program as determined by reputation. Those that only offer CE degrees are not ranked, and statistics are given on a separate line, apart from the rankings.

All ethnicity tables: Ethnic breakdowns are drawn from guidelines set forth by the U.S. Department of Education.

All faculty tables: The survey makes no distinction between faculty specializing in CS versus CE programs. Every effort is made to minimize the inclusion of faculty in electrical engineering who were not computer engineers.

1998-1999 Taulbee Survey

Table 24. Nine-Month Salaries, 132 Responses of 155 US Computer Science Departments

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Non-Tenure Teaching Faculty	429	$24,000	$43,439	$98,131	$48,609	$29,500	$55,226	$126,904
Assistant	600	$40,000	$61,065	$75,500	$64,244	$54,583	$67,995	$84,000
Associate	841	$42616	$65,767	$90,000	$72,177	$57,677	$80,286	$131,667
Full	1107	$45,600	$77,150	$109,650	$95,526	$63,400	$121,966	$239,135

Table 25. Nine-Month Salaries, 11 Responses of 12 US Computer Science Departments Ranked 1-12

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Non-Tenure Teaching Faculty	59	$24,470	$56,943	$98,131	$65,273	$48,434	$74,082	$126,904
Assistant	84	$55,650	$64,992	$68,800	$69,414	$67,300	$74,435	$81,800
Associate	89	$51,050	$71,415	$90,000	$79,686	$77,570	$86,700	$95,000
Full	202	$45,600	$81,557	$93,300	$108,896	$130,000	$149,875	$180,000

Table 26. Nine-Month Salaries, 12 Responses of 12 US Computer Science Departments Ranked 13-24

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Non-Tenure Teaching Faculty	46	$33,333	$48,010	$65,592	$57,296	$48,428	$68,229	$83,200
Assistant	54	$61,192	$65,576	$70,000	$69,546	$67,000	$75,091	$81,800
Associate	66	$61,811	$72,096	$82,000	$80,715	$80,200	$89,574	$101,750
Full	172	$66,818	$83,735	$109,650	$108,595	$130,000	$156,953	$239,135

Table 27. Nine-Month Salaries, 12 Responses of 12 US Computer Science Departments Ranked 25-36

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Non-Tenure Teaching Faculty	28	$38,000	$49,904	$65,000	$56,036	$43,900	$63,467	$120,000
Assistant	75	$58,000	$64,248	$71,000	$67,301	$62,237	$71,040	$80,000
Associate	81	$60,810	$70,585	$83,400	$77,710	$70,000	$89,241	$131,667
Full	137	$67,574	$79,296	$92,383	$102,842	$96,678	$139,909	$190,000

Table 28. Nine-Month Salaries, 96 Responses of 120 US Computer Science Departments Ranked Higher than 36 or Unranked

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Non-Tenure Teaching Faculty	296	$24,000	$40,470	$95,000	$44,693	$29,500	$50,478	$95,000
Assistant	387	$40,000	$59,593	$75,500	$62,538	$54,583	$65,911	$84,000
Associate	605	$42,616	$63,747	$87,000	$70,310	$57,667	$77,395	$104,700
Full	596	$52,898	$75,933	$100,000	$91,164	$63,400	$112,799	$235,000

Table 29. Twelve-Month Salaries, 19 Responses of 23 Canadian CS & CE Departments (Canadian Dollars)

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Non-Tenure Teaching Faculty	43	$35,500	$47,728	$70,000	$51,267	$39,008	$56,452	$83,696
Assistant	91	$46,640	$61,012	$80,916	$64,862	$51,728	$69,526	$90,725
Associate	139	$54,000	$67,755	$90,030	$77,109	$73,352	$87,161	$120,000
Full	190	$58,088	$79,781	$109,867	$95,766	$79,712	$118,756	$168,299

Table 30. Nine-Month Salaries for New Ph.D's, Responding US CS & CE Departments

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Tenure-Track	103	$42,000	$63,893	$83,000	$64,283	$55,000	$65,283	$83,000
Researcher	7	$40,200	$56,400	$82,000	$57,400	$48,000	$58,000	$62,000
Non-Tenure Teaching Faculty	13	$36,000	$50,555	$68,000	$50,861	$36,000	$51,000	$68,000
Postdoc	11	$25,000	$34,333	$44,000	$36,833	$35,000	$41,000	$55,000

Table 31. Nine-Month Salaries, 5 Responses of 24 US CE Departments

Faculty Rank	Number of Faculty	Reported Salary Minimum			Average of all Salaries	Reported Salary Maximum		
		Minimum	Mean	Maximum		Minimum	Mean	Maximum
Non-Tenure Teaching Faculty	3	$29,024	$39,675	$50,000	$39,675	$29,024	$39,675	$50,000
Assistant	26	$57,420	$60,606	$65,000	$62,942	$61,524	$66,713	$73,000
Associate	53	$60,543	$66,012	$71,300	$70,781	$74,619	$80,582	$89,500
Full	70	$66,393	$80,133	$91,000	$91,168	$94,988	$127,668	$150,500

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Performance Computing and Communications program (HPCC), the Next Generation Internet initiative (NGI), and the short-lived Information Technology for the 21st Century initiative (IT^2). (Also, a portion of the Department of Energy's Accelerated Strategic Computing Initiative [ASCI], and some base computing research programs not formerly counted as HPCC or IT^2, are now included under the IT R&D umbrella.) Collectively, IT R&D programs would receive nearly $600 million in new funding; the aggregate FY 2001 budget, $2.3 billion, would be about $1 billion more than FY 1999 spending.

IT R&D priorities for FY 2001 include: teams to exploit advances in computing; infrastructure for advanced computational modeling and simulation; more reliable software; storing, managing, and preserving data; intelligent machines and networks of robots; ubiquitous computing and wireless networks; managing and ensuring the security and privacy of information; future generations of computers; broadband optical networks; social, economic, and workforce implications of IT; and educating and training a new generation of researchers.

Given the new classification, it is expected that the Administration will consolidate the various interagency coordination mechanisms for IT R&D programs.

Following are descriptions of the budget requests of the major players in federal IT R&D efforts.

National Science Foundation

The National Science Foundation budget request for FY 2001 is $4.6 billion, an increase of $675 million, the largest requested dollar increase in the agency's history and more than 17 percent above current funding. NSF Director Rita Colwell calls it a "21st century budget for 21st century science and engineering."

Focused Initiatives. The NSF is highlighting four focused initiatives in FY 2001 (see Table 4), each of which would see its funding more than doubled.

The Information Technology Research initiative includes the three following components: 1) $190 million would be spent by the Computer and Information Science and Engineering directorate on its ITR activity; 2) $45 million, from the Major Research Equipment line item, is slated for the Terascale Computing Systems program to fund another node associated with the Partnership for Advanced Computational Infrastructure; and 3) an additional $92 million would be scattered throughout the remaining NSF directorates. The initiative can also be disaggregated by function: $133 million for IT research; $101 million for IT infrastructure; $74 million for IT applications; and $19 million for IT education.

NSF Research. NSF's total support for research would be expanded by nearly 20 percent, to $3.54 billion in FY 2001. While the increases for the focused initiatives account for about $490 million of NSF's overall proposed budget increase, for the first time in many years a portion of the funding increment would be used to strengthen investments in core disciplinary research, including computing research.

In another notable development, the current plans for FY 2000 and FY 2001 would catapult CISE over Biological Sciences and Engineering as the NSF's third largest research directorate.

Computer and Information Science and Engineering. The budget request for the CISE Directorate is $529.1 million, an increase of $140.7 million (or 36 percent) over estimated FY 2000 spending. Most of the increase, $100 million, would be for the Information Technology Research program; an additional $40 million would be distributed among the traditional divisions and activities.

CISE's Information Technology Research (ITR) activity supports broad thematic, large-scale, long-term, basic computer science research, including research that entails a higher risk than that prevailing in established areas. Priority areas include: building "no-surprise," performance-engineered software and infrastructure systems; realizing broadband Internet access for tetherless devices; understanding, modeling, and predicting the behavior of networks; hardware/software co-design; multiplying individuals' physical and mental capabilities; meeting, working, and collaborating in cyberspace; building a ubiquitous content infrastructure for seamless retrieval of available information; and empowering computational discovery.

With the proposed FY 2001 increment, CISE would expand ITR to include support for connectivity programs; IT applications in biology; research to determine the reasons for the lower participation of women and minorities in IT education and career paths; research in interactive education; and mathematical methods underlying software, high confidence systems, large-scale networking, and high-end computing.

CISE also plans to participate in two of the other NSF-wide initiatives: $5 million would be spent on research in support of the Nanoscale Science and Engineering initiative in the following areas: quantum computing; self-assembly of biomolecular computer components; algorithms for extracting signals from noise in atomic force microscopy; nano-robotics; design automation tools; and nanoscale cellular automata.

CISE would contribute $1.25 million to the 21st Century Workforce initiative to support programs that encourage creative approaches to meeting U.S. IT workforce needs and to participate in the Interagency Education Research Initiative. This figure is up from $1.15 million in FY 2000.

