# COMPUTING RESEARCH NEWS

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# Despite Budget Climate, Industry/Academia Argue for Fundamental R&D

## *Administration grows defensive over impact of proposed cuts on U.S. competitiveness*

**By Peter Harsha**

As the fiscal year 2006 budget process heats up in Congress with an austere outlook for federal research and development funding, a loose coalition of industry and scientific groups is taking its case to Capitol Hill to advocate for increased federal support for fundamental research, especially in the physical sciences.

In the wake of an FY 2005 appropriations deal in Congress that led to a two percent cut in the budget of the National Science Foundation (NSF) and the President's FY 2006 budget submission that included a 4.5 percent cut to information technology research and development (as well as cuts to several science agencies), companies, academic institutions, and professional societies are making the case for research support by arguing that it plays a critical role in fueling the innovation necessary to keep the United States competitive in a global economy. The resonance of the message in Congress and in the national press appears to have put the Administration on the defensive.

While scientific societies like CRA have continually argued the importance of federal support for basic research, the relatively recent enthusiasm with which U.S. companies and industry groups have begun to make a similar case appears to be the reason for Congress's attention. In December 2004, the Council on Competitiveness—representing 400 industrial CEOs and university presidents—released a report on innovation in America that argued that the U.S. had to do more to develop an innovative and talented workforce, increase federal support of long-term research, and invest in "innovation infrastructures" if the country wanted to maintain its dominant position in a world that is becoming more interconnected and competitive, and when the pace of innovation worldwide has accelerated so rapidly.

In the report, titled *Innovate America* (available at http://www.compete.org), the Council made a number of recommendations relating to the federal investment in research, including a call to "spur radical innovation" by reallocating three percent of all federal agency R&D budgets towards grants that invest in "novel, high-risk and exploratory research"; a call to "increase significantly the research budgets of agencies that support basic research in the physical sciences and engineering, and complete the commitment to double the NSF budget"; and "[restoring] the Department of Defense's historic commitment to fundamental knowledge creation" by "directing at least 20 percent of the DOD science and technology budget to long-term, basic (6.1) research performed at the nation's universities and laboratories."

Not coincidentally—and emblematic of the tension between groups calling for increases in federal funding for fundamental research and the Administration—the White House chose the same day (indeed, the same building) that the Council planned to hold its press conference announcing the release of the report to host an economic summit with industrial and small business CEOs. At that summit the President announced that the American economy was fundamentally sound and that American competitiveness would be guaranteed by encouraging "capital flows and job creation." His closing speech on the theme of "securing our economic future" contained considerable detail about

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## Inside CRN



# Lazowska and Margolis to Receive CRA Service Awards

CRA is pleased to announce the winners of its 2005 service awards. The Distinguished Service Award will be presented to Ed Lazowska, the Bill and Melinda Gates Chair in Computer Science & Engineering at the University of Washington. Jane Margolis, Research Educationist, IDEA, UCLA Graduate School of Education Information Studies, will receive the A. Nico Habermann Award. The awards will be presented at ACM's Awards Banquet in San Francisco on June 11, 2005.

### CRA Distinguished Service Award

Ed Lazowska is widely recognized for his incredible effectiveness, unbridled enthusiasm, and overwhelming energy. He has furthered the computing research agenda in so many ways that are simply transparent to the entire community. Only a few of his many contributions are mentioned here.

Lazowska is a Member of the NAE; and a Fellow of the ACM, IEEE, AAAS, and the American Academy of Arts & Sciences. Currently he co-chairs the President's Information Technology Advisory Committee. From 1992-2004, he was a member of the CRA Board of Directors, serving as chair from 1997-2001; Ed is currently a co-chair of CRA's Government Affairs Committee. He has long been involved with ACM activities, where he served as a member (and 1999-2000 chair) of ACM's A.M. Turing Award selection committee and as a member of the ACM Council. From 1995-2000, Ed served on (and in 1998 and 1999 he chaired) the National Science Foundation's Advisory Committee for Computer and Information Science and Engineering. He has testified before the U.S. House Appropriations Committee concerning NSF and the U.S. House Science Committee concerning HPCC.

Lazowska chairs the Defense Advanced Research Projects Agency's Information Science and Technology (ISAT) study group and served as a member from 1998-2001; he also chairs the Peer Committee for Section 5 (Computer Science & Engineering) of the National Academy of Engineering. He is a member of the Executive Advisory Council of the National Center for Women and Information Technology, and also has served on a number of industry advisory boards.

Recently Ed completed six years of service on the National Research Council's Computer Science and Telecommunications Board (CSTB), and served on the NRC Committee on Improving Learning with Information Technology. In addition, he served on the NRC Committee on Science and Technology for Countering Terrorism—Panel on Information Technology, as well as contributing extensively to the

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## Expanding the Pipeline

# In a More Balanced Computer Science Environment, Similarity is the Difference and Computer Science is the Winner[1]

**By Lenore Blum and Carol Frieze**

Gender differences in computer science tend to dissolve—that is, the *spectrum* of interests, motivation, and personality types of men and of women becomes *more alike than different*—as the computing environment becomes more balanced. This finding is emerging from our ongoing studies of the evolving culture of computing at Carnegie Mellon as our undergraduate computer science (CS) environment becomes *more balanced* in three critical domains: gender, the mix of students and breadth of their interests, and the professional experiences afforded all students.

In contrast, studies of gender and computer science conducted within imbalanced environments, including those carried out at our own institution from 1995-99, point to strong gender differences. A principal finding of the Carnegie Mellon study was that men focused more on programming and women more on applications of computers [Margolis and Fisher 2002]. This led to recommendations for a *female friendly/contextual* approach to the CS curriculum. We would advise caution. Whether or not it is a good idea to incorporate applications into a particular course should depend on whether it makes sense for the subject matter, for the intellectual and technical skills to be developed, and/or for pedagogical purposes. To do so as a means to promote gender equity may actually help reinforce, even perpetuate, stereotypes. Given the changes we are observing in our evolving student body, we believe this is misguided.

Indeed, we believe that the gender differences observed in the earlier study tell more about the *biases* in our former admissions criteria (and a limited view of the undergraduate CS major) rather than significant or intrinsic gender differences in potential computer scientists. As we have pointed out [Blum and Frieze 2005], during the latter half of the 1990s, the undergraduate CS major at Carnegie Mellon fed primarily into the booming high-tech industry. The high school computer "geek" had an admissions advantage. Women and men with potential to become computer science leaders, but without long-standing programming experience or commitment, had little chance. The very few women who managed to get in had exceptional academic records.

## How Our CS Environment Became More Balanced

When our CS admissions criteria changed in the late 1990s so did our student body. *Eliminating prior programming* from the admissions criteria (while retaining high standards in mathematics and science) and *valuing broader interests*—to more closely reflect both our school's goals as well as rational prerequisites for the major—opened the door for a more diverse student body of women and men.[2] Importantly, an *outreach program* focusing on high school CS teachers resulted in increases in female applicants to our undergraduate program.[3] As a result, over the past few years, women have comprised about a third of our undergraduate CS population.

To meet the needs of students entering with varying backgrounds, *multiple entry routes* were created for the first-year programming sequence. In addition, a one-hour weekly *Immigration course* for freshmen (inspired by our Immigration course for entering Ph.D. students) had faculty from across the School of Computer Science (SCS) talk about their diverse research interests. These were the only major changes to a curriculum that is still boot camp for CS.

In 1999, the *proactive student organization* Women@SCS was established to help create an environment in which the new student body could flourish.[4] As we have emphasized [Blum and Frieze 2002], "Women@SCS explicitly provides crucial educational and professional experiences generally taken for granted by the majority in the community, but typically not available for the minority participants. Many of these experiences are casual and often happen in social settings. For example, in an undergraduate CS program, male students often have the opportunity to discuss homework with roommates and friends late at night or over meals. Course and job information and recommendations are passed down from upperclassmen, from fraternity files, and from friends. Women students, being in the minority, do not have access to—in fact are often excluded from—these implicit and important advantages. As one proceeds into the professional world, similar phenomena occur."

## Findings from Ongoing Interviews

In the spring of 2002 and again in 2004 we interviewed graduating seniors in CS using a protocol adapted from the Margolis-Fisher studies.[5] The 2002 graduating class, like all previous classes, had relatively few women. By their senior year, all three classes following them had significant numbers of women. Thus, we dubbed this 2002 class *'the class in transition.'* Their unique positioning made us eager to record their views before they disappeared into the world beyond Carnegie Mellon. The 2004 graduating class entered our program after the increases in female enrollment and the creation of Women@SCS.

Already in the class in transition we observed *marked changes* to the earlier findings of Margolis and Fisher. These changes became even more pronounced in the latter class of 2004. Here we present a glimpse of our findings. A fuller picture of the class in transition can be found in [Blum and Frieze, 2005]; our results on the 2004 class will be covered in an upcoming paper.

Whereas in the earlier Margolis and Fisher study, men tended to view computers as an object of study and women viewed computers as a "tool," *this was one area in which our cohort showed strong gender similarities*. We found men and women who enjoyed programming and the "geekier" aspects of computer science, and we found men and women who didn't. Almost all students saw programming as one part of their interests and the computer as a "tool" for their primary focus, which was applications. The image of "dreaming in code" as the dominant characteristic of male computer science students was clearly being challenged. As one woman from the class of 2004 explained, "It's always fun to sit down in front of a computer and kind of producing code until something is done and it's such a good feeling. A lot of the time once I sit down and do programming I find myself living in the cluster for a day without eating or sleeping." Yet she also doesn't "want to do it for the rest of my life. I want to combine it with other stuff."

A man in the transition class reflects on his own transition: "I still find computers to be very interesting. But because the field of computer science has grown as I've learned more about it, it's no longer the computer itself and the programming that is interesting. It's what can be done with the programs that is now interesting…The computer I see more as a tool now, as opposed to this neat toy."

Another example of how the view of the field crossed gender lines emerged when students were asked to define computer science. The most common theme to emerge was that computer science meant "problem solving" and a "way of thinking." As one woman in the 2004 class put it, "I look at computer science as a sort of logic-based way to solve problems."