Apart from the focused initiatives, CISE would also use $21 million of its increment to expand support for disciplinary research. Priority areas include: research in cognitive neuroscience to increase understanding of how the human brain performs computational types of actions, such as recognizing faces or voices; research, demonstrations, and technical assistance on ways to make technology more accessible; research in methods for storage and access of scientific data to improve the use of existing resources; research on visualization and analysis for large, scientific data sets; research on new mechanisms for computing, such as quantum devices and DNA

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Table 2. Information Technology R&D Funding by Agency
in millions of US dollars

	FY 2000 Estimate	FY 2001 Proposed	FY 00-01 % change
National Science Foundation	517	740	43%
Department of Energy	517	667	29%
Office of Science	120	190	58%
Accelerated Strategic Computing Initiative	397	477	20%
Department of Defense	282	397	41%
Defense Advanced Research Projects	195	307	57%
National Security Agency	77	80	4%
University Research Initiatives	10	10	--
Dept. of Health and Human Services	191	233	22%
National Institutes of Health	183	217	19%
Agency for Healthcare Research & Quality	8	16	100%
NASA	174	230	32%
Department of Commerce	36	44	22%
Environmental Protection Agency	4	4	--
Total, IT R&D	**1,721**	**2,314**	**35%**

Table 3. National Science Foundation Budget
in millions of US dollars

	FY 1999 Actual	FY 2000 Estimate	FY 2001 Proposed	FY 00-01 % change
Research & Related Activities	2,821.6	2,958.5	3,540.7	19.7%
Education & Human Resources	662.5	690.9	729.0	5.5%
Major Research Equipment	56.7	93.5	138.5	48.2%
Administrative Expenses	149.5	154.3	164.2	6.4%
Total R&D	**3,690.5**	**3,897.2**	**4,572.4**	**17.3%**

Table 4. NSF Focused Initiative Budgets
in millions of US dollars

	FY 2000 Estimate	FY 2001 Proposed	FY 00-01 % change
Information Technology Research	126.0	326.9	159%
Nanoscale Science and Engineering	97.3	216.7	123%
Biocomplexity in the Environment	50.0	136.3	173%
21st Century Workforce	73.7	157.0	113%

Table 5. NSF Research Directorate Budgets
in millions of US dollars

	FY 1999 Actual	FY 2000 Estimate	FY 2001 Proposed	FY 00-01 % change
Biological Science	392.1	414.4	511.1	23.3%
Computer Information S&E	298.6	388.4	529.1	36.2%
Engineering	370.1	381.8	456.5	19.6%
Geosciences	478.0	487.8	583.0	19.5%
Math & Physical Sciences	733.7	757.6	881.2	16.3%
Social, Behav., & Economic Sciences	142.0	146.1	175.1	19.8%
Integrative Activities*	161.6	129.2	119.2	-7.7%

*includes major research instrumentation, the Opportunity Fund, and the Science and Technology Centers

Table 6. NSF Computer and Information Science & Engineering Budgets
in millions of US dollars

	FY 1999 Actual	FY 2000 Estimate	FY 2001 Proposed	FY 00-01 % change
Computer-Communications Research	60.34	60.16	69.16	15.0%
Information & Intelligent Systems	41.22	41.62	53.70	29.0%
DevExperimental & Integrative Activities	57.57	57.62	63.32	9.9%
Advanced Computational Infrastructure	69.05	70.83	75.83	7.1%
Advanced Computational Research	9.00	7.27	8.32	14.4%
Advanced Networking Infrastructure	42.27	43.90	45.40	3.4%
Advanced Networking Research	19.11	17.42	23.37	37.3%
Information Technology Research	0.00	90.00	190.00	111.0%
Total CISE	**298.55**	**388.42**	**529.10**	**36.2%**

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or chemical-based techniques; fundamental research on networking to address needs such as increased users, new types of services, increased complexity of protocols, and wireless networked devices; research in biological applications such as genome sequencing and database tools, protein motif recognition, biomolecular computing, computational biology, and hydrology and ecosystems modeling.

Another budget item slated for growth is research in support of the interagency Critical Infrastructure Protection R&D initiative. CISE would increase its contribution by $4 million (most expected to come from the ITR activity) to a total of $29 million in FY 2001. This initiative provides for research in networking, high performance computing, and software that will enable computer and communications systems to be safer, more reliable, and free from intrusions.

Across its programs, CISE intends to increase the average size of awards by 10 percent and the average duration of awards to 3.3 years to meet NSF-wide objectives for FY 2001.

The Department of Defense

The Department of Defense's FY 2001 budget request for research, development, test, and evaluation (RDT&E) is $37.9 billion, down from estimated FY 2000 spending of $38.3 billion. However, basic research at DOD would increase by about 5 percent to $1.2 billion. There are three DOD components included in the IT R&D crosscut: 1) a portion of support from the Defense Advanced Research Projects Agency for computing and communications R&D (see below); 2) $80 million for the National Security Agency's Advanced Research and Development Activity (ARDA), a joint effort of the Defense Department and the intelligence community to support long-term research on problems and enabling technologies relevant to intelligence and information security; and 3) $10 million for fundamental IT research within the DOD-wide University Research Initiative, a competitive program managed through the office of the Director of Defense Research and Engineering.

DOD also participates in the Critical Infrastructure Protection R&D initiative; the National Security budget would be $463 million in FY 2001, up from current spending of $418 million.

Defense Advanced Research Projects Agency. While support for RDT&E would decrease at each of the service branches, DARPA's budget request, at just under $2.0 billion, is 4 percent more than the estimated FY 2000 budget. There are three DARPA line items related to computing: Computing Systems and Communications Technology, with an FY 2001 budget of $377 million, 17 percent more than current funding; Next Generation Internet, whose budget would shrink from $36 million to $15 million in FY 2001, as the NGI initiative begins to wind down; and Extensible Information Systems, a line item created in FY 2000 to reflect DARPA's participation in IT^2. As it did in FY 2000, DARPA is requesting $70 million for Extensible Information Systems, up from the FY 2000 appropriation of $30 million.

Department of Energy

The Department of Energy's theme for FY 2001 is "Strength Through Science," and indeed, R&D programs would grow by 8 percent, from $7.1 to $7.7 billion, under its budget plan. More than half of this R&D supports DOE's defense and nuclear weapons mission. Spending on civilian R&D programs, conducted through the Office of Science, would grow to $3.2 billion, up from $2.8 billion in FY 2000, an increase of 13 percent. The office will emphasize a number of thrusts in FY 2001, including non-defense scientific supercomputing; nanoscale discovery, as part of the National Nanotechnology Initiative; and life sciences and bioengineering.

DOE's two computing programs—the Advanced Scientific Computing Research (ASCR) activity in the Office of Science and the Accelerated Strategic Computing Initiative (ASCI), a component of the Nuclear Stockpile Stewardship program—would both see healthy budget increases in FY 2001.

The ASCR budget would grow from $127.9 million to $182.0 million, a 42-percent increase. Under the FY 2001 plan, ASCR would emphasize computer modeling and simulation R&D in several key areas of basic science, including fusion, high energy physics, and genomics; development of scientific computing, networking, and collaboration tools needed by DOE researchers; and advanced scientific software that would enable unique, data-intensive collaboratories of the future and meet terascale software challenges. DOE's Accelerated Strategic Computing Initiative, funded at $510.2 million in FY 2000, would increase to $595.2 million in FY 2001.

Portions of both ASCR and ASCI funding are included under the IT R&D crosscut, as are some smaller efforts in other disciplines supported by the Office of Science.

Other Agencies

National Institutes of Health. The NIH budget would total $18.8 billion in FY 2001, an increase of $1 billion (or 5.6 percent) over last year's funding level. One of NIH's budget thrusts is Fostering Interdisciplinary Research, and it includes a new Biomedical Information Science and Technology Initiative (BISTI). For several years, NIH has been emphasizing that progress in biomedical research depends on expertise from many disciplines beyond the traditional ones of biology and medicine, including computing and computational expertise. BISTI is designed to address these needs, and will include support for National Programs of Excellence in Biomedical Computing Support; development of new tools and technologies to handle the increasing amount of biomedical data; training of bioinformatics specialists to address emerging research needs; and Centers of Excellence in Genomic Science. A portion of BISTI funding, $217 million in FY 2001, is counted as part of the IT R&D initiative.

On February 15, as CRN was going to press, the House of Representatives passed the Networking and Information Technology Research and Development Act (H.R. 2086) by voice vote. The legislation, which was sponsored by House Science Chairman James Sensenbrenner and endorsed by CRA, would authorize nearly $7 billion for high performance computing and information technology research programs at seven agencies over the next five years and reorient the federal investment toward fundamental research. For more information, please see: http://www.cra.org/govaffairs/issues/nitrd.html.

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which they could compete with each other in a variety of vertical applications, such as music, books, news, and software. As a utility, it would not compete with any of them itself. Its primary revenue source would be a small fraction of each transaction in the system (rather like the credit card companies, but a smaller percentage). Thus its income would be directly related to the success of its partners in using its system for real commerce. This model has survived essentially intact.

By 1996, the world was changing rapidly: e-commerce was becoming a hot topic, companies were starting to announce e-commerce products, and it appeared that the world would soon be ready for the system EPR was designing. Owners of IP (particularly music and videos) were becoming painfully aware that a pirated digital copy posted on the Web could be rapidly duplicated anywhere in the world, and that they had no effective protection against digital piracy. It was time for EPR to prepare to launch its system. This called for an order-of-magnitude expansion. EPR recruited substantial engineering and business development groups to complete a production system and to arrange partnerships. It also changed its name to InterTrust Technologies Corporation.

Shear had always planned that, as the company grew, the development and advanced development groups would eventually be supplemented by a full-scale research lab. While engineering focused on building products on schedule, another group would be responsible for ensuring that the company had adequate technical options further down the road.

By the end of 1996, internal and external developments made it clear that "eventually" should come very soon. We could see several key problems requiring research that we could not rely on anyone else doing for us. At the same time, potential partners were looking for clear evidence that InterTrust would maintain the technological lead that had resulted from its head start. Shear asked me to develop a proposal for a research lab.

Much of my proposal was based

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on what I learned from nearly twenty years of closely observing Bob Taylor at Xerox PARC and DEC/SRC, adapted to the very different environment at InterTrust and to Shear's vision for the new laboratory. Working closely with John Guttag, I wrote draft Roles, Principles, and Charter documents and had them reviewed by several people.

The proposed mission of the lab was to conduct research and related activities that would ultimately benefit InterTrust. More specifically, it was to:

- Maintain and increase InterTrust's lead in relevant technologies;
- Invent and discover technologies that would create new business opportunities;
- Track the state-of-the-art and advise InterTrust on its strategic implications;
- Ensure that relevant technology became part of InterTrust's practice and products;
- Consult with all parts of InterTrust on issues related to technology; and
- Demonstrate that InterTrust could govern its own technological destiny.

InterTrust's executives accepted my proposal with only minor modifications. Large parts of it are still on our website (http://www.star-lab.com/details.html) and form the continuing basis of our operation.

InterTrust established the Strategic Technologies and Architectural Research Laboratory in February 1997. We believe it was the first lab fully devoted to research in digital rights management and related electronic commerce technologies. At that time, the company had about 60 employees, and the lab had two members. Since then, the company has grown more than three-fold, and STAR Lab has grown to 14 members, including Susan Owicki, Bob Tarjan, Jim Donahue, Andrew Goldberg, and younger members with "STAR potential." With strong support from management, we expect substantial continued growth, limited mainly by our ability to recruit people of the requisite quality, talents, and interests.

STAR Lab is intentionally co-located with the rest of the company, physically closest to advanced development and product development. We also have surprisingly strong ties to marketing and business development, and try to minimize barriers to interaction with all parts of InterTrust. Not being in a large company helps. More importantly, the lab is populated by researchers who have a keen interest in doing research that changes the world and who are willing to put extra effort into communicating their ideas.

STAR Lab spans the spectrum from theoretical to applied research. However, on another spectrum, from strategy-driven to curiosity-driven, most of its projects are near the strategic end. That is, they are motivated more by potential needs of InterTrust than by "a pure sense of wonder." In Donald E. Stokes's classification,[1] STAR Lab works in "Pasteur's Quadrant" and "Edison's Quadrant," rather than "Bohr's Quadrant." STAR Lab's most valued results are those that inform and influence InterTrust's business and technical strategies.

STAR Lab members are working in a variety of areas, including: languages for electronic contracts; theory of auctions for digital goods; secure databases; system security and cryptography; software self-defense; code obfuscation; secure hardware; and digital watermarking. We will be starting work in a number of related areas, when they meet the following three criteria:

1. The result could be important to InterTrust.
2. We have, or can obtain, the necessary expertise.
3. There is a plausible idea to pursue.

I am now ready to return to the original question, "How can InterTrust afford a substantial research lab?"

Given that:

- InterTrust has largely developed its own technology and sees many important research problems ahead that we dare not wait for others to solve for us;
- The field is so large that InterTrust needs strong bonds to the larger research community;
- InterTrust's partner strategy depends on its promise of continuing technological leadership;
- InterTrust's success in competing with giant companies is buttressed by its strong patent position;

the real question is, "How could InterTrust afford ***not*** to have a first-class research lab?"

———

[1] Donald E. Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation*, Brookings Institution, 1997.

Dr. Horning is the director of InterTrust's Strategic Technologies and Architectural Research Laboratory (http://www.star-lab.com).

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software design and programming experience as a member of a system team, is a strong asset. We expect that students entering the program will have experience equivalent to three or more years with an industrial software development team. Students with less quantity or quality of experience will spend more time during the program gaining practical experience through internships, practicums, and other engagements. Extensive, high-quality software development experience may substitute for any of the normal requirements. We especially value the perspective that senior software developers can bring to a research program.

Program Requirements

The program requires eight courses, distributed across software design and engineering, systems, analysis, and economics or public policy. Two of these courses are principally practical experience courses. In addition to the course requirements, students must demonstrate proficiency in speaking and writing, serve as a teaching assistant in a classroom course and a studio/project course, and participate in ongoing professional activities of the ISRI.

As in any Ph.D. program, the program culminates in an original research investigation leading to significant new results. Students can do research in a broad range of areas, such as those mentioned above. Our focus is on systems that exploit the growing infrastructure for high performance, nearly ubiquitous computing and communication, especially systems that the public depends on for services provided through the electronic marketplace. The research approach for each project will be selected to match the needs of the project. Approaches appropriate to Ph.D. theses include (but are not limited to):

- Novel methods for software development;
- Automated support for software activities;
- Descriptive models that generalize from practical examples;
- Empirical models with predictive power;
- Implementation techniques for novel applications;
- Measurement techniques for system evaluation;
- Guidance for making classes of design decisions
- Analytic models that permit quantitative or symbolic analysis.

We anticipate that the program will require four years to complete. In the first two years, most students will complete the courses, teaching requirement, and preparation for the research proposal. The last two years will be principally devoted to research, including thesis work and contributions to a sponsoring project. Students without significant prior industrial experience should expect to spend up to an additional year gaining practical experience.

The authors are members of the Institute for Software Research International in the School of Computer Science at Carnegie Mellon University, Pittsburgh, PA 15213, isri@cs.cmu.edu, www.isri.cs.cmu.edu.

Gender from Page 2

single-sex schools. If our students map their own values onto their expectations of others they may well find it difficult to reconcile what is, to them, unexpected behavior.

What Next?

The provision of extra tutorials at Leeds was intended to help all students equally, but this has not been the effect. The female students have used them as a means to receive extra instruction, and the male students have interpreted this in their own terms: staff preferring to help female students. Positive discrimination was not the intention, and as we are not able to address the underlying causes, a more male-friendly approach is also required to redress the balance, and to actually help the male students who are struggling.

For the 1999-2000 session we decided to run the classes as before. This could be justified because another method of help-seeking, an anonymous, web-based question-asking facility, was introduced at the same time. Previous experience at Kent has suggested that this would be used most by the male students. At the same time, it was decided to confront some of the issues raised previously. When the classes were announced, it was also announced that past form indicated that only the females would apply. It was suggested that this was fine if the male students were happy with the other support available, but that if they were not, they should certainly join.

The classes ran as before, and 18 students joined, of whom only one was male; the gender balance of the whole class remained much as before. Anecdotal evidence suggests that male students exclusively are using the anonymous question-asking facility. Overall, our experiences suggest that a range of help provision and help-seeking opportunities must support introductory programming. But, importantly, the students need to be made aware of the range of facilities, and that some of them are more obvious than others.

Janet Carter, from the Computing Laboratory, University of Kent at Canterbury, UK (J.E.Carter@ukc.ac.uk), mainly teaches Mathematics to Computer Science undergraduates and has taught MSc students. Her research interests lie within Computer Science Education with a particular interest in how students learn and gender issues.

Tony Jenkins, School of Computer Studies, University of Leeds, UK (tony@scs.leeds.ac.uk), teaches on several Computing modules, including first-year programming. His research interests lie within the remit of Computer Science Education, with his main areas of interest being motivation and gender issues.

Professional Opportunities

CRN Advertising Policy

Send copy and payment for Professional Opportunities advertisements to Advertising Coordinator, e-mail: crn@cra.org. **E-mail submissions are preferred**. Items may be mailed to *Computing Research News*, 1100 Seventeenth Street, NW, Suite 507, Washington, DC 20036-4632; fax: 202-667-1066.

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

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

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

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

Bucknell University
Department of Computer Science

Applications are invited for one or more one year entry-level visiting assistant professor positions beginning mid-August, 2000. 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, but networks and operating systems are particularly desirable. 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: Jerry Mead, Acting Chair, Dept. of Computer Science, Bucknell University, Lewisburg, PA 17837.

Bucknell encourages applications from women and members of minority groups (EEO/AA).

California Institute of Technology
Computer Science Department

Caltech invites applicants for tenure-track or tenured faculty positions in Computer Science with possible joint appointments in Electrical Engineering and other disciplines. Faculty searches have been approved for positions in the broad area of Computer Science, including, but not restricted to:

* Computer Networks
* Information Systems: Multimedia Databases and Internet Data Systems
* Fundamentals of Computer Science: Algorithms, Complexity, and Logic

The principal requirements include demonstrated excellence in innovative research and the potential for high quality teaching and mentoring. Completion of a Ph.D. in Computer Science or in a related field is required. The initial appointment term for tenure-track positions is four years.

Interested persons should send a one-page summary of their future research and teaching plans, a resume, names of at least three references, a list of publications, and a URL of a personal webpage that includes pre/reprints of publications. Applications should be mailed to:

CS Search
Caltech, MC 256-80
Pasadena, CA 91125

In addition, applicants are requested to fill out an online summary of their application at http://www.cs.caltech.edu/search.

Questions about the application process may be directed to: search@cs.caltech.edu.

Caltech is an Equal Opportunity/Affirmative Action Employer. Women, minorities, veterans, and disabled persons are encouraged to apply.

Carnegie Mellon University
School of Computer Science

Carnegie Mellon University's School of Computer Science seeks applicants for junior level tenure track faculty positions. Outstanding candidates in all areas will be considered. We are especially interested in candidates whose research activities lie in these areas:

Algorithms, Computational Applications, Computer Systems, Databases and Information Retrieval, Electronic Commerce, Computer Graphics, Interactive Design, Machine Learning, Networking, Robotics, Security, Software Engineering, and Speech.

Candidates are expected to have a strong interest in both teaching and research, outstanding academic credentials, and an earned Ph.D. The successful candidate will be expected to initiate and carry out independent research, collaborate with other faculty, and teach both undergraduate and graduate level courses. The highly selective undergraduate and graduate programs in the School of Computer Science draw top students from around the world. Further information about the School of Computer Science may be found at http://www.scs.cmu.edu/.

To apply please send curriculum vitae, research and teaching statements, copies of 1-3 representative papers, and three letters of recommendation to:

Sharon Burks, Assistant Dean
School of Computer Science
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3891

We also welcome electronic applications (in postscript or .pdf format) sent to faculty-search@cs.cmu.edu.

To ensure full consideration, applications should be received by March 1, but we will accept applications until the positions are filled. Carnegie Mellon is an affirmative action/equal opportunity employer and we invite and encourage applications from women and minorities.

College of William & Mary
Department of Computer Science
Faculty Position

Applications are invited for a tenure-track faculty position in Computer Science to begin either Fall 2000, Spring 2001 or Fall 2001 at either the assistant or associate level. Applicants must hold a Ph.D. in computer science or computational science. Appointment at the assistant level requires that the applicant must hold a Ph.D. at the time of appointment and demonstrate strong interests in both research and teaching. Appointment at the associate level requires a documented record of sustained excellence in both research and teaching. We are primarily interested in individuals with research expertise in one of the following areas: high performance systems, parallel computing, parallel and distributed numerical algorithms, networks, visualization, and scientific databases. However, applicants from all areas of computer science or computational science will be considered. A demonstrated interest in multi-disciplinary applied research is highly desirable.

The department currently consists of fifteen faculty members who support B.S., M.S. and Ph.D. programs graduating approximately 40 B.S. students annually and enrolling approximately 40 M.S. and 35 Ph.D. students. Teaching loads and salary are consistent with those in other Ph.D. granting departments. More information about the department and the College can be obtained by connecting to the Web server http://www.cs.wm.edu/.