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# CRA Elects New Board Members

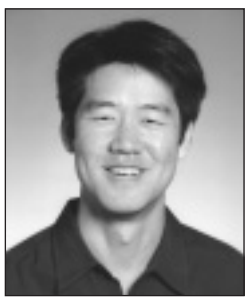
CRA recently elected five new members to its board of directors. **Anne Condon** (University of British Columbia), **Richard A. DeMillo** (Georgia Institute of Technology), **Peter Lee** (Carnegie Mellon University), **J Strother Moore** (University of Texas at Austin), and **David Notkin** (University of Washington) will serve three-year terms beginning July 1, 2005.

Two current board members, **Lori Clarke** (University of Massachusetts at Amherst) and **Richard C. Waters** (Mitsubishi Electric Research Laboratories), were re-elected to three-year terms. **Wim Sweldens** (Lucent Technologies, Bell Labs) and **Bryant York** (Portland State University) were appointed to complete the terms (ending June 30, 2006) of two members who resigned from the board.

## Newly Elected

**Anne Condon** is Professor of Computer Science at the University of British Columbia. She is the NSERC Chair for Women in Science and Engineering (2004-09), and received the Distinguished Alumna Award from University College in Cork, Ireland, in 2001. Professor Condon has been an active member of CRA-W since 1994, serving as co-chair from 1999-2002, and has been an effective fundraiser for the Canadian Distributed Mentor Project. She is a theoretical researcher, contributing to the foundations of the field and to prediction of molecular structure, bio-molecular computation, verification, and probabilistic planning. Professor Condon received a Ph.D. in Computer Science from the University of Washington.

**Richard A. DeMillo** is Dean and Distinguished Professor of Computing, College of Computing, Georgia Institute of Technology. He is an AAAS Fellow and a widely respected computer scientist. Professor DeMillo served as Chief Technology Officer at the Hewlett Packard Company and as Head of Information and Computer Sciences Research at Telcordia Technologies. He also directed the CISE Computer and Computation Research Division of the National Science Foundation. Professor DeMillo's research interests lie in the areas of information security, nanotechnology, computing and communication architectures, and software engineering. He received a Ph.D. in Information and Computer Science from the Georgia Institute of Technology.



**Peter Lee** is Professor of Computer Science at Carnegie Mellon University. He has served as Associate Dean for Undergraduate Programs in the CS school where he was involved in initiatives related to women and minorities. Professor Lee is an ACM Fellow, and has received the Allen Newell Award for Research Excellence, the Herbert A. Simon Award for Teaching Excellence, and an NSF Presidential Young Investigator Award. He serves on the Army Science Board, as well as DARPA's ISAT Committee and its IXO Senior Advisory Group. Professor Lee's research interests include programming language design and implementation, compiler design, static program analysis, and certified code, especially proof-carrying code. Professor Lee received a Ph.D. in Computer and Communications Sciences from the University of Michigan.

**J Strother Moore** is Chair of the CS Department and holds the Admiral B.R. Inman Centennial Chair in Computing Theory at the University of Texas at Austin. He is an AAAI Fellow, and in 1999 was a co-recipient of the Herbrand Award at the Conference on Automated Deduction. Professor Moore previously was a founder and chief scientist at Computational Logic, Inc. He is currently a member of the Academic Alliance of the National Center for Women and Information Technology. Professor Moore helped found the fields of mechanized inductive theorem proving and hardware and software verification. He received a Ph.D. in Computational Logic from the University of Edinburgh.

**David Notkin** is Bradley Professor and Chair of the Department of Computer Science and Engineering at the University of Washington. He is an ACM Fellow, and he has received the R1edu Award for Distinguished Faculty Contributions to Online Learning, the University of Washington Distinguished Graduate Mentor Award, and an NSF Presidential Young Investigator Award. Professor Notkin has been active in ACM, serving as Chair of SIGSOFT, as a member of the SIG Governing Board, and as Associate Editor of *ACM Transactions on*

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creation of the CSTB summary report *Innovation in Information Technology*.

In the words of one supporter of his nomination: "Ed Lazowska is a most worthy recipient of the CRA Distinguished Service Award given his prodigious service to our community over multiple decades. He has served on more committees with national impact than almost any other computer professional I know, and continued to do so even while he was the highly proactive chairman of the University of Washington's distinguished computer science department."

## CRA A. Nico Habermann Award

Jane Margolis was selected for this award because the passion and scholarship she brings to the computing research community is really unique.

Unlike previous winners of the Habermann Award, Jane Margolis is not a computer scientist. Instead she is a social scientist who has worked on issues of gender and minority status within computer science education. She is being honored because of the way she uses her research to inform ongoing interventions; she is committed both to rigorous research and to making important changes in society.

As her nomination states: "Her ability to collaborate with teachers, administrators, computer scientists, policymakers, and foundations allow her to gain insight and collect data from groups representing a variety of perspectives, often serving different interests. She reminds computer scientists, educators, and policymakers alike of the need to collaborate to reform computer science education." She is passionate about creating more equitable educational environments and she is a crusader for diversifying the field of computer science.

Margolis is most well-known for the work she did at Carnegie Mellon University with Allan Fisher that culminated in the award-winning book, *Unlocking the Clubhouse: Women in Computing*, and in research-based changes at CMU that significantly reduced their gender gap, helping to increase the enrollment of undergrad majors from 7 percent to 42 percent.

Since 2000, Margolis has been working on a similar research project at UCLA aimed at better understanding the psychological and institutional factors responsible for the under-representation of females and students of color in high school computer science. Again the research involved collaboration with teachers and administrators within the Los Angeles Unified school district (LAUSD). This collaboration led to a week-long summer institute for a group of high school computer science educators, helping them to increase their knowledge of Java, develop engaging pedagogies, and use more enticing curricula, while simultaneously establishing a professional network for them.

As a result, new CS courses have been added, the number of Latino/as taking the Advanced Placement computer science course in LAUSD tripled, and the number of African Americans and female students doubled. Margolis is publishing her findings, enabling other scholars and interveners to gain a better understanding of the factors at play. You can see a recent campus news article on this work at: http://www.dailybruin.ucla.edu/news/articles.asp?id=32447.

## About the Awards

CRA presents these awards, usually annually, to individuals for outstanding service to the computing research community. The Distinguished Service Award recognizes service in the areas of government affairs, professional societies, publications, or conferences, and leadership that has a major impact on computing research. The A. Nico Habermann Award honors the late A. Nico Habermann, former head of NSF's Computer and Information Science and Engineering Directorate. This award is given to an individual who has made outstanding contributions aimed at increasing the numbers and/or successes of underrepresented members in the computing research community. The award recognizes work in areas of government affairs, educational programs, professional societies, public awareness, and leadership that has a major impact on advancing these members in the computing research community. Recognized contributions can be focused directly at the research level or at its immediate precursors—namely, students at the undergraduate or graduate levels. ∎

# Computing, We Have a Problem…..

**By Jim Foley, CRA Board Chair**

The computing community—including the computing research community—suffers from one major problem: the public does not fully understand, and hence does not appreciate, what computing is and why computing and computing research are important. The bottom line is: We have an "image" problem, and it extends to our elected and appointed government officials, prospective students and their parents, some colleagues in other disciplines who use computing in their research, and the general public.

Two of the most obvious consequences of this image problem are:

1. Decreased funding for basic computing research (NSF funding is flat and DARPA's is decreasing), which leads to decreases in the proposal success rates.
2. Decreased enrollments in many undergraduate computing programs.

For these two reasons, the flow of people and ideas coming from our universities is threatened by what many observers (including me) believe will be disastrous impacts on our innovation, economic growth, international competitiveness, national security, and quality of life. Coupled with the decreasing attractiveness of the United States to international students for graduate studies and for work after graduate school, the future does not look as bright as it did five or ten years ago.

What is CRA doing about this? We convened an ad-hoc leadership summit meeting at Snowbird last July to start coordinating the ongoing activities of our member societies (see: http://www.cra.org/CRN/articles/sept04/foley.html). We continued with an all-day leadership summit this February that brought together computing community leaders from AAAI, ACM, ASIST, CACS/AIC, CASC, CNRI, CRA, CSTB, ECEDHA, Google, HP, IBM, IEEE-CS, Lucent/Bell Labs, Microsoft, NAE, NCWIT, NSF, PITAC, SIAM, Sun, TechNet, and USENIX to develop strategies for addressing the problem. An outline of the strategies and other meeting information is available at: http://www.cra.org/Activities/summit/home.html.

Working with the leadership summit attendees, CRA is forming two task forces to refine and execute the strategies we developed, to coordinate the activities of the many groups that are tackling pieces of the problem, and to take new initiatives that "fill in the gaps" between ongoing activities.

The *Computing Research Funding Task Force*, led by CRA, will develop a coalition of societies and companies to be *the* source of computing research information and advocacy to the government and to coalitions such as ASTRA, the Council on Competitiveness, the National Association of Manufacturers, TechNet, the Task Force on the Future of American Innovation, as well as to our member societies. The CRA task force will aggressively present the case for computing research to the administration and the legislature, drawing on the human and financial resources of our corporate and society members for personal visits, print media, behind-the-scenes lobbying, events, letters to the editors, and any other effective means it can develop.

The *Image of Computing Task Force* will work to increase the public's understanding of computing, thereby increasing the number of computing students at all levels—K-12, undergraduate, and graduate. The challenges are to:

- Convey positive images of career opportunities in computing.
- Counter concerns about job security created by the dot-com crash and the outsourcing scare.
- Help high school students and others know there is more to computing than AP programming.
- Help publicize the highly successful ways of introducing computing to college students that do NOT scare the students away—such as those of Mark Guzdial at Georgia Tech and Randy Pausch at CMU.
- Encourage the very brightest college students to study computing.
- Encourage more CS undergrads to go on to grad school.

This is much more than a CRA-centric undertaking: we are working with CRA member societies to set up a leadership team that will move the effort forward.

*Jim Foley, CRA's board chair, is Professor and Stephen Fleming Chair in Telecommunications at the Georgia Institute of Technology.* ∎

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his plans for tort reform, regulatory reform, social security reform, and tax reform, but only the following about the role of innovation: "We've always got to stay on the leading edge of innovation. There's always got to be a proper role between government and the economy. The role of government is not to create wealth; the role of government is to create an environment in which the entrepreneurial spirit is strong and vibrant."