The department maintains a contemporary computing environment for both teaching and research and is currently supported by a competitive NSF Major Research Instrumentation grant for several high performance computing research projects. Opportunities exist for joint research activity within the department, with members of the Computational Science Cluster, and with scientists and engineers at the nearby NASA Langley Research Center, ICASE, and the DOE's Thomas Jefferson National Accelerator Facility.

A resume, the names and addresses of three references, and any supporting documents should be sent to:

Faculty Search Committee
Department of Computer Science
College of William & Mary
P.O. Box 8795
Williamsburg, VA 23187—8795

Questions can be e-mailed to search@cs.wm.edu. Review of candidates will begin immediately and continue until the position is filled. The College is an EEO/AA employer.

Dalhousie University

Dalhousie University invites applications for tenure track positions at all levels within the new Faculty of Computer Science. The Faculty has a combined complement of 23 faculty positions and approximately 600 undergraduate majors and 135 master's and doctoral students. The expansion and development of the Faculty is a priority for the University.

The Faculty will continue to experience considerable growth over the next few years in all aspects; faculty complement, student enrollment, funding levels and facilities. The Faculty recently moved to a new building and has secured significant infrastructure funding for 2000 - 2001. New research laboratories are planned, and initiatives involving multidisciplinary research projects with university and industrial partners are under development. As an example a new Master of Electronic Commerce degree is now offered in collaboration with the Faculties of Law and Business.

Applicants should have a Ph.D in Computer Science or related area and show a strong commitment to and aptitude for teaching and research. Rank and salary will be commensurate with qualifications. The major research foci of the Faculty are Network Centric Computing and Software Engineering. Individuals with expertise in these and related areas, such as, networking, HCI, distributed applications, etc., are especially encouraged to apply. Successful candidates will be required to teach in both the undergraduate and graduate programs, to establish research programs, to contribute to the administration of the Faculty and will also be encouraged to establish significant industrial connections.

Dalhousie University is located in Halifax, Nova Scotia, which is the largest city in Atlantic Canada and affords its residents outstanding quality of life.

Applications should include a curriculum vitae and the names and complete addresses of three references. They should be addressed to:

The Chair, Appointments Committee
Faculty of Computer Science
Dalhousie University
6050 University Avenue
Halifax, Nova Scotia Canada
B3H 1 W5
E-mail: appointments@cs.dal.ca
URL: http://www.cs.dal.ca

Applications will be reviewed on an ongoing basis until all available positions are filled.

In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Dalhousie University is an Employment Equity and Affirmative Action employer. The University encourages applications from qualified Aboriginal peoples, persons with a disability, racially visible peoples, and women.

Dartmouth College

The Department of Computer Science at Dartmouth College invites applications for a tenure-track position in computer science. The department seeks strong candidates in systems areas.

A Ph.D. in computer science is required. We are particularly interested in applications from people able to contribute to the new Institute for Security Studies at Dartmouth <http://iss.dartmouth.edu>. Candidates should have a substantial record of research.

The Department of Computer Science currently includes twelve tenure-track faculty members. In addition several faculty members in the Thayer School of Engineering and the Department of Mathematics have research interests related to computer science and hold joint or adjunct appointments in Computer Science. The department offers Bachelors, M.S., and Ph.D. degrees in Computer Science. Information on faculty and their research, facilities, graduate students, etc., is available over the World Wide Web at URL <http://www.cs.dartmouth.edu>.

Submit hardcopy of a curriculum vitae, a statement of research, and four letters of recommendation. Review of applications will begin immediately and will continue until the search is complete. Please address application material and general inquiries to Computer Science Recruiting, Computer Science Department, Dartmouth College, 6211 Sudikoff Laboratory, Hanover, New Hampshire 03755-3510.

Specific inquires may be addressed to Professor David Kotz at <facapps@cs.dartmouth.edu>

Dartmouth College is an equal opportunity/Affirmative Action Employer.

Duke University
Deptartment of Electrical and Computer Engineering

The Department of Electrical and Computer Engineering is seeking outstanding tenure-track or tenured faculty members, with particular emphasis in the area of Computer Engineering (with primary interest in the subfields of networking, computer architecture and software engineering). Candidates with a doctorate in electrical and computer engineering or a related field, an outstanding research record commensurate with their experience, and dedication to excellent teaching, should apply by sending a resume, a statement of research interests with copies of three publications, and names, addresses, and phone numbers of five references to:

Search Committee - Computer Engineering
Dept. of Electrical and Computer Engineering
Duke University
Campus Box 90291
Durham, NC 27708-0291

Duke University is an equal opportunity/affirmative action employer. Our WWW address is www.ee.duke.edu

Professional Opportunities

Florida Atlantic University
Department of Computer Science and Engineering
College of Engineering

The Department of Computer Science and Engineering seeks applications for at least one tenure-track faculty position at the Assistant/Associate Professor level. A doctorate in computer science, computer engineering, or a closely related field is required. The appointments will begin from August 2000. Review of applications will begin from February 1, 2000 and will continue until the positions are filled. Salary, fringe benefits, and teaching load are competitive.

The Department has several well-equipped laboratories. It interacts closely with many high-tech companies located in the area, which have helped provide state-of-the-art facilities. We have an active research program, with both federal and industrial sponsors. More information about the Department can be accessed through the World-Wide Web at http://www.cse.fau.edu.

Applicants should send a resume, including the names, phone numbers, and email addresses of at least three professional references, along with a cover letter specifying teaching and research interests, to Faculty Search Committee, Department of Computer Science and Engineering, Florida Atlantic University, 777 West Glades Road, Boca Raton, Florida 33431. Electronic mail communications should be addressed to searchcomm@cse.fau.edu.

Florida Atlantic University is an equal opportunity/access/affirmative action institution.

Harvard University
Postdoctoral Position in Statistical Natural-Language Processing

A postdoctoral position is available to work on a project to improve upon current statistical natural-language processing through lexico-grammatical methods, including work on statistical language modeling and parsing. Candidates must have a Ph.D. in computer science with specialization in statistical modeling of language. Initial appointment will be for one year, with possible extension to a second year. Harvard is an Equal Opportunity/Affirmative Action employer and encourages applications from women and members of minority groups.

Principal investigator: Stuart M. Shieber, Harvard University http://www.eecs.harvard.edu/~shieber. Interested applicants should send a CV and three letters of reference to:

Ronda Scott
Division of Engineering and Applied Sciences
Harvard University
33 Oxford Street, room 247
Cambridge, MA 02138
ronda@deas.harvard.edu.

Harvard University
Postdoctoral Position on Collaborative Human-Computer Interface Design Project

This research project aims to provide the scientific and technological base to enable the principled design of multi-modal dialogue-supporting interfaces. The project comprises three interrelated activities: specialization of a general theory of collaboration, SharedPlans,to provide a framework for the design of collaborative interfaces; application of the theory to human-computer interface design leading to a set of design principles enabling system designers to construct software elements that communicate well in multiple modalities; and implementation of specific collaborative interfaces in a range of domains. The postdoctoral position includes both theoretical research and systems development activities. Candidates must have a Ph.D. in computer science with specialization in human-computer interfaces or artificial intelligence. Significant implementation experience is desirable.

Initial appointment will be for one year, with possible extension to a second year. Harvard is an Equal Opportunity/Affirmative Action employer and encourages applications from women and members of minority groups.

Principal Investigators: Barbara J. Grosz and Stuart M. Shieber, Harvard University
http://www.eecs.harvard.edu/~grosz/
http://www.eecs.harvard.edu/~shieber/

Interested applicants should send a CV and three letters of reference to:

Ronda Scott
Maxwell Dworkin 247
Division of Engineering and Applied Sciences
Harvard University
Cambridge MA 02138
ronda@deas.harvard.edu

Harvard University
Computer Science

In September 1999, Harvard's computer science faculty added two new members and moved to the new Maxwell Dworkin Laboratory. These changes mark the beginning of a period of extensive growth of the faculty, with a corresponding increase in the size of the graduate program. The computer science program benefits from its outstanding undergraduate and graduate students, an excellent location, significant industrial support, and substantial support from the Division of Engineering and Applied Sciences.

We are currently inviting applications and nominations for a tenure-track faculty position in Computer Science, at the level of Assistant Professor, to begin in the fall of 2000. We are seeking candidates with interests in one of two target areas, to be broadly construed:

Cryptography and computer security
Data mining and large-scale and distributed data systems

Candidates should have an outstanding research record and a strong commitment to undergraduate teaching and graduate training. Applicants must have completed a Ph.D. by September 1, 2000. Information about Harvard's current faculty, research, and educational programs is available at http://www.deas.harvard.edu/csecse.

Candidates should send a curriculum vitae, a list of publications, and a statement of research and teaching interests, and should also arrange to have at least three letters of reference sent to:

CS Search Committee
Division of Engineering and Applied Sciences
Maxwell Dworkin 247
33 Oxford Street
Cambridge, MA 02138

Applicants may, in addition, include up to three papers representative of their research.

Harvard is an Equal Opportunity/Affirmative Action employer and encourages applications from women and members of minority groups.

Applications will be reviewed as they are received.

Hunter College of The City University of New York
Department of Computer Science

The rapidly expanding Computer Science Department at Hunter College CUNY seeks an outstanding teacher to fill the position of Lecturer, effective September 2000. Candidates should have a Masters degree in Computer Science or a closely related field; some doctoral work is preferred. A minimum of three years experience in undergraduate teaching is required, along with an exceptional record of classroom instruction.

Candidates must be capable of teaching a wide range of introductory, lower division, and upper division courses in the undergraduate curriculum. Duties also include course coordination for multi-section courses, curriculum development, and curriculum innovation. Lecturers are expected to teach seven to nine courses per year.

The salary range is $29,997 - $49,714, commensurate with expertise and experience. Hunter is a predominately undergraduate institution with a longstanding commitment to excellence in teaching. Qualified applicants should send a letter of application, a detailed resume, and three letters of reference to:

Chair, Department of Computer Science
Hunter College CUNY
695 Park Avenue
New York, N.Y. 10021

Preference will be given to applications received by March 1, 2000.

Hunter College is an AA/EEO employer. Minorities and women are encouraged to apply.

Illinois Institute of Technology

Assistant Professor, tenure track. Begins August, 2000. 3 courses per semester, undergraduate/graduate. The applicant must be prepared to teach courses in web page and site design that are integral to our degree programs in technical and professional communication and information design. The teaching specialization should include instruction in computer languages used in web design. The area of research/publication is open. The Lewis Department of Humanities seeks a teacher-scholar whose interests relate to the present departmental strengths in areas such as rhetoric, literature, history, history of the fine arts, and philosophy. Ph.D., M.F.A., or other relevant terminal degree, prior to appointment. Salary competitive. For more information, see: www.iit.edu/departments/humanities. EO/AAE. Send cover letter, curriculum vitae, and three letters of recommendation to:

Warren Schmaus, Chairperson
Search Committee
Lewis Department of Humanities
Illinois Institute of Technology
Chicago, IL 60616
Email: schmaus@iit.edu
Telephone: (312) 567-3465.

Kennesaw State University
Computer Science and Information Systems Department

KSU invites applications for a tenure-track position. Located on an attractive campus in suburban Metropolitan Atlanta, KSU enrolls 13,000 baccalaureate and masters students and is engaged in an impressive array of applied research and professional service initiatives. Housed within the College of Science and Mathematics, the CSIS Department has excellent computing facilities to support its degree programs: BS computer science, BS information systems, and MS information systems. An earned doctorate is required, preferably in computer science, information systems, or related. Expertise is sought in electronic commerce, database systems, embedded software, or object-oriented development. Industry experience is desirable. Salary is competitive. KSU has established a notable record for the inclusion of minorities and women in its educational mission and strongly encourages applications from both groups. KSU is an affirmative action/equal opportunity employer. Application Instructions: Candidates should send a letter of application addressing the applicant's position qualifications, teaching philosophy, and scholarship activity; current curriculum vita; names, address, and telephone numbers of at least three references; and official graduate transcripts to:

Dr. Martha Myers
(mmyers@kennesaw.edu)
Kennesaw State University
1000 Chastain Road
Kennesaw, GA 30144-5591
http://science.kennesaw.edu/csis.

Northern Michigan University
Computer Science

The Department of Mathematics and Computer Science at Northern Michigan University invites applications for a tenure-track position in Computer Science at the rank of Assistant Professor beginning with the 2000-2001 academic year. The successful applicant must possess a Ph.D. in Computer Science or closely related computing field prior to employment, be prepared to teach the range of courses in an undergraduate curriculum and demonstrate the potential to become an effective teacher and an active scholar. Applicants with specialized interests in any area of computer science are encouraged to apply; however, preference will be given to applicants whose special interests are in one or more of the following areas: *software engineering, object oriented design, databases, real-time or embedded systems, network and computer security and mobile computing*. Additional desirable qualifications include a willingness to contribute to the development of our computer science program, to work with business and industry to develop career opportunities for our graduates, and to involve undergraduates in ongoing research efforts. Applicants interested in emerging areas of computer science are especially encouraged to apply.

Northern Michigan University is a comprehensive institution of approximately 8,000 students located in the city of Marquette on the shore of Lake Superior. Marquette is a community of 24,000 and is the cultural, commercial, medical and governmental center of Michigan's beautiful Upper Peninsula. The region offers unexcelled outdoor recreational opportunities in all seasons.

Applications should include a complete resumé, letter of application with statement of teaching philosophy, transcripts, and names, addresses (including e-mail), and telephone numbers of three references. Nominations are welcome and should be submitted as early as possible. Application materials should be sent to:

Donald L. Zalewski, Head
Department of Mathematics and Computer Science
Northern Michigan University
1401 Presque Isle

The University of Texas at Arlington
Computer Science and Engineering Department

The University of Texas at Arlington (UTA), Computer Science and Engineering Department invites applications for a tenure-track faculty position at all levels. Applicants with expertise in the following areas are preferred; telecommunications including networks and multimedia and systems including distributed and high-performance computing. UTA, part of The University of Texas System, is located in the heart of the rapidly growing Dallas/Fort Worth area, the nation's third largest high-technology region, with a flourishing industrial base and excellent opportunities for industry/university collaboration. The CSE Department (url: www-cse.uta.edu) currently has eighteen faculty members with 438 undergraduate and 362 graduate students and, in 1998-99, received $1.5 million in external funds. Applicants for an assistant professor position must have an earned doctorate in computer science, computer engineering, or closely related fields and a commitment to teaching and scholarly research. Applicants for a senior level position must have demonstrated an excellent record of professional accomplishments in their field of expertise. The faculty opening is anticipated for September 2000, pending final budget approval. Screening of applications will begin immediately and will continue until all positions are filled. Interested persons should send a resume and reference letters to Chair of Search Committee, Department of Computer Science and Engineering, P.O. Box 19015, Arlington, TX 76019-0015. Phone: 817-272-3605. FAX: 817-272-3070. Email: search@cse.uta.edu.

The University of Texas at Arlington is an Equal Opportunity/Affirmative Action Employer.

MIT

SOFTWARE ENGINEERING FACULTY POSITION

The Aeronautics and Astronautics Department at MIT, a leader in the design and development of complex aircraft, space, transportation, information telecommunications systems, has a faculty opening in the Aerospace Information Systems Division. To find out more, please visit the following web site: http://sunnyday.mit.edu/testdir/software.html.

The successful candidate will have a Ph.D. and relevant SW engineering research credentials (requirements specification and analysis, assurance techniques, human-machine interaction, software design for embedded systems, safety, reliability and other quality attributes, software fault tolerance, or real-time application issues like scheduling and verification). He or she will be responsible for designing classes and teaching and supervising undergraduate and graduate students in research programs in software engineering.

A joint professorship with Computer Science is possible. Women or other minorities are encouraged to apply, because of MIT's strong commitment to diversity in engineering education, research, and practice.

Send CV to Professor Edward F. Crawley, Head, Dept. of Aero/Astro, MIT, 33-207, 77 Mass. Ave., Cambridge, MA 02139-4307. Please visit our web site at http://web.mit.edu/aeroastro/www/core.html

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
An Equal Opportunity/Affirmative Action Employer
Non-Smoking Environment
web.mit.edu/personnel/www

Professional Opportunities

Marquette, Michigan 49855-5340
(906) 227-2020
E-mail Address: dzalewsk@nmu.edu
For additional information see http://www.nmu.edu/.

Applicant review will continue until the position is filled.

NMU is an equal opportunity, affirmative action employer and is strongly committed to increasing the diversity of its faculty.

Old Dominion University
Computer Science Department

The Department of Computer Science invites applications for a tenure track position at the Assistant/Associate Professor level beginning Fall 2000. A Ph.D. in Computer Science, or a related field augmented by research experience in computer science is required. Potential for external funding is also required. Appointment at the Associate Professor level requires several years of university teaching experience and a record of substantial external funding and research. Areas of interest include high performance computing and communication, mobile computing, 3-D visualization, and networking. The position involves teaching, research, and grants.

The department awards the BS, MS, and Ph.D. degree. We provide an environment that encourages and supports research. Collaborative opportunities exist across departments and colleges, as well as with other institutions in the area. The Eastern Virginia Medical School, NASA Langley Research Center, Thomas Jefferson National Laboratory, and Virginia Modeling, Analysis and Simulation Center are within thirty minutes of campus. The department has extensive computational facilities, including access to a 32-processor Sun Starfire HPC 10000 for on campus parallel computing. The department has funded initiatives to develop high performance solvers on Teraflop-flop parallel computers (an ASCI level-2 grant from DOE) and for delivering our degree program using modern instructional technology.

To apply, send a curriculum vitae and the names, addresses and telephone numbers of three references to:

Larry Wilson
Chair Recruiting Committee
Department of Computer Science
Old Dominion University
Norfolk, VA 23529-0162
Fax (757) 683-4900

Review of applications will begin March 15, 2000 and continue until the position is filled. Old Dominion University is an Affirmative Action/Equal Opportunity Employer and requires compliance with the Immigration Reform and Control Act of 1986.

Oregon State University
Department of Computer Science
Corvallis and Bend Faculty

The Dept. of Computer Science at OSU seeks to hire two full-time, fixed term instructors. One position is at the main campus in Corvallis; the second is in Bend. The positions will begin fall term 2000. Successful applicants will have a master's degree in Computer Science or Computer Science Education with a Ph.D. preferred. Faculty will hold the rank of Instructor and will be appointed to full-time nine-month contracts with reappointment at the discretion of the Department Head.

Applicants for the Corvallis position should be effective educators committed to teaching an array of introductory undergraduate courses offered by the Department. Nominal teaching load of 2-3 courses per term, depending upon class sizes. Salary range: $33,000-$40,000 for nine months.

Applicants for the Bend position should be effective educators capable of teaching a wide variety of upper-division computer science courses. Nominal teaching load is 2 courses per term. The person holding this position will also serve as liaison between the Department and the Central Oregon University Center and Central Oregon Community College. Salary range: $46,000-$54,000 for nine months.

To apply, send a letter of application (including specific instructional competencies), resume covering all academic work and teaching experience, and contact information (phone and email) for three references to:

Corvallis Instructor Hiring
Commit tee or Bend Instructor Hiring Committee
Oregon State University
Department of Computer Science
303 Dearborn Hall
Corvallis, OR 97331-3202

or jobs@cs.orst.edu. Contact information number: (541)737-5556.

Review of applications will begin March 1, 2000. Positions will remain open until filled.

OSU is an Affirmative Action/Equal Opportunity Employer and has a policy of being responsive to dual-career couples.

Purdue University
School of Electrical and Computer Engineering

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

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

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

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

Rensselaer Polytechnic Institute

Electrical, Computer, and Systems Engineering Department invites applications for several open tenure-track positions in Computer Engineering starting in Fall 2000. All areas of computer engineering are of interest. The candidates must have a Ph.D. in Computer Engineering or equivalent. While we are looking for primarily Assistant Professors, appointment of candidates with outstanding academic or industrial research experience and leadership at the Associate and Full Professor levels will also be considered. Rensselaer has identified Information Technology and Biotechnology as two key research areas for new investment. The candidates are expected to play key roles in these two areas.