Since the release of the Council's report, a number of other industry groups have issued reports of their own, all echoing a similar theme: support for fundamental research, especially in the physical sciences, is crucial for fostering the innovation that will ensure America's future competitiveness. In February, recognizing that "federal support of science and engineering research in universities and national laboratories has been key to America's prosperity for more than half a century," the *Task Force on the Future of American Innovation*, a coalition of 22 industry and academic groups—including Intel, Hewlett Packard, CRA, the National Association of Manufacturers, American Physical Society and others—compiled a set of benchmarks to assess the international standing of the U.S. in science and technology.

The benchmarks (available at http://futureofinnovation.org), the task force argued, showed that the U.S. still enjoyed a lead in scientific discovery and innovation, but that all the long-term trends—indicators in education, workforce, knowledge creation, R&D investments, the high-tech economy and specific high tech sectors—were all headed in the wrong direction. Other influential industry groups such as the American Electronics Association, TechNet, the Semiconductor Industry Association, and the Computing Systems Policy Project have released reports or hosted events of their own, echoing many of the findings of the Council's report or the Task Force's benchmarks report.

Similar messages have appeared more frequently in the mainstream press in recent months. *New York Times* columnist Thomas Friedman reacted strongly to the NSF cut that was part of the FY 2005 Omnibus Appropriations bill, noting "[o]f all the irresponsible aspects of the 2005 budget bill that the Republican-led Congress just passed, nothing could be more irresponsible than the fact that funding for the National Science Foundation was cut by nearly 2 percent, or $105 million." Similarly, the *San Jose Mercury News* editorialized about the cuts by reasoning "without a renewed commitment to funding basic and technology research, America's leadership in science and technology is certain to slip even further. Already, the proportion of Americans winning scientific prizes or publishing breakthrough research in international journals is declining. The American share of industrial patents has also dropped steadily in recent years."

"It looks like Congress is not alarmed by these trends. But everyone involved in innovation and research understands what they portend—a poorer, weaker, less dynamic and less vibrant America."

Most recently, a February 14, 2005, piece in *Business Week* lamented President Bush's decisions to cut federal support of R&D in his FY 2006 budget by noting that multifactor productivity—the "single biggest indicator of the economy's true strength"—is "borne of the essence of technological innovation." The cut in non-defense R&D spending in the President's budget, the piece argued, "can only hurt the nation's ability to maintain a rapid pace of multifactor productivity growth."

The combination of pressure from industry and articles in the press garnered attention from key members of Congress and placed the Administration on the defensive regarding agency budget requests. In a testy hearing in March before the new House Appropriations Subcommittee on Science, State, Justice and Commerce, John Marburger, Director of the White House Office of Science and Technology Policy, faced questions about reconciling the Administration's budget request for science agencies with apparently well-founded fears that future U.S. competitiveness may be at risk because of R&D cutbacks. Marburger said he hears the warnings, but feels that U.S. competitiveness is not facing an immediate crisis. "It's kind of hard to see into the future," he said. "The U.S. is so far ahead in these areas that we are going to be able to maintain our competitive strength. I don't see the same danger signs."

"I think you are in the minority in regard to our competitiveness," responded Frank Wolf (R-VA), chairman of the subcommittee.

Although there appears to be some popular sentiment in Congress in support of fundamental research in the physical sciences, congressional staff caution that the budget environment overall is still remarkably austere. The appropriators may be sympathetic to the case for basic research, but could be held to budget caps that preclude any increases to science agencies.

CRA will continue to make the case for assigning priority to long-term R&D funding.

As always, for the latest on the budget debate, or anything else related to computing research policy, check out the CRA *Computing Research Policy Blog.* ∎

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*Software Engineering & Methodology*. His research interests lie in software engineering, software evolution, and software testing and evaluation. Professor Notkin received a Ph.D. in Computer Science from Carnegie Mellon University.

### Board Appointments

**Wim Sweldens**, Vice President, Computing Sciences Research, Lucent Technologies, Bell Labs, has been appointed to complete the term (ending June 30, 2006) of Elaine Weyuker, AT&T - Research, who resigned from the board. He is an IEEE Fellow and the winner of the 2003 SPIE Wavelet Pioneer Award. MIT's *Technology Review* chose him as one of 100 top young innovators in 1999, and in the same year he won the SIAM Outstanding Paper Award (across all SIAM journals). Dr. Sweldens' research interests include wavelets algorithms and high dimensional multiresolution; computer graphics; image and video compression; network management and network modeling languages; and secure networking. Dr. Sweldens received a Ph.D. from the Katholieke Universiteit Leuven, Belgium.

**Bryant York**, Professor of Computer Science, Portland State University, has been appointed to complete the term (ending June 30, 2006) of Jan Cuny, University of Oregon, who resigned from the board. Professor York has been awarded the CRA A. Nico Habermann Award, the Tapia Award, and in 2001 was named one of the Top 50 African Americans in Information Technology. He has been an active member of the Coalition to Diversify Computing (CDC, a joint organization of ACM, CRA and IEEE-CS) and the CDC Executive Committee, and was General Co-Chair of the Tapia Conference in 2003. Professor York's research interests lie in the areas of parallel computing, machine learning, and educational technology. He received a Ph.D. in Computer Science from the University of Massachusetts, Amherst. ▮

## CRA Welcomes New Members

**Academic**

**Drexel University (IST)**

**Iowa State University (ECE)**

**Lab/Center Members**

**Google**

# CRA-Women Honored by National Science Board

Congratulations to CRA-W, which was recently selected by the National Science Board to receive its NSB 2005 Public Service Award (Group).

The selection of CRA-W was based on the following:

For the past 14 years, CRA-W has been committed to public service through programs and projects aimed at increasing the participation of women in computer science and engineering research and education. Among some of the activities promoted by CRA-W are:

- Increasing the number of women entering graduate school in computer science and computer engineering by matching outstanding female undergraduates with female mentors for a summer of research at the mentor's institution.
- Encouraging the next generation of scientists and fostering awareness of women in science and technology through a Distinguished Lecture Series.
- Publishing reports and articles that focus on career advancements for women, such as *Recruitment and Retention of Women Graduate Students in CSE*; and "Expanding the Pipeline" column for *Computing Research News*, to name a few.

The award will be presented to the co-chairs, Carla Ellis and Mary Jean Harrold, at a formal dinner at the State Department on May 25, 2005.

Information on the Public Service Award is available at: http://www.nsf.gov/nsb/awards/public/public.htm/ Past recipients at: http://www.nsf.gov/nsb/awards/public/public_recipients.htm ▮

# Thanks to Retiring Board Members

This year CRA bids farewell to several long-term board members whose contributions will be sorely missed.

On behalf of CRA and the computing research community, we express our gratitude to these board members for their dedicated service. We highlight only a few of their many contributions here.

**Jim Foley** (1996-2005; served as treasurer from 1998-2001 and two terms as board chair 2001-05; Jim will remain on the board for one more year as Past Chair); **Kathy McKeown** (1999-2005; served two terms as secretary 2001-05 and chaired several important committees); **Larry Snyder** (1996-2005; spearheaded several of CRA's "Best Practices" papers and chaired a number of important committees); **Mary Lou Soffa** (1996-2005; served as vice chair of the board for two terms 1997-2001 and as co-chair of CRA-W 1999-2002); **Jack Stankovic** (1996-2005; served as treasurer from 2001-03, Snowbird co-chair in 2002, and directed the CRA study on "Recruitment and Retention of Faculty in Computer Science and Engineering").

Our thanks also to two board members who recently resigned due to other professional commitments—**Jan Cuny,** University of Oregon (2000-05; served as board vice chair 2001-05 and as co-chair of CRA-W 1996-99); and **Elaine Weyuker,** AT&T – Research (2000-05; served on the industry and membership committees and the Faculty Retention and Recruitment study group). ▮

# Awards/Transitions

ACM has named **Vinton G. Cerf** and **Robert E. Kahn** the winners of the 2004 A.M. Turing Award, considered the "Nobel Prize of Computing," for pioneering work on the design and implementation of the Internet's basic communications protocols. Cerf and Kahn developed TCP/IP, a format and procedure for transmitting data that enables computers in diverse environments to communicate with each other. This computer networking protocol, widely used in information technology for a variety of applications, allows networks to be joined into a network of networks now known as the Internet. Kahn is a member of the CRA board of directors. The award will be presented at ACM's Annual Awards Banquet in San Francisco on June 11.

The Franklin Institute Committee on Science and Arts has announced that **Aravind K. Joshi**, a professor of computer and cognitive science at the University of Pennsylvania, will receive the Benjamin Franklin Medal in computer and cognitive science at a ceremony in Philadelphia on April 21. His work has enabled computers to process human languages more efficiently, leading to new methods of computer translation.

Among those recently appointed ACM Fellows is new CRA board member **Peter Lee**, Carnegie Mellon University; **Benjamin W. Wah**, University of Illinois, Urbana-Champaign; and **David S. Wise**, Indiana University.

Congratulations to CRA board member, **Jennifer Rexford**, Professor of Computer Science at Princeton University, who has been recognized by ACM with the Grace Murray Hopper Award for her work on assuring stable and efficient Internet routing. She will receive the Hopper Award for outstanding young computer professional of the year at ACM's Annual Awards Banquet in San Francisco on June 11. ▮

# EPICS Project at Purdue Wins NAE's 2005 Gordon Prize

Pictured above are Purdue's Engineering Projects in Community Service (EPICS) facilitators, from left, William C. Oakes, Leah Jamieson and Edward J. Coyle. The EPICS program was awarded the National Academy of Engineering's 2005 Bernard M. Gordon Prize for Innovation in Engineering and Technology Education. Oakes is an associate professor of engineering education and co-director of EPICS; Jamieson is the Ransburg Professor of Electrical and Computer Engineering, associate dean of engineering for undergraduate education and co-founder and director of EPICS; and Coyle is director of the EPICS entrepreneurship initiative, professor of electrical and computer engineering and co-founder of EPICS. Jamieson is a member of the CRA board. (Purdue News Service photo/David Umberger).▮

# Challenges for Computing Research

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

**Advances by computer science and engineering (CS&E) researchers have, over the past forty years, changed the world. Similar opportunities still exist, but excitement is tempered by challenges beyond our control. We explore issues facing our field and describe efforts by NSF's CISE (Computer and Information Science and Engineering) to better understand future opportunities and also to maximize the impact of current resources.**

During the past ten years there has been unprecedented growth in our field. The community of researchers has grown dramatically both in size and in the scope of research undertaken. Our undergraduate and graduate programs are the envy of the world and attract many of the best students from around the globe. Important discoveries have led to major advances in a wide variety of areas. There has been a blossoming of cooperation between computer scientists and colleagues in other science and engineering fields. Our research has continued to spawn new industries that account for a significant fraction of the growth in the US economy. So overall, for computer science and related disciplines, the recent past has been a time of scientific vitality and significant impact on society as a whole.