The ECSE Department offers programs in Electrical Engineering and Computer and Systems Engineering. Our major strengths are in microelectronics technology and design, computer communication networks, digital signal and image processing, control and automation, and electromagnetics. The department is growing and has three other ongoing faculty searches in controls, microelectronics, and the department chair position. New faculty will receive attractive start-up arrangements including summer support, equipment, graduate student support and reduced teaching loads to encourage the development of successful research and teaching programs. Letters of application and resumes (including a list of references) should be sent to:

Dr. Joe H. Chow, Acting Chair
Electrical, Computer and Systems Engineering
Rensselaer Polytechnic Institute
Troy, NY 12180-3590
Email: chowj@rpi.edu

For more information, see ECSE's webpage (http://www.ecse.rpi.edu). Rensselaer is an affirmative action/equal opportunity employer and specifically encourages applications from women and underrepresented minority groups.

State University of New York at Buffalo
Department of Computer Science and Engineering
Teaching Faculty

The Department of Computer Science and Engineering at the University at Buffalo (SUNY) is strongly committed to hiring and retaining non-tenure-track Lecturers. We anticipate openings for 3 such positions beginning Fall 2000. Initial appointments would be for 1- to 3-year terms. This is a career-oriented, non-tenure-track appointment, renewable for an unlimited number of 3-year terms.

Applicants for these positions must have at least an MS degree in computer science or engineering, or related field, by September 2000, and strong teaching credentials. Holders of the PhD are eligible for the in-house title of Teaching Assistant Professor and for membership in the Graduate Faculty.

Duties include teaching and development of undergraduate Computer Science and Engineering courses (with an emphasis on lower-division courses) advising undergraduate students, and participation in department and university governance. Participation in research is encouraged.

The Department offers the BA, BS, MS, and PhD degrees, with programs in both computer science and computer engineering. We currently have 19 tenure-line faculty and 4 Lecturers. In support of undergraduate teaching, the department has four undergraduate laboratories, containing Sun workstations running Solaris 7, and Intel-based workstations running Windows NT. Programming languages in use in the department include C, C++, Java, ML, and Common Lisp.

The University at Buffalo is New York's largest and most comprehensive public university. Buffalo, the second largest city in New York State, is the hub of a metropolitan area with a population over 1.1 million.

University life is enriched by scenic, recreational, and cultural opportunities in the city, suburbs, and the neighboring Niagara and Metro Toronto regions. For more information about our department, the university, and the metropolitan area, please visit our website at http://www.cse.buffalo.edu.

Address applications (including cover letter, curriculum vitae, and names and addresses of three references) to:

Chair, Lecturer Search Committee
Department of Computer Science & Engineering
226 Bell Hall, Box 60200
State University of New York at Buffalo
Buffalo, NY 14260-2000
E-mail:cse-lecturer search@cse.buffalo.edu
Fax: (716) 645-3464

In addition, all applicants should have letters of reference sent to the above address.

SUNY is an Equal Opportunity/ Affirmative Action employer, and strongly encourages applications from women and minorities.

Texas A&M University
Department of Computer Science

Applications are invited for several tenure-track and visiting faculty positions. Outstanding candidates at all levels and from all areas of specialization will be considered. Candidates should include in their letter of application the type of position for which they are applying.

Texas A&M University has long enjoyed national leadership status in engineering education. Today, the Dwight Look College of Engineering is one of the largest and best endowed in the nation, and it ranks among the top institutions in every significant national poll.

The Department of Computer Science is one of the fastest-developing departments in the College. In recent years it has built a strong national reputation based on the quality of its faculty and programs.

The Department offers B.S., Master's and Ph.D. degrees in computer science and, jointly with the Department of Electrical Engineering, in computer engineering. The computer science graduate and undergraduate programs are among the largest in the nation. Full-time faculty currently numbers 35, and the annual research budget is approximately $3 million, including six NSF PYI/NYI/CAREER awards. More information is available on the Web at http:www.cs.tamu.edu.

Candidates should have a Ph.D. in computer science or a closely related field, a strong commitment to both research and teaching, and demonstrated ability to perform research and acquire external funding appropriate to the rank being sought. Applications from minority and women candidates are especially encouraged. Texas A&M University is an affirmative action equal opportunity employer committed to diversity. Applicants should send a statement of research and teaching interest, a complete resume, and the names of at least three references, their addresses (including email) and telephone/fax numbers to:

Faculty Search Committee
Department of Computer Science
Texas A&M University
College Station
Texas 77843-3112

Applications will be accepted until the positions are filled.

University of Missouri-Rolla

The Department of Computer Science at the University of Missouri-Rolla is seeking qualified applicants for tenure-track faculty positions. All areas of Computer Science specialization will be considered, with special attention to candidates with depth in

Professional Opportunities

United Technologies Research Center

United Technologies Research Center (http://www.utrc.utc.com/) has a broad research program with the objective of developing novel concepts that enhance the characteristics of United Technologies Corporation's http://www.UTC.com/) products. These well known products include Otis elevators, Carrier air conditioners, Pratt & Whitney jet engines, Sikorsky helicopters, International Fuel Cell and Hamilton Sundstrand aerospace systems.

The Information, Computer & Communication Technology department at UTRC is expanding its activities in the areas of:

- **Embedded Computing Architectures R&D**

This activity involves defining, developing, and evaluating hardware, software, and communication architectures that address performance, redundancy, availability, fault detection/isolation, and graceful degradation while enhancing the control and communication of embedded computing products. (Refer to Job *# ICCT-3030-0007)*

- **Signal Processing, Communications, and Diagnostics R&D**

This activity involves developing, running, and evaluating computer routines that do linear/non-linear signal processing, communication system design and analysis, and diagnostics and prognostics. (Refer to Job *# ICCT-3035-0006)*

Both activities are fundamental to UTC's R&D programs. Additional job duties include interacting with technical managers, experimental technicians, computer architects, and control engineers. Job responsibilities include the design of technical approaches, the communication of technical information to a diverse audience, and the efficient use of modern computer tools.

Qualifications:

- Masters degree in EE, CE, or CS, plus solid knowledge of the theory and practice of signal processing, communications, controls, diagnostics, and prognostics. Also required are excellent programming and mathematics skills, plus strong result orientation.

Preferred Qualifications:

- Ph.D. in EE, CE, or CS, plus interest/experience in system level solutions and computer simulation techniques. Formal or informal experience in a variety of application domains is also an asset.

Please submit a cover letter, a resume, and any applicable publications. Include references from at least two people who are qualified to evaluate your work, send to: employment@utrc.utc.com, mail to: United Technologies Research Center, 411 Silver Lane, East Hartford, CT 06108, or fax to: 860/610-7835.

UTRC is an equal opportunity employer.

Distributed/Internet Software. Applicants for junior positions must demonstrate evidence of their ability to perform research and have had prior involvement in group research activities and hold an earned Ph.D. by the appointment start date. Applicants for senior positions must have a demonstrated record of research and funding emphasizing research team leadership as the principal investigator. The successful candidate will be expected to contribute to the Departmental research effort. All applicants must show a commitment to quality teaching.

The Department grants the BS, MS and Ph.D. degrees. The Ph.D. program has been active since 1977. The Department has an aggressive young faculty with growing levels of funded research. Interdisciplinary research activities exist in the UMR Intelligent Systems Center and faculty members in the Department may become Research Investigators in this Center.

The University of Missouri-Rolla is the primary science and engineering campus of the University of Missouri system; it currently has an enrollment of 4500 students. UMR is situated in the beautiful non-urban environment of the Ozarks. St. Louis is 1 ½ hours away via interstate highway. Salary is competitive with Big-10/Big-12 universities. Position will remain open until filled.

Please submit application and vitae to:
Human Resource Services
Reference Number: R50072
University of Missouri-Rolla
1202 North Bishop
1870 Miner Circle
Rolla, MO 65409-1050

UMR is an AA/EEO employer. Females, minorities and persons with disabilities are encouraged to apply.

University of Utah
Department of Computer Science

The University of Utah's Department of Computer Science seeks applicants for a non-tenured teaching-track faculty position at the instructor, assistant, or associate professor level. Over the next three years, the Department intends to greatly increase the number of undergraduate majors, establish programs targeted toward working professionals, develop introductory computing classes appropriate for students from across the campus, and increase its staff of teaching-track faculty from two to four. The ideal candidate will have a strong academic background in computer science or allied field (Ph.D. strongly preferred), practical experience in the computer industry, a demonstrated proficiency in teaching, and a keen interest in curriculum development.

A teaching appointment in the Department of Computer Science is a separate career path from the regular tenure track. The successful applicant will work with two other faculty members on the teaching track who have been on the Computer Science faculty for 18 and 13 years, respectively. The University of Utah is located in Salt Lake City, the hub of a large metropolitan area with excellent cultural facilities and unsurpassed opportunities for outdoor recreation only a few minutes drive away. Additional information about the department can be found at http://www.cs.utah.edu. Please send Curriculum Vitae, a teaching goals statement, and names and addresses of at least four references to:

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

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

University of Western Ontario
Department of Computer Science
Assistant or Associate Professor

The University of Western Ontario, established in 1876, ranks among the the top-tier research Universities in Canada, and is actively expanding its activities in Computer Science. Applications are invited for tenure-track positions at the Assistant or Associate Professor level.

The Computer Science Department currently consists of 24 regular faculty, with additional visiting and term positions. The Department offers BSc, MSc and PhD degrees in Computer Science, as well as degrees with specialization in Software Engineering. In addition to the core curriculum, links with the Faculty of Law, the Faculty of Information and Media Studies, and the Ivey School of Business allow the department to offer courses of a nature not readily available elsewhere.

Research in the department spans topics in the fundamental areas of computer science, as well as emerging subjects such as molecular computing, legal issues in computing, network quality of service, and web technologies. See www.csd.uwo.ca/research for a description of activities within the department. Major research projects are funded by international, federal, provincial and private sector sources. New faculty are invited to participate in existing research projects, and to initiate projects of their own.

With a full-time enrollment of about 25,000, The University of Western Ontario graduates students from a full range of academic and professional programs. The university campus is located in London, a city of 340,000, located between Toronto and Detriot. Parks, tree-lined streets and bicycle trails contribute to the "Forest City" reputation. An international airport, galleries, theater, music and sporting events are as would be expected of a larger center. See www.city.london.on.ca for more information.

The closing dates for applications are the second Friday of each month until August 11, 2000. Candidates should have a PhD in Computer Science or Software Engineering and must show evidence of a strong research program and commitment to teaching. Priority will be given to candidates who build on existing strengths of the department, or who can establish leading projects in new areas. To apply, please send a CV, a statement of your teaching philosophy and three representative publications to

Prof Stephen M. Watt, Chair
Department of Computer Science
MC355
The University of Western Ontario
London Ontario, CANADA
N6A 5B7

Positions are subject to budget approval. The University of Western Ontario is committed to employment equity, welcomes diversity in the workplace, and encourages applications from all qualified individuals, including women, members of visible minorities, aboriginal persons and persons with disabilities.

University of Alabama in Huntsville
Computer Science Department

The Computer Science Department of the University of Alabama in Huntsville (UAH) invites applications for anticipated tenure-track faculty positions at the Assistant Professor level. A Ph.D. in Computer Science or closely related area is required. Applicants should have good communication and teaching skills and a demonstrated ability to do research.

The UAH is located in one of the country's most rapidly expanding high technology areas with a population of approximately 365,000 and a large technical community with excellent public schools and inexpensive housing. Opportunities to pursue research supporting NASA and other government activities are numerous. The University has an enrollment of over 7000 students with research centers in the areas of information technology, robotics, optics, microgravity, space plasma and materials development in space, which provide opportunities for joint projects.

The Computer Science Department has 16 full-time faculty, offers the B.S., M.S., and Ph.D. degrees and has research emphasis in the areas of Programming Languages, Computer Architecture, Software Engineering, and High Performance Computing and Networking.

Please submit a detailed resume with references to:

Professor Carl G. Davis
Computer Science Department
University of Alabama in Huntsville
Huntsville, Alabama 35899

Qualified women and minority candidates are encouraged to apply.

Initial review of applications will begin on March 15, 2000 and will continue until suitable candidates are found.

The University of Alabama in Huntsville is an Equal Opportunity/Affirmation Action Institution.

University of Alberta
Department of Computing Science

Do you have a commitment to the science of computing? Are you looking for an academic environment that focuses on the science of your discipline? Join us in a dynamic Computing Science department, known for its collegial atmosphere and collaborative research environment. Our department is in the Faculty of Science at the

Professional Opportunities

University of South Carolina

Department of Computer Science and Engineering

Department Chair

The University of South Carolina invites applications and nominations for the position of Chair, Department of Computer Science and Engineering (CSE). CSE is one of five departments with accredited degree programs in the College Engineering and Information Technology. It was formed in October 1999 through the merger of the Computer Science and Computer Engineering programs. The department currently has 18 full-time faculty members; it is scheduled to grow to about 50 within 5 years with additional support from a planned $40 million state-of-the-art "innovation center". It offers Bachelors, Masters and Doctoral degrees in Computer Science and Computer Engineering and a BS degree in Computer Information Systems; it anticipates establishing additional masters-level degree programs in Software Engineering, Network Engineering, and Information Systems Engineering. The department faculty have research strengths in artificial intelligence, communications, computational science, software engineering, and advanced database technology.

The position requires an individual with exceptional leadership and research skills who can effectively lead the new department during a period of high growth and expansion. Candidates should have a Ph.D. in computer science, computer engineering, or a closely related field and credentials appropriate for appointment at the rank of tenured full professor. The candidate will also be expected to work with industrial leaders to foster economic development of computing within the state of South Carolina. The successful candidate will have a commitment to the mission of a major research university, the capacity for creating a shared vision, and the ability to build and lead the department. Strong experience in the current application of information technology is highly desirable. Prior management experience in academic, business, or government is also highly desireable.

The University of South Carolina is a comprehensive public university serving 26,000 students in the state's capital city, within a metropolitan area of approximately 450,000 residents.

Please send applications, nominations, and inquiries to: Dr. Larry Druffel, Chair, CSE Chair Search Committee, College of Engineering and Information Technology, University of South Carolina, Columbia, SC 29208; or e-mail: richards@engr.sc.edu. The search committee will be pleased to receive nominations or applications via e-mail. A curriculum vitae should accompany the letter of application or nomination, along with the names of three references. Letters of reference will not be sought until authorized by the candidate after initial screening of applicants and nominees. Female and minority candidates are encouraged to apply. Foreign nationals should indicate current US immigration status. The committee will begin reviewing applications upon receipt and will continue to receive them until the position is filled. USC is an affirmative action/equal opportunity employer.

University of Alberta, in Edmonton, the capital of Alberta. We have eight established research laboratories, including Algorithmics, Artificial Intelligence and Cognitive Science, Database Management, Graphics, Networks and Communications, Parallel and Distributed Systems, Software Engineering, and Vision and Robotics. We have abundant computing facilities, and our department leads broadly-based multidisciplinary research within the Multimedia and Advanced Computational Infrastructure (MACI) project, and the Research Institute for Multimedia Systems (RIMS). In addition to the standard computational research facilities, we also have a large SGI Origin 2000, and a 3D immersive display powered by an SGI Onyx2. We are currently constructing a new research laboratory building adjacent to a renovated historical building, to provide us with office and research space consolidated in the middle of our campus of about 30,000 students (see WebCam at www.cs.ualberta.ca). Our current complement of 37 regular faculty work within a department of 28 support staff, 135 graduate students (50/50 MSc/PhD) and 325 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 young, eager computing scientists to complement our strengths in all areas. We are especially keen on those who can demonstrate that they are driven by curiosity and interested in collaborative research with existing faculty across subdisciplines. Candidates should have a PhD in Computing Science, a proven research record, and a strong commitment to excellence in teaching. Responsibilities include research as well as teaching at the graduate and undergraduate 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, which includes over 1600 existing software development companies. Our current recruiting segment will end March 31, 2000. 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 2H1
or 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 Arizona
Department of Computer Science
http://www.cs.arizona.edu

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

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

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

Faculty Recruiting Committee
Department of Computer Science
The University of Arizona
PO BOX 210077
Tucson, AZ 85721-0077

We will continue to consider applicants until the positions are filled, subject to availability of funds. The University of Arizona is an EEO/AA employer - M/W/D/V.

University of Nevada, Reno
Department of Computer Science

Applications are invited for a tenure track *Assistant or Associate Professor* position beginning in August, 2000. A Ph.D. in Computer Science or Computer Engineering is required by the date of appointment. Candidates should possess a demonstrated potential and strong commitment to quality research and teaching at the undergraduate and graduate levels. Candidates with expertise in one or more of the following areas may be given preference: *software engineering, operating systems, programming languages, human-computer interaction, networking, databases, graphics and algorithms*. The department is dynamic, growing and offers BS, MS and Ph.D. degrees. Visit www.cs.unr.edu or email varol@cs.unr.edu for further information. The Reno area has four mild seasons and is a scenic half-hour drive to Lake Tahoe, one of the largest and most beautiful alpine lakes on the planet. The Pacific Crest Trail is nearby for hiking and fantastic ski areas abound. San Francisco and the Silicon Valley are within a short half-day's drive. To apply, a letter, vita and three letters of references should be sent to:

Y. L. Varol, Chair
Computer Science Department
171, University of Nevada
Reno, NV 89557

Review of applications will begin March 17, 2000, and continue until position is filled. UNR is an AA/EOE and employs only US citizens or persons lawfully authorized to work in the United States.

University of Rochester
Department of Computer Science

The Computer Science Department at the University of Rochester invites applications for tenure-track positions. Candidates at the assistant professor level must have received, or be about to receive, a doctorate in Computer Science or a related discipline, and must demonstrate exceptional potential for both research and teaching. Candidates at more senior levels must possess an outstanding record of scholarly achievement. Research interests in all areas of computer science will be considered, but we are particularly interested in networking, IO/databases, compilers, and other areas of experimental systems.

Our department is small (twelve faculty), with a strong record of research publication and external funding. We offer an outstanding research environment, with excellent students and facilities, and an unusually close-knit and collegial atmosphere. Current research interests include artificial intelligence (vision/robotics/virtual reality, natural language/knowledge representation), parallel systems (compilers, operating systems and runtime environments, computer architecture, performance analysis and prediction), and theory of computation (algorithms, computational complexity, data mining, DNA computing). Total enrollment in the Ph.D. program is approximately forty students. Further information can be found at http://www.cs.rochester.edu.

Applicants should send a curriculum vitae, copies of relevant papers, and the names and addresses of at least three references to:

Faculty Recruiting Committee
Department of Computer Science
University of Rochester
Rochester, NY 14627-0226

The University of Rochester is an Equal Opportunity employer; women and members of minority groups are strongly encouraged to apply.

University of Saskatchewan
Department of Computer Science

Applications are invited for two tenure-track faculty positions at the Assistant Professor level to start July 1, 2000. The Department is interested in outstanding candidates from all areas of computer science. However, preference will be given to candidates interested in collaborative, applied research that cuts across traditional boundaries.

For information about the Department, see http://www.cs.usask.ca. Please direct applications or inquiries to the Chair:

Professional Opportunities

Professor Derek Eager
Department of Computer Science
University of Saskatchewan
Saskatoon SK S7N 5A9
Canada
eager@cs.usask.ca.

Applications should include curriculum vitae and the names and addresses of three references, and will be accepted until the positions are filled.

These positions have been cleared for advertising at the two-tier level. Applications are invited from qualified individuals regardless of their immigration status in Canada. The University is committed to Employment Equity. Members of Designated Groups (women, aboriginal people, people with disabilities and visible minorities) are encouraged to self-identify on their applications.

University of South Carolina

Faculty Positions in Computer Science and Engineering

Applications are invited for at least two tenure-track positions in computer science and engineering at the Assistant Professor level. Target research areas include software engineering, computer networks, distributed information systems, computer architecture, forensic computing, computer security, computational science, bioinformatics, computer graphics, and visualization; however, exceptional candidates in all areas will be considered.