With this incredible vitality and growth have also come problems that potentially threaten our ability to maintain US leadership over future decades. While our domestic community has grown and has welcomed a wide variety of "non-traditional" colleagues, the resources needed to support the wide gamut of potentially high-impact and world-class research have not kept pace. This is due to the increase in the size of the community and also to factors beyond our control, including US government budget constraints, retrenchment of industrial research support, and re-orientation of research away from universities by various agencies.

Another issue beyond our control is the increasing competition for international students. With the upsurge in the economies of countries such as India and China and the attendant professional opportunities for students who remain at home, increasing numbers have opted for local universities. In addition, the difficulties facing foreign students trying to enter the United States since September 11, 2001, have sometimes made universities elsewhere (e.g., Australia) more attractive. If current trends continue, our cutting-edge industries may not be able to acquire sufficient numbers of first-rate graduates, government may not have the people and technology it needs, and, worst of all, the most innovative ideas, products, and services may spring from organizations elsewhere.

There are also problems that we have created ourselves. Proposal submissions have soared in recent years. This has led to lower success rates and to a tendency by researchers to submit even more proposals, leading to even lower success rates. As part of this process, CISE Program Directors have, at times, reacted by cutting budgets so larger numbers of projects can be funded. Ideally, CISE could fund all truly outstanding research and education projects at levels that are justified by the scientific needs of the project. Unfortunately, budget constraints have made this difficult to achieve.

Some of the growth in submissions is due to the increasing numbers of researchers, the broadening of the scope of CISE-funded activities, and the introduction of cross-cutting programs such as ITR and Cybertrust. However, much of the problem has resulted from the currently common strategy of submitting multiple proposals in a year. Given that resources have not expanded to match this increased submission rate, multiple submissions have played a major role in the lowering of success rates.

We also need to address the incredible workloads imposed on CISE investigators and on NSF personnel as a result of the large number of proposals submitted. Researchers today spend a significant fraction of their time on proposal-writing. NSF personnel are overloaded by the number of proposals, including the difficulty in identifying top-notch panelists who do not have conflicts and the demands of providing a high-quality review process. Indeed, this topic and the related issue of low success rates seem to be a major concern of many in the community.

Given the above analysis, it appears that constraints on multiple submissions by individual researchers will go a long way in addressing both the overload issue and the perceived drop in funding rates. For example, we might limit researchers to, at most, one research proposal per year per solicitation. Another option might be to disallow submissions to a solicitation by those who have been successful in the prior year's competition. Still another might be to limit the number of research proposals submitted to CISE in a given year. These, together with the change to annual solicitations, have the potential to cut the number of submissions and increase success rates. An associated benefit will be the extra time that researchers have to work on research instead of proposal-writing. It also will make it possible for CISE Program Directors to play a more active role in managing the scientific programs for which they are responsible. Some combination of these mechanisms is under consideration.

One further change that we have made in recent solicitations is the introduction of clusters. Each cluster is a collection of related areas. In the past, each program had a small budget and it was difficult to move funds between individual programs. A principal motivation of the cluster approach is to make it possible to fund the best projects submitted to the cluster, regardless of area. This may entail, on a year-to-year basis, more or less funding for a particular area. Limiting submissions to clusters also has the potential to deal with the workload/success-rate issue.

One positive factor is that, despite the FY2005 budget cut experienced by NSF, CISE received a (small) increase in its budget. In addition, while the ITR program has ended, the associated funds remain in the CISE account. As ITR commitments end, some of these funds will be channeled into CISE divisions to enable growth in core CISE programs. In addition, some will be used to introduce new cross-cutting emphases such as the current CyberTrust, Information Integration, Science of Design, and Broadening Participation in Computing.

We also need to consider what proactive steps we can take to ensure that the United States maintains its research leadership in computing. To address this, we have initiated a study of the scientific vitality of research areas. The first phase of the study involved developing a taxonomy of CISE areas. This was done cooperatively by the CISE Program Directors. The second phase involves asking researchers to assess the state-of-the-art in their areas, including past achievements and future opportunities. Many of you have agreed to participate in this study, and for this you have both our thanks and those of your colleagues. The third phase of the study will be to convene panels of prominent individuals from academia, industry, and government. These panels will be given the information obtained in the second phase. They will be asked to provide evaluations of areas for consideration by CISE. It is hoped that, in the aggregate, the above information will be helpful in a variety of ways.

While much of the tone here may sound negative, there are positives, including those cited in the first paragraph. At the present time, the glass is certainly more than half full. The challenge for all of us going forward is to maintain our global leadership in computer science and engineering research and education, while adjusting to the external constraints over which we have no control.

Let us close our final *CRN* article for this academic year by thanking all of you for your help during the past year. Your willingness to serve as panel members and advisors, as well as your feedback on the full array of issues affecting CISE, is greatly appreciated. As is always the case, we welcome your comments on this article. Have a productive and pleasant summer!

***Peter A. Freeman*** *(pfreeman@nsf.gov) is Assistant Director and* ***Lawrence H. Landweber*** *(llandweb@nsf.gov) is a Senior Advisor, both in NSF's Computer and Information Science and Engineering (CISE) directorate.* ■

## Department Chairs and Lab Directors

**Plan Ahead—Only 12 Months Until the Next CRA Snowbird Conference**

**Note the Dates: June 25-26, 2006**

## Grimes Receives Outstanding Undergraduate Award

Photo credit: Joseph A. Konstan, University of Minnesota

**Andrea Grimes**, Northeastern University, receives CRA's 2005 Outstanding Undergraduate Award (female) from board chair Jim Foley. The presentation took place at the Conference on Human Factors in Computing Systems (CHI) in Portland, Oregon, on April 4.

## 2003-2004 Taulbee Survey

# Record Ph.D. Production on the Horizon; Undergraduate Enrollments Continue in Decline

**By Stuart Zweben**

This article and the accompanying figures and tables present the results of the 34th 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.

The information was collected in the fall of 2004. Responses received by January 17, 2005 are included in the analysis. The period covered by the data varies from table to table. Degree production and enrollment (Ph.D., Master's, and Bachelor's) refer to the previous academic year (2003-04). Data for new students in all categories refer to the current academic year (2004-05). Projected student production and information on faculty salaries and demographics also refer to the current academic year. Faculty salaries are those effective January 1, 2005.

The data were collected from Ph.D.-granting departments only. A total of 229 departments were surveyed, four more than last year. As shown in Figure 1, 189 departments submitted their survey forms, for a response rate of 83% (the highest in the past ten years). The return rate of 10 out of 30 (33%) for Computer Engineering (CE) programs is very low, as has been customary. Many CE programs are part of an ECE department, and they do not keep separate statistics for CE vs. EE. In addition, many of these departments are unaware of the Taulbee Survey or its importance. The response rate for US CS departments (158 of 172, or 92%) was very good, while the 78% response rate for Canadian programs was moderately good.

The set of departments responding varies slightly from year to year, even when the total numbers are about the same; thus, we must approach any trend analysis with caution. We must be especially cautious in using the data about CE departments because of the low response rate. However, we have reported CE departments separately because there are some significant differences between CS and CE departments.

The survey form itself is modified slightly each year to ensure a high rate of return (e.g., by simplifying and clarifying), while continuing to capture the data necessary to understand trends in the discipline and also reflect the changing concerns of the computing research community. In December 2004, preliminary survey results about faculty salaries were provided to departments that had responded. The CRA Board views this as a benefit of participating in the survey. This practice began last year and is expected to continue.

We thank all respondents who completed this year's questionnaire. The names of the departments that participated are listed at the end of this article.

## Ph.D. Degree Production and Enrollments *(Tables 1-8)*

As shown in Table 1, a total of 1,032 Ph.D. degrees were awarded in 2004 by the 189 responding departments. This is an increase of more than 17% over last year, and represents the highest number of Ph.D.s produced in almost a decade. In previous Taulbee reports, we foresaw a large increase in Ph.D. production based on the growing number of students passing qualifier exams. It appears that this was the year the significantly increased degree production really materialized, even allowing for the increased number of departments reporting.

As in previous years, the prediction from last year's survey that 1,350 Ph.D. degrees would be awarded in 2004 was overly optimistic. The "optimism ratio," defined as the actual over the predicted, was 0.76, a slight increase over last year. Based on previous experiences, next year's prediction of 1,480 graduates (Table 1) is likely to yield an actual production in the 1,100 range, and production may exceed the 1992 all-time annual Taulbee Survey record of 1,113 (see Figure 2).

The number entering Ph.D. programs (Table 5) decreased from 3,131 to 2,887 (8%), following a 5% decrease last year. This year, the

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

| | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| Male | 731 | 81.5% | 92 | 86.0% | 823 | 82.0% |
| Female | 166 | 18.5% | 15 | 14.0% | 181 | 18.0% |
| **Total have Gender Data for** | **897** | | **107** | | **1,004** | |
| Unknown | 26 | | 2 | | 28 | |
| **Total** | **923** | | **109** | | **1,032** | |

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

| | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| Nonresident Alien | 362 | 45.9% | 60 | 69.0% | 422 | 48.2% |
| African-American, Non-Hispanic | 12 | 1.5% | 1 | 1.1% | 13 | 1.5% |
| Native American/ Alaskan Native | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Asian/Pacific Islander | 100 | 12.7% | 12 | 13.8% | 112 | 12.8% |
| Hispanic | 10 | 1.3% | 0 | 0.0% | 10 | 1.1% |
| White, Non-Hispanic | 290 | 36.8% | 14 | 16.1% | 304 | 34.7% |
| Other/Not Listed | 15 | 1.9% | 0 | 0.0% | 15 | 1.7% |
| **Total have Ethnicity Data for** | **789** | | **87** | | **876** | |
| Ethnicity/Residency Unknown | 134 | | 22 | | 156 | |
| **Total** | **923** | | **109** | | **1,032** | |

**Figure 1. Number of Respondents to the Taulbee Survey**

| 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%) |
| 2000 | 148/163 (91%) | 6/28 (21%) | 19/23 (83%) | 173/214 (81%) |
| 2001 | 142/164 (87%) | 8/28 (29%) | 23/23 (100%) | 173/215 (80%) |
| 2002 | 150/170 (88%) | 10/28 (36%) | 22/27 (82%) | 182/225 (80%) |
| 2003 | 151/169 (89%) | 7/29 (24%) | 19/27 (70%) | 177/225 (79%) |
| 2004 | 158/172 (92%) | 10/30 (33%) | 21/27 (78%) | 189/229 (83%) |

**Figure 2. Ph.D. Production**

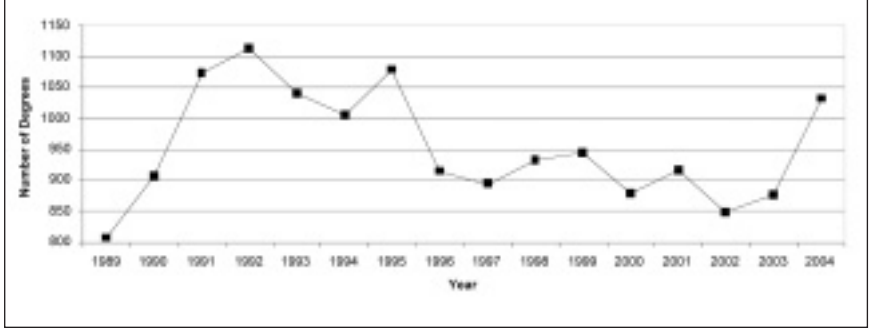


**Table 1. Ph.D. Production by Type of Department and Rank**

| Department, Rank | Ph.D.s Produced | Avg. per Dept. | Ph.D.s Next Year | Avg. per Dept. | Passed Qualifier | Avg. per Dept. | Passed Thesis Exam | Avg. per Dept. |
|---|---|---|---|---|---|---|---|---|
| US CS 1-12 | 196 | 16.3 | 265 | 22.1 | 330 | 27.5 | 164 | 13.7 |
| US CS 13-24 | 142 | 11.8 | 147 | 12.2 | 257 | 21.4 | 155 | 12.9 |
| US CS 25-36 | 91 | 7.6 | 179 | 14.9 | 275 | 22.9 | 72 | 6.0 |
| US CS Other | 435 | 3.6 | 677 | 5.5 | 1,192 | 9.8 | 522 | 4.3 |
| Canadian | 115 | 5.5 | 119 | 5.7 | 145 | 6.9 | 79 | 3.8 |
| US CE | 53 | 5.3 | 93 | 10.3 | 119 | 11.9 | 33 | 3.3 |
| **Total** | **1,032** | **5.5** | **1,480** | **7.8** | **2,318** | **12.3** | **1,025** | **5.4** |

Continued on Page 8

# 2003-2004 Taulbee Survey

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decrease is entirely in the U.S. programs, which exhibited no change in the size of the entering class last year. Canadian departments actually reported a 20% increase in new Ph.D. students after a drop last year, though Canadian numbers are more greatly affected by the specific departments responding to the survey than are the U.S. CS numbers. There were reports of a large drop in applications from international students last year, and this apparently also affected eventual admissions to the graduate programs. However, the number who passed qualifiers (Table 1) increased tremendously, from 1,545 to 2,318 (50%). On a per-department basis, the number passing qualifiers has risen from 6.5 to 12.3 (89%) in four years. The number who passed thesis proposal exams (Table 1) rose 16% this year to 1,025 after being flat last year. Total Ph.D. enrollment (Table 6) increased from 12,007 to 14,234 (19%), on the heels of a similar (20%) increase last year. While there are fewer new students entering the programs, those who are entering appear to be staying in much larger numbers than was the case several years ago. Economic conditions no doubt have a lot to do with this.

Figure 3 shows a longer-term trend of the number of CS Ph.D. graduates, normalized by the number of departments reporting to the Taulbee Survey. The figure also indicates the number of new students entering Ph.D. programs and the number of students who passed qualifiers. These also are normalized for the number of departments reporting. The graph offsets the qualifier data by one year from the data for new students, and offsets the graduation data by five years from the data for new students, to approximate the lag between student entrance into the pipeline and the qualifier and exit timeframe for the same cohort. The figure suggests that a much larger fraction of those entering the program are now passing qualifiers; the most recent data look more like the pre-dot-com boom years. Unless a larger fraction of those passing qualifiers do not complete the program, record levels of Ph.D. production can be expected soon.

Table 4 shows employment for new Ph.D. recipients. Of those who reported employment domestically, 60% took academic employment (compared to 63% last year and 53% the year before). Most of these academic positions were in Ph.D.-granting departments, but a smaller percentage went into tenure-track positions (27.5% vs. 34.2% last year). Only 31 were in other CS/CE departments. This is identical to the number reported last year as having gone to non-Ph.D.-granting CS/CE departments. It still appears quite low relative to meeting the needs of those departments. There was a considerable increase (from 89 to 122) in the number of postdoctoral positions taken by new Ph.D.s (up from 56 three years ago), although the total number of postdocs in the academic departments (295, see Table 17) actually fell slightly (from 312 last year). Figure 4 shows the trend of employment of new Ph.D.s to academia and industry, and the proportion of those going to academia who took positions other than in Ph.D-granting CS/CE departments. The trend in favor of academic jobs during the most recent three years is in sharp contrast to that of the dot-com boom years, though this year there was a slight narrowing of the gap.

Continued on Page 9

**Figure 3. Ph.D. Pipeline corrected for year of entry**

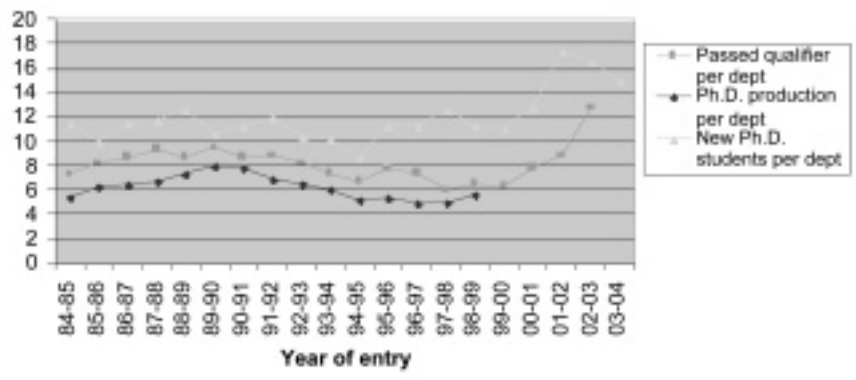



**Table 4. Employment of New Ph.D. Recipients by Specialty**

| | 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 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **New Ph.D.s in Ph.D.-Granting Depts.** | | | | | | | | | | | | | |
| Tenure-track | 32 | 28 | 3 | 20 | 44 | 27 | 19 | 20 | 22 | 12 | **227** | 27.5% | |
| Researcher | 23 | 7 | 3 | 6 | 8 | 6 | 6 | 10 | 5 | 6 | **80** | 9.7% | |
| Postdoc | 35 | 7 | 7 | 6 | 14 | 3 | 21 | 8 | 5 | 16 | **122** | 14.8% | |
| Teaching Faculty | 2 | 2 | 2 | 3 | 5 | 1 | 4 | 4 | 3 | 6 | **32** | 3.9% | |
| | | | | | | | | | | | | 55.8% | **Total** |
| **New Ph.D.s, Other Categories** | | | | | | | | | | | | | |
| Other CS/CE Dept. | 2 | 2 | 2 | 2 | 5 | 3 | 4 | 4 | 3 | 4 | **31** | 3.8% | |
| Non-CS/CE Dept. | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | **4** | 0.5% | |
| Industry | 29 | 24 | 4 | 12 | 64 | 30 | 9 | 27 | 22 | 28 | **249** | 30.1% | |
| Government | 5 | 2 | 2 | 1 | 2 | 5 | 2 | 2 | 3 | 4 | **28** | 3.4% | |
| Self-Employed | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 2 | 1 | 0 | **8** | 1.0% | |
| Employed Abroad | 6 | 5 | 0 | 2 | 5 | 6 | 1 | 3 | 5 | 4 | **37** | 4.5% | |
| Unemployed | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 2 | **8** | 1.0% | |
| | | | | | | | | | | | | 44.2% | **Total** |
| **Total have Employment Data for** | **138** | **77** | **23** | **54** | **152** | **83** | **66** | **81** | **70** | **82** | **826** | **100.0%** | |
| Unknown | 27 | 5 | 4 | 2 | 16 | 4 | 7 | 27 | 7 | 107 | **206** | | |
| **Total** | **165** | **82** | **27** | **56** | **168** | **87** | **73** | **108** | **77** | **189** | **1,032** | | |

**Table 5. New Ph.D. Students in Fall 2004 by Department Type and Rank**

| | CS | | | | CE | | | | CS&CE | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Department, Rank** | **New Admit** | **MS to Ph.D.** | **Total** | **Avg. per Dept.** | **New Admit** | **MS to Ph.D.** | **Total** | **Avg. per Dept.** | **Total** | **Avg. per Dept.** |
| US CS 1-12 | 374 | 34 | 408 | 34.0 | 0 | 0 | 0 | 0.0 | 408 | 34.0 |
| US CS 13-24 | 275 | 40 | 315 | 26.3 | 6 | 0 | 6 | 0.5 | 321 | 26.8 |
| US CS 25-36 | 232 | 19 | 251 | 22.8 | 8 | 0 | 8 | 0.7 | 259 | 23.5 |
| US CS Other | 1,165 | 289 | 1,454 | 11.9 | 98 | 24 | 122 | 1.0 | 1,576 | 12.9 |
| Canadian | 184 | 27 | 211 | 10.0 | 21 | 0 | 21 | 1.0 | 232 | 11.0 |
| US CE | 19 | 0 | 19 | 2.4 | 66 | 6 | 72 | 9.0 | 91 | 11 |
| **Total** | **2,249** | **409** | **2,658** | **14.3** | **199** | **30** | **229** | **1.2** | **2,887** | **15.5** |

# 2003-2004 Taulbee Survey

**Table 6. Ph.D. Degree Total Enrollment by Department Type and Rank**

| Department, Rank | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| US CS 1-12 | 2,172 | 17.4% | 0 | 0.0% | 2,172 | 15.3% |
| US CS 13-24 | 1,618 | 12.9% | 14 | 0.8% | 1,632 | 11.5% |
| US CS 25-36 | 1,423 | 11.4% | 3 | 0.2% | 1,426 | 10.0% |
| US CS Other | 6,260 | 50.0% | 563 | 32.8% | 6,823 | 47.9% |
| Canadian | 965 | 7.7% | 108 | 6.3% | 1,073 | 7.5% |
| US CE | 77 | 0.6% | 1,031 | 59.98% | 1,108 | 7.8% |
| **Total** | **12,515** | | **1,719** | | **14,234** | |

**Table 7. Ph.D. Program Total Enrollment by Gender**

| | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| Male | 9,769 | 79.5% | 1,436 | 84.6% | 11,205 | 80.1% |
| Female | 2,525 | 20.5% | 261 | 15.4% | 2,786 | 19.9% |
| **Total have Gender Data for** | **12,294** | | **1,697** | | **13,991** | |
| Unknown | 221 | | 22 | | 243 | |
| **Total** | **12,515** | | **1,719** | | **14,234** | |

**Table 8. Ph.D. Program Total Enrollment by Ethnicity**

| | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| Nonresident Alien | 5,946 | 53.8% | 706 | 45.4% | 6,652 | 52.8% |
| African-American, Non-Hispanic | 173 | 1.6% | 49 | 3.2% | 222 | 1.8% |
| Native American/ Alaskan Native | 22 | 0.2% | 2 | 0.1% | 24 | 0.2% |
| Asian/Pacific Islander | 1,212 | 11.0% | 405 | 26.0% | 1,617 | 12.8% |
| Hispanic | 131 | 1.2% | 27 | 1.7% | 158 | 1.3% |
| White, Non-Hispanic | 3,337 | 30.2% | 349 | 22.4% | 3,686 | 29.2% |
| Other/Not Listed | 226 | 2.0% | 17 | 1.1% | 243 | 1.9% |
| **Total have Ethnicity Data for** | **11,047** | | **1,555** | | **12,602** | |
| Ethnicity/Residency Unknown | 1,468 | | 164 | | 1,632 | |
| **Total** | **12,515** | | **1,719** | | **14,234** | |

**Figure 4. Employment of New Ph.D.s in U.S. and Canada**

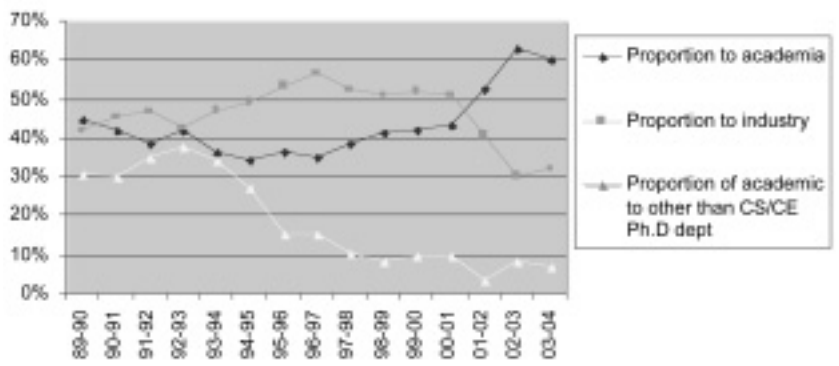
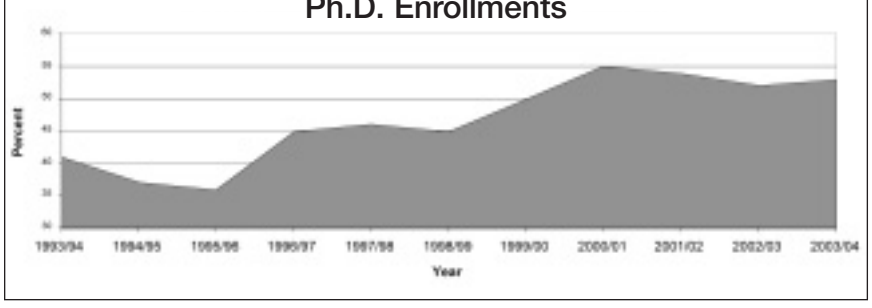



**Figure 5. Nonresident Aliens as Fraction of Ph.D. Enrollments**




Taulbee from Page 8

The proportion (4.5%) of Ph.D. graduates who were reported as having taken positions abroad, among those whose employment is known, is similar to that of the previous three years (4.1, 4.5, and 4.1%, respectively). Unless there really is a change hidden in the much larger number of those in the "employment unknown" category (206 this year vs. 126 last year), this lack of a trend may surprise those who feel that the offshoring of jobs is taking many more graduates of our Ph.D. programs away from North America.

The data in Table 4 also indicate increases over last year in the proportion of new CS/CE Ph.D.s in the AI/robotics, OS/networks, and software engineering areas, while the programming languages/compilers, theory/algorithms, numerical analysis/scientific computing, and database/information systems areas each experienced a decreased proportion of Ph.D.s. Multi-year trends are less clear, with only the graphics/HCI area showing any reasonably consistent trend (increasing) during the past five years.

Most statistics on gender and ethnicity for Ph.D. students (Tables 2, 3, 7, 8) again show little change from the last several years. White and nonresident-alien men continue to account for a very large fraction of our Ph.D. production and enrollments. The proportion of female Ph.D. graduates (18.0%) is up from the 16.5% figure last year. However, with women representing only about 20% of the overall Ph.D. enrollments, the proportion of female graduates is unlikely to climb considerably in the near future. All other underrepresented groups are very small minorities. The proportion of enrolled Ph.D. students who are nonresident aliens (more than 50%) is similar to last year. Thus, the reported decreases in Ph.D. applications from abroad and the decline in the total number of new Ph.D. students does not seem to have affected the overall demographics of the Ph.D. programs, at least not yet.

## Master's and Bachelor's Degree Production and Enrollments *(Tables 9-16)*

The statistics on Master's and Bachelor's degrees awarded show mixed trends. Master's degrees were awarded to 9,879 students, an increase of 8% (following an increase of 15% the previous year). As was noted last year, this increase may be a byproduct of the increased enrollment trends in Ph.D. programs, since in many schools students obtain the M.S. on the way to the Ph.D. No doubt it is influenced also by the increase of 6% in the number of departments reporting this year. Actual masters degrees awarded exceeded last year's projections by 21%. This year's expected Master's production (Table 12) exceeds the projection from last year's survey by 4%, but this also happened last year. In any case, next year's production level may well exceed 10,000.

Bachelor's degrees numbered 20,971 (Table 9), a 5% increase over last year (following a 3% decrease the year before). There still appears to be residual influence of the high level of undergraduate program enrollment that began in the late 1990s and remained strong until the early 2000s. There also is the effect of the larger number of programs reporting this year. On a per-department basis, the number of Bachelor's graduates is about the same as last year. Actual Bachelor's production in departments reporting this year exceeded the projection from last year's reporting departments by 11%. Projected Bachelor's production for this year shows a decrease from this year's actuals of 6%, but this represents an increase over last year's projections of 5%, probably again due in large part to the increased number of departments reporting (see Figure 6).

The number of new undergraduate majors dropped 10%, from 17,706 to 15,950, (see Figure 7). This follows last year's 23% drop in new majors. The number of pre-majors in both computer science and computer engineering also is down considerably from last year (20% in CS and 17% in CE) so we likely have not yet seen the end of the decreased undergraduate enrollments. Also note that the larger number of departments reporting this year softens the impact on the totals, so the percentage declines in new majors and pre-majors likely are even greater. As Table 14 shows, per-department numbers are holding steady in CS departments ranked 1-12, but are down for all others. This trend has been reported extensively in the media during the past year.

New Master's students (Table 13) decreased by 17% after having decreased by 8% last year. This continues, and accelerates the trend from the dot-com crash, as fewer students seek degree programs designed mainly to prepare them for

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**Table 9. Gender of Bachelor's and Master's Recipients**

| | Bachelor's | | | | | | Master's | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CS | | CE | | CS&CE | | CS | | CE | | CS&CE | |
| Male | 13,854 | 82.3% | 2,559 | 86.9% | 16,413 | 83.0% | 6,341 | 74.6% | 896 | 78.3% | 7,237 | 75.1% |
| Female | 2,972 | 17.7% | 387 | 13.1% | 3,359 | 17.0% | 2,155 | 25.4% | 248 | 21.7% | 2,403 | 24.9% |
| **Total have Gender Data for** | **16,826** | | **2,946** | | **19,772** | | **8,496** | | **1,144** | | **9,640** | |
| Unknown | 1,050 | | 149 | | 1,199 | | 239 | | 0 | | 239 | |
| **Total** | **17,876** | | **3,095** | | **20,971** | | **8,735** | | **1,144** | | **9,879** | |

# 2003-2004 Taulbee Survey

**Table 10. Ethnicity of Bachelor's and Master's Recipients**

| | Bachelor's | | | | | | Master's | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CS | | CE | | CS&CE | | CS | | CE | | CS&CE | |
| Nonresident Aliens | 1,309 | 10.1% | 252 | 10.4% | 1,561 | 10.2% | 3,974 | 51.9% | 346 | 39.5% | 4,320 | 50.6% |
| African-American, Non-Hispanic | 399 | 3.1% | 116 | 4.8% | 515 | 3.4% | 113 | 1.5% | 23 | 2.6% | 136 | 1.6% |
| Native American/ Alaskan Native | 47 | 0.4% | 9 | 0.4% | 56 | 0.34% | 17 | 0.2% | 17 | 1.9% | 34 | 0.4% |
| Asian/Pacific Islander | 2,977 | 23.1% | 527 | 21.8% | 3,504 | 22.9% | 1,266 | 16.5% | 174 | 19.8% | 1,440 | 16.9% |
| Hispanic | 500 | 3.9% | 95 | 3.9% | 595 | 3.9% | 87 | 1.1% | 21 | 2.4% | 108 | 1.3% |
| White, Non-Hispanic | 7,027 | 54.5% | 1,308 | 54.1% | 8,335 | 54.4% | 1,954 | 25.5% | 295 | 33.6% | 2,249 | 26.3% |
| Other/Not Listed | 642 | 5.0% | 109 | 4.5% | 751 | 4.9% | 248 | 3.2% | 1 | 0.1% | 249 | 2.9% |
| **Total have Ethnicity Data for** | **12,901** | | **2,416** | | **15,317** | | **7,659** | | **877** | | **8,536** | |
| Ethnicity/ Residency Unknown | 4,975 | | 679 | | 5,654 | | 1,076 | | 267 | | 1,343 | |
| **Total** | **17,876** | | **3,095** | | **20,971** | | **8,735** | | **1,144** | | **9,879** | |

**Figure 6. BS Production**

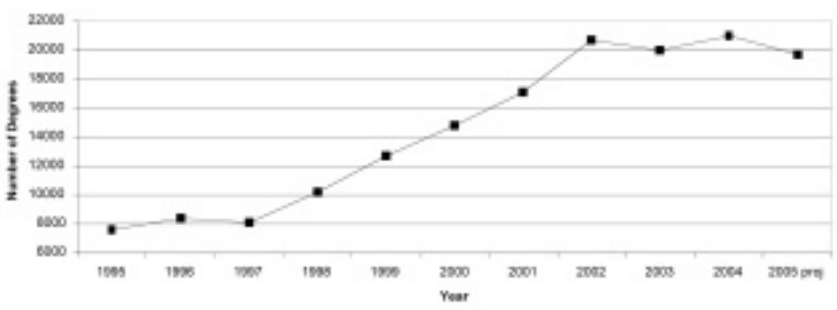


**Figure 7. Newly Declared CS/CE Undergraduate Majors**

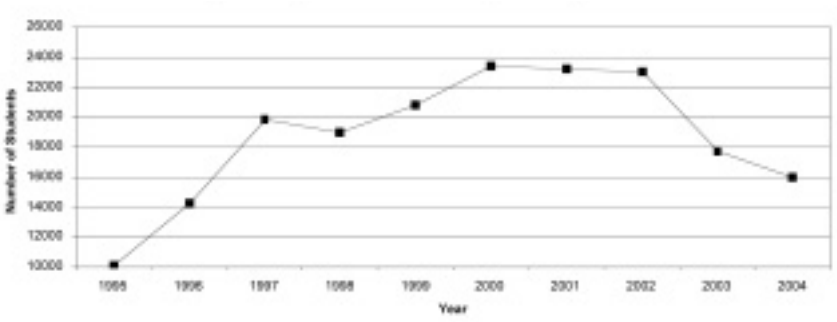


**Table 11. Bachelor's Degree Candidates for 2004-2005 by Department Type and Rank**

| Department, Rank | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| US CS 1-12 | 1,687 | 10.1% | 243 | 7.9% | 1,930 | 9.8% |
| US CS 13-24 | 1,256 | 7.5% | 415 | 13.5% | 1,671 | 8.5% |
| US CS 25-36 | 1,626 | 9.8% | 41 | 1.3% | 1,667 | 8.4% |
| US CS Other | 8,129 | 48.8% | 1,478 | 48.3% | 9,607 | 48.7% |
| Canadian | 3,864 | 23.2% | 182 | 5.9% | 4,046 | 20.5% |
| US CE | 105 | 0.6% | 704 | 23.0% | 809 | 4.1% |
| **Total** | **16,667** | | **3,063** | | **19,730** | |

**Table 12. Master's Degree Candidates for 2004-2005 by Department Type and Rank**

| Department, Rank | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| US CS 1-12 | 781 | 10.4% | 80 | 8.7% | 861 | 10.2% |
| US CS 13-24 | 837 | 11.1% | 1 | 0.1% | 838 | 9.9% |
| US CS 25-36 | 566 | 7.5% | 0 | 0.0% | 566 | 6.7% |
| US CS Other | 4,618 | 61.3% | 370 | 40.2% | 4,988 | 59.0% |
| Canadian | 717 | 9.5% | 45 | 4.9% | 762 | 9.0% |
| US CE | 11 | 0.1% | 425 | 46.1% | 436 | 5.2% |
| **Total** | **7,530** | | **921** | | **8,451** | |

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industry employment. Total enrollment in Bachelor's programs (Table 16) is approximately the same as it was last year (having dropped last year by 19% from the previous year). However, the U.S. CS total enrollment is down by 7%; this represents an increased number of reporting departments, so the downward trend appears to be continuing, as one might predict from the new student enrollment trends. Total enrollments in Master's programs (Table 15) increased by about 3% (having dropped by 4% last year), but the larger number of departments reporting probably counters this increase in numbers.

Most demographics regarding gender and ethnicity for Bachelor's and Master's students continue to be similar to those of previous years. The proportion of Master's degree recipients who are nonresident aliens (50.6%) is down from 55.8% the previous year, while there are slight gains in the fractions of White, non-Hispanic and Asian/Pacific Islanders (Table 10).

## Faculty Demographics *(Tables 17-23)*

Over the past year, the total number of faculty increased by only 1.5% to a total of 5,919. Increases of 4% in tenure-track faculty and 5% in teaching faculty were offset by decreases in other categories, and also should be viewed in terms of the increased number of departments reporting this year.

Ph.D. production shows 461 graduates known to have taken faculty positions at CS/CE Ph.D-granting departments (Table 4). Tables 19 and 20 indicate that a total of 608 persons were hired during the past year. Thus, more than 75% of the faculty hires made this past year by Ph.D.-granting CS/CE departments appear to have been new Ph.D.s, with the rest consisting of a combination of faculty who changed academic positions, persons joining academia from government and industry, new Ph.D.s from outside of North America and from disciplines outside of CS/CE, and non-Ph.D. holders (e.g., taking a teaching faculty appointment). The fraction of tenure-track hires who were new Ph.D.s appears to be more than 80% (227 new Ph.D.s taking tenure-track faculty positions at Ph.D.-granting programs, and 279 new tenure-track faculty hired by these programs).

This year's total faculty size of 5,919 is very close to the prediction of 5,928 from last year's survey. This is the second year in a row that departments collectively did a good job predicting their faculty growth. Planned growth for this year is 6% and an additional 5% is predicted for the following year. This apparent increased opportunity for faculty jobs over the past year is good news for the larger number of Ph.D.s we are producing.

Table 23 on faculty "losses" shows that only 75 people (which is less than 2% of all faculty) actually left academia this past year through death, retirement, or taking nonacademic positions. The amount of "churn," the number of professors moving from one academic position to another, went from 74 to 87. This reflects an increase over last year, even after accounting for the number of departments reporting, but is 20% less than that observed just two years ago.

The percentage of newly hired women faculty dropped from 19% to 17%. The gender split of new faculty (83% male, 17% female) again is close to the split for new Ph.D. recipients (Table 2). The percentage of newly hired postdoctoral students who are women decreased from 21% last year to only 15% this year.

In examining the ethnicity data for new faculty (Table 20), we note that the percentage of newly hired tenure-track faculty who are Asian/Pacific Islanders increased slightly. The fraction of new postdocs who were nonresident aliens increased from 33% to 45%. The fraction of new teaching faculty who were nonresident aliens decreased, while the fraction who were White, non-Hispanic increased.

As we observed last year, it appears that once again disproportionately fewer foreign students are being hired into faculty positions at North American universities. Approximately 49% of the newly hired tenure-track faculty in PhD-granting departments and 78% of the newly hired teaching faculty are White, non-Hispanic, even though only 35% of the Ph.D. recipients are in this category (Table 3). In contrast, only 27% of the new faculty (all employment categories combined, where ethnicity is known) are nonresident aliens, while 48% of the degree recipients are in that category.

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**Table 13. New Master's Students in Fall 2004 by Department Type and Rank**

| | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| Department, Rank | Total | Avg. per Dept. | Total | Avg. per Dept. | Total | Avg. per Dept. |
| US CS 1-12 | 572 | 52.0 | 55 | 9.2 | 627 | 57.0 |
| US CS 13-24 | 695 | 57.9 | 3 | 0.6 | 698 | 58.2 |
| US CS 25-36 | 270 | 22.5 | 3 | 0.5 | 273 | 22.8 |
| US CS Other | 3,156 | 27.4 | 193 | 2.8 | 3,349 | 28.9 |
| Canadian | 678 | 32.3 | 71 | 14.2 | 749 | 35.7 |
| US CE | 18 | 6.0 | 89 | 10.5 | 107 | 11.9 |
| **Total** | **5,389** | | **414** | | **5,803** | **32.1** |

**Table 15. Master's Degree Total Enrollment by Department Type and Rank**

| | CS | | CE | | CS&CE | |
|---|---|---|---|---|---|---|
| Department, Rank | | | | | | |
| US CS 1-12 | 1,326 | 6.6% | 88 | 4.3% | 1,414 | 6.4% |
| US CS 13-24 | 1,933 | 9.6% | 6 | 0.3% | 1,939 | 8.8% |
| US CS 25-36 | 857 | 4.3% | 2 | 0.1% | 859 | 3.9% |
| US CS Other | 13,580 | 67.5% | 986 | 48.7% | 14,566 | 65.7% |
| Canadian | 2,389 | 11.9% | 354 | 17.5% | 2,743 | 12.4% |
| US CE | 44 | 0.2% | 589 | 29.1% | 633 | 2.9% |
| **Total** | **20,129** | | **2,025** | | **22,154** | |

**Table 14. New Undergraduate Students in Fall 2004 by Department Type and Rank**

| | CS | | | CE | | | CS&CE Majors | |
|---|---|---|---|---|---|---|---|---|
| Department, Rank | Pre-Major | Major | Avg. Major per Dept. | Pre-Major | Major | Avg. Major per Dept. | Major | Avg. Major per Dept. |
| US CS 1-12 | 274 | 776 | 64.7 | 0 | 165 | 18.3 | 941 | 78.4 |
| US CS 13-24 | 147 | 737 | 61.4 | 0 | 389 | 48.6 | 1,126 | 93.8 |
| US CS 25-36 | 246 | 1,296 | 108.0 | 0 | 0 | 0.0 | 1,296 | 108.0 |
| US CS Other | 3,033 | 6,942 | 61.4 | 904 | 1,670 | 24.9 | 8,612 | 75.5 |
| Canadian | 433 | 3,026 | 144.1 | 0 | 290 | 48.3 | 3,316 | 157.9 |
| US CE | 60 | 27 | 9.0 | 108 | 632 | 70.2 | 659 | 73.2 |
| **Total** | **4,193** | **12,804** | | **1,012** | **3,146** | | **15,950** | **89.1** |

**Table 16. Bachelor's Degree Program Total Enrollment by Department Type and Rank**

| | CS | | | CE | | | CS&CE Majors | |
|---|---|---|---|---|---|---|---|---|
| Department, Rank | Pre-Major | Major | Avg. Major per Dept. | Pre-Major | Major | Avg. Major per Dept. | Total | Avg. Major per Dept. |
| US CS 1-12 | 386 | 4,959 | 413.3 | 0 | 701 | 77.9 | 5,660 | 471.7 |
| US CS 13-24 | 233 | 4,097 | 341.4 | 0 | 1,757 | 219.6 | 5,854 | 487.8 |
| US CS 25-36 | 771 | 5,500 | 458.3 | 0 | 122 | 15.3 | 5,622 | 468.5 |
| US CS Other | 6,544 | 35,102 | 302.1 | 1,486 | 5,844 | 85.4 | 40,946 | 350.0 |
| Canadian | 444 | 15,007 | 714.6 | 0 | 797 | 159.4 | 15,804 | 752.6 |
| US CE | 137 | 255 | 85.0 | 284 | 2,655 | 298.8 | 2,910 | 323.3 |
| **Total** | **8,515** | **64,920** | **354.8** | **1,770** | **11,876** | **64.9** | **76,796** | **419.7** |

**Table 17. Actual and Anticipated Faculty Size by Position**

| | Actual | Projected | | | |
|---|---|---|---|---|---|
| | 2004-2005 | 2005-2006 | 2006-2007 | Expected Two-Year Growth | |
| Tenure-Track | 4,360 | 4,583 | 4,814 | 454 | 10.4% |
| Researcher | 427 | 478 | 521 | 94 | 22.0% |
| Postdoc | 295 | 361 | 407 | 112 | 38.0% |
| Teaching Faculty | 737 | 753 | 764 | 27 | 3.7% |
| Other/Not Listed | 100 | 102 | 106 | 6 | 6.0% |
| **Total** | **5,919** | **6,277** | **6,612** | **693** | **11.7%** |

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## Research Expenditures and Graduate Student Support *(Tables 24-26)*

Table 24-1 shows the department's total expenditure (including indirect costs or "overhead" as stated on project budgets) from external sources of support. Table 24-2 shows the per capita expenditure, where capitation is computed two ways. The first is relative to the number of tenured and tenure-track faculty members, which also was the method used in previous years. The second is relative to researchers and postdocs, as well as tenured and tenure-track faculty. As is typical, the higher the ranking, the more external funding the department receives (both in total and per capita). Canadian levels are shown in Canadian dollars.

The median per capita amount of support compared to the median reported in last year's survey varied widely (here we only compare relative to the first capitation method, since only that method was used last year). In ranks 1-12 and 25-36 there was double-digit growth, while in ranks 13-24 and greater than 36 there actually was a decline in the medians. The 3.6% decline among those ranked greater than 36 may be attributable to the larger number of departments reporting this year. In ranking stratum 13-24, the median total expenditure actually rose 9.5%, though the minimum and maximum values both declined.

Canadian departments show an increase of 12% over last year in median per capita expenditure, but the funding model in Canada results in a lower level of expenditures from external sources than every US ranking band. It is difficult to draw meaning for the numbers for computer engineering because of the small number of departments reporting; the median per capita expenditure for computer engineering departments rose 78% but the median total expenditure declined.

Table 25 shows the number of doctoral students supported as full-time students as of fall 2004, further categorized as teaching assistants, research assistants, fellows, or computer systems supporters, and split between those on institutional vs. external funds. Departments ranked 25-36 showed a decline (17%) in the number of teaching assistants. Other U.S. ranking strata showed increases in teaching assistants.

Respondents were asked to "provide the net amount (as of fall 2004) of an academic-year stipend for a first-year doctoral student (not including tuition or fees)." The results are shown in Table 26. Canadian stipends are shown in Canadian dollars. As was reported last year, the higher the ranking band, the higher the median level of support for teaching assistants. Median amounts of support for research assistants at the top 24 schools also are much higher than those for the lower-ranked bands. Actual stipend levels at U.S. departments showed no noticeable pattern this year. Some median

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# 2003-2004 Taulbee Survey

**Table 18. Actual and Anticipated Faculty Size by Department Type and Rank**

| | Actual | Projected | | |
|---|---|---|---|---|
| | 2004-2005 | 2005-2006 | 2006-2007 | Expected Two-Year Growth |
| US CS 1-12 | 731 | 758 | 784 | 53 7.3% |
| US CS 13-24 | 564 | 621 | 659 | 95 16.8% |
| US CS 25-36 | 485 | 530 | 567 | 82 16.9% |
| US CS Other | 3,114 | 3,301 | 3,511 | 397 12.7% |
| Canadian | 860 | 889 | 902 | 42 4.9% |
| US CE | 165 | 179 | 189 | 24 14.5% |
| **Total** | **5,919** | **6,278** | **6,612** | **693 11.7%** |

**Table 19. Gender of Newly Hired Faculty**

| | Tenure-track | | Researcher | | Postdoc | | Teaching Faculty | | Other | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | 229 | 82.1% | 48 | 88.9% | 143 | 85.1% | 68 | 77.3% | 15 | 78.9% | 503 | 82.7% |
| Female | 50 | 17.9% | 6 | 11.1% | 25 | 14.9% | 20 | 22.7% | 4 | 21.1% | 105 | 17.3% |
| **Total** | **279** | | **54** | | **168** | | **88** | | **19** | | **608** | |

**Table 20. Ethnicity of Newly Hired Faculty**

| | Tenure-track | | Researcher | | Postdoc | | Teaching Faculty | | Other | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nonresident Alien | 54 | 22.3% | 9 | 17.0% | 63 | 45.3% | 9 | 11.0% | 10 | 52.6% | **145** |
| African-American, Non-Hispanic | 2 | 0.8% | 1 | 1.9% | 0 | 0.0% | 2 | 2.4% | 0 | 0.0% | **5** |
| Native American/ Alaskan Native | 1 | 0.4% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | **1** |
| Asian/Pacific Islander | 57 | 23.6% | 5 | 9.4% | 21 | 15.1% | 5 | 6.1% | 0 | 0.0% | **88** |
| Hispanic | 3 | 1.2% | 0 | 0.0% | 1 | 0.7% | 1 | 1.2% | 0 | 0.0% | **5** |
| White, Non-Hispanic | 118 | 48.8% | 36 | 67.9% | 51 | 36.7% | 64 | 78.0% | 9 | 47.4% | **278** |
| Other/Not Listed | 7 | 2.9% | 2 | 3.8% | 3 | 2.2% | 1 | 1.2% | 0 | 0.0% | **13** |
| **Total have Ethnicity Data for** | **242** | | **53** | | **139** | | **82** | | **19** | | **535** |
| Ethnicity/ Residency Unknown | 37 | | 1 | | 29 | | 6 | | 0 | | **73** |
| **Total** | **279** | | **54** | | **168** | | **88** | | **19** | | **608** |

**Table 21. Gender of Current Faculty**

| | Full | | Associate | | Assistant | | Teaching Faculty | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Male | 1,648 | 90.4% | 1,077 | 88.1% | 1,148 | 83.9% | 558 | 73.1% | 4,431 | 85.6% |
| Female | 176 | 9.6% | 146 | 11.9% | 221 | 16.1% | 205 | 26.9% | 748 | 14.4% |
| **Total have Gender Data for** | **1,824** | | **1,223** | | **1,369** | | **763** | | **5,179** | |

**Table 22. Ethnicity of Current Faculty**

| | Full | | Associate | | Assistant | | Teaching Faculty | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nonresident Alien | 15 | 0.9% | 34 | 3.1% | 219 | 17.9% | 24 | 3.4% | 292 | 6.3% |
| African-American, Non-Hispanic | 9 | 0.6% | 8 | 0.7% | 24 | 2.0% | 12 | 1.7% | 53 | 1.1% |
| Native American/ Alaskan Native | 4 | 0.2% | 3 | 0.3% | 6 | 0.5% | 2 | 0.3% | 15 | 0.3% |
| Asian/Pacific Islander | 341 | 20.9% | 221 | 20.4% | 287 | 23.5% | 52 | 7.4% | 901 | 19.4% |
| Hispanic | 20 | 1.2% | 27 | 2.5% | 23 | 1.9% | 22 | 3.1% | 92 | 2.0% |
| White, Non-Hispanic | 1,214 | 74.5% | 764 | 70.5% | 640 | 52.3% | 579 | 82.7% | 3,197 | 68.9% |
| Other/Not Listed | 27 | 1.7% | 27 | 2.5% | 24 | 2.0% | 9 | 1.3% | 87 | 1.9% |
| **Total have Ethnicity Data for** | **1,630** | | **1,084** | | **1,223** | | **700** | | **4,637** | |
| Ethnicity/ Residency Unknown | 194 | | 139 | | 146 | | 63 | | 542 | |
| **Total** | **1,824** | | **1,223** | | **1,369** | | **763** | | **5,179** | |

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values increased while others decreased. Maximum values went down considerably in some strata; it appears that special assistantships or incentives are less prevalent than in previous years, as was suggested by the more extensive 'Profiles' data collected in last year's survey.

## Faculty Salaries *(Tables 27-34)*

Each department was asked to report individual (but anonymous) faculty salaries if possible; otherwise, the department was requested to provide the minimum, median, mean, and maximum salaries for each rank (full, associate, and assistant professors and non-tenure-track teaching faculty) and the number of persons at each rank. The salaries are those in effect on January 1, 2005. For U.S. departments, nine-month salaries are reported in U.S. dollars. For Canadian departments, twelve-month salaries are reported in Canadian dollars. Respondents were asked to include salary supplements, such as salary monies from endowed positions.

Here we report tables comparable to those used in previous Taulbee surveys. The tables contain data about ranges and measures of central tendency only. Departments that reported individual salaries were provided more comprehensive distributional information in December 2004. A total of 147 departments (78% of those responding to the survey) provided salaries at the individual level.

The minimum and maximum of the reported salary minima (and maxima) are self-explanatory. The range of salaries in a given rank

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**Table 23. Faculty Losses**

| | Total |
|---|---|
| Died | 4 |
| Retired | 45 |
| Took Academic Position Elsewhere | 87 |
| Took Nonacademic Position | 26 |
| Remained, but Changed to Part-Time | 21 |
| Other | 39 |
| Unknown | 5 |
| **Total** | **227** |

**Table 24-1. Total Expenditure from External Sources for CS/CE Research