Candidates should have a doctorate in computer science, computer engineering, or a closely related discipline. They are expected to have strong research potential as well as interest in teaching at both the undergraduate and graduate levels.

These positions are in a new department created by the merger of the Department of Computer Science and the Computer Engineering Program of the Department of Electrical and Computer Engineering. The Department is located within the College of Engineering and Information Technology. The Department has about 700 undergraduate majors and 300 graduate students; it offers BE, BS, ME, MS, and Ph.D. degrees. The University of South Carolina has an enrollment of more than 26,000 students and is the comprehensive graduate institution in South Carolina. Columbia is the state capital and is the technology center of the state. For more information, see http://www.cs.sc.edu and http://www.ece.sc.edu.

Applicants should submit a curriculum vitae along with the names and addresses of three references to: Dr. Caroline M. Eastman, Chair, Faculty Search Committee, Department of Computer Science, University of South Carolina, Columbia, SC 29208. Electronic applications should be sent to eastman@cs.sc.edu. Applicants will be accepted until positions are filled. Foreign nationals should indicate current US immigration status.

The University of South Carolina is an affirmative action/equal opportunity employer.

University of Toronto

Department of Computer Science

The Department of Computer Science at the University of Toronto seeks applications for teaching stream positions at the rank of Lecturer. The department is an international leader in Computer Science research and education, and is currently undergoing a significant expansion in faculty and research resources. Candidates should have an advanced degree in Computer Science or related field and an exceptional record of classroom instruction and curricular innovation.

Responsibilities include undergraduate teaching, managing teaching assistants, developing course materials, and curriculum development. In addition, all faculty, including lecturers have some responsibility for student recruitment and departmental administration.

Initial appointments are for one-year terms. Under university policy, appointments to the teaching stream may be eligible for continuing positions at the rank of Senior Lecturer after five years. We are seeking candidates who are interested in establishing a long-term teaching career in the Department. The department currently has five Lecturers and Senior Lecturers, who enjoy a stimulating and collegial work environment.

Successful applicants will be joining a group of excellent Lecturers and Senior Lecturers, who enjoy a collegial and stimulating work environment. Toronto is a vibrant and cosmopolitan city, one of the most desirable in the world in which to work and live. It is also a major centre for advanced technology and the computer industry with which the department enjoys strong interactions.

Applications, which should include a curriculum vitae, statement of teaching objectives, evidence of teaching excellence, and the names and addresses of at least three references, should be sent by email (text, postscript or PDF only, please) to lecturer-search@cs.toronto.edu or, if that is not possible, by post to

Lecturer Recruiting Committee Chair
Department of Computer Science
University of Toronto
Toronto, Ontario M5S 3G4
Canada

The deadline for applications is March 15, 2000 or until the position is filled. We will consider applications as they arrive and we encourage early applications.

The University of Toronto is committed to employment equity and especially encourages applications from women, members of visible minorities, native persons and persons with disabilities. Canadians and non-Canadians are encouraged to apply.

University of Virginia

Department of Computer Science

General Teaching Faculty

The Computer Science Department at the University of Virginia invites applications for outstanding teachers to serve as general teaching faculty. Duties include teaching University-wide service courses such as Computer Literacy and undergraduate courses for CS majors. An active interest in being in a research oriented department as well as in innovation in education is highly desired. These positions are ideal for faculty interested in teaching excellent undergraduates within an innovative curriculum. While these positions are not tenure track, there is a long term commitment to these positions. Initial appointments will be for 9 month academic year appointments for a three year period. Additional possibilities exist for summer employment either in research, teaching, or both. A Ph.D. in Computer Science is required. Women and minorities are encouraged to apply.

Please send a resume and a list of at least 3 references to

Prof. Jack Stankovic
Department of Computer Science
School of Engineering & Applied Science
University of Virginia
151 Engineer's Way
P. O. Box 400740
Charlottesville, VA 22904-4740

Applications should be received by April 1, 2000 to be assured full consideration. Applications will be accepted until the position is filled. The University of Virginia is an Equal Opportunity/affirmative action employer.

University of Utah

Department of Computer Science

The University of Utah's Department of Computer Science seeks applicants for tenure track faculty positions at the assistant, associate, or full professor level. The department places a strong emphasis on interdisciplinary, multi-investigator research activities addressing large-scale problems of significant impact. Both research areas and course offerings benefit from the quality and breadth of our faculty and emphasize a balance of theoretical foundations and practical engineering. Our recruiting emphasis is in scientific computing & visualization, systems, networking, languages, and artificial intelligence, but we will consider strong candidates in all areas of computer science. Applicants should have earned a Ph.D. in Computer Science or a closely related field. The University of Utah is located in Salt Lake City, the hub of a large metropolitan area with excellent cultural facilities and unsurpassed opportunities for outdoor recreation only a few minutes drive away. Additional information about the department can be found at http://www.cs.utah.edu.

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

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

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

Virginia Tech

Virginia Tech's Department of Computer Science seeks applicants for a tenure-track appointment at the rank of Assistant Professor to start August 2000 at the Northern Virginia Center in Falls Church, VA (metropolitan Washington, DC). Exceptional candidates at the Associate Professor level will also be considered.

The Northern Virginia Center offers graduate education leading to the Master/Ph.D. of Computer Science. The six full-time computer science faculty at the Center work in collaboration with other faculty at the Center and approximately 25 full-time faculty at the Blacksburg campus through teleconferencing facilities over the University's Net.Work.Virginia. Three new laboratories provide state-of-the-art equipment for both teaching and research. Additional research opportunities exist at Virginia Tech's Alexandria Research Institute (http://www.ari.vt.edu), as well as throughout the high-tech sector of Northern Virginia.

Candidates are expected to demonstrate solid teaching skills and the potential for strong research. We are particularly interested in candidates with research and teaching interests in software engineering and Internet computing. Consideration will also be given to strong candidates in the fields of databases, electronic commerce, virtual reality, multimedia and algorithms. The current teaching load is 3 courses per year.

Candidates must have a Ph.D. (or expect completion by date of appointment) in Computer Science or a closely related field. Applicants should send a curriculum vitae, a 1-2 page statement of professional plans and goals, and contact information for three references, to:

Dr. Athman Bouguettaya
Department of Computer Science
7054 Haycock Road
Falls Church, VA 22043

We invite electronic applications to <athman@cs.vt.edu>. Review of candidates is ongoing and will continue until the position is filled, but priority will be given to applications received by March 15, 2000. For more information, see <http://www.cs.vt.edu/new-faculty/nvc/>.

The university is deeply committed to recruiting, selecting, promoting, and retaining women, persons of color, and persons with disabilities. We strongly value diversity in the college community and seek to assure equality in education and employment.

Widener University

Tenure Track Assistant Professor Position

Widener University seeks candidates for a tenure track position, at the Assistant Professor level, in the Computer Science Department beginning in the Fall of 2000. Demonstrated excellence in teaching, preferably at a comparable institution, and a PhD in Computer Science or related field (Physics, Mathematics, or Philosophy) is required. Candidates with any area of specialization will be considered, but experience in networks or operating systems is preferred. Candidates should send a letter of application, a curriculum vita, and three letters of reference to:

Bob Neveln, Computer Science Coordinator
Widener University
One University Place
Chester, PA 19013

Questions may be directed via email to neveln@cs.widener.edu

Applications will be considered as soon as they are complete and the position remains open until filled. Widener University encourages women and minorities to apply.

Philosophy, Psychology and Cognitive Science

The Department of Philosophy, Psychology and Cognitive Science at Rensselaer Polytechnic Institute seeks outstanding scientists for three tenure-track positions. Rank is open. These scholars should be able to contribute to the department's general theme of applied cognitive science. We maintain a broad definition of this theme, including at least the following areas of research: the interface of mind and machines, particularly human factors; industrial/organizational psychology; behavioral neuroscience; psychopharmacology; artificial intelligence; information technology; and complex systems.

The department integrates these research areas to explore a wide variety of applications. Example topics include studying how information technology: affects training programs and classroom instruction, impacts workplace behavior, influences design of systems (human factors), contributes to the development of psychopharmacology, allows for advances in entertainment and gaming, and enables knowledge representation and reasoning. We are not as interested in the background or area of education of potential new faculty as we are in the quality of their scholarship. Successful candidates for these positions must have a doctoral degree, present evidence of outstanding scholarship commensurate with their years post doctorate, and have grants to help finance their scholarly activities or show evidence of their ability to obtain grant support.

The department currently offers B.S. degrees in psychology and philosophy, M.S. degrees in these two fields and in cognitive systems engineering, and expects to offer a Ph.D. in Information Technology and AI in collaboration with Rensselaer's faculty of Information Technology. We also enjoy collaborative arrangements with other doctoral granting units, including the Department of Decision Sciences and Engineering Systems. Rensselaer is a private, non-sectarian nationally ranked university with 350 faculty serving approximately 4,000 undergraduates and 2,000 graduate students. Founded in 1824, Rensselaer is the oldest technological university in the country.

Rensselaer is located in Troy, New York, one of the three cities comprising New York's Capital District. Troy is located on the historic Hudson River within easy driving distance of New York City, Boston, Montreal, as well as the Adirondack, Berkshire and Catskill mountains.

Application materials should include a cover letter, c.v., selected reprints, and three letters of recommendation and be directed to: Search Committee; Department of Philosophy, Psychology and Cognitive Science; 305 Carnegie Building; 110 Eighth Street; Rensselaer Polytechnic Institute; Troy, NY 12180-2590. Fax: 518-276-8268; E-mail: bestlj@rpi.edu.

Screening of candidates will begin immediately and continue until the positions are filled. Applications from women and minorities are especially invited. Rensselaer is an equal opportunity/affirmative action employer.

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Transitions

David J. Farber, the Alfred Fitler Moore Professor of Telecommunication Systems at the University of Pennsylvania, has recently been named Chief Technologist for the Federal Communications Commission.

David Tennenhouse, formerly Chief Scientist and Director of the Information Technology Office at DARPA, is now a Vice President and Director of Research at Intel Corporation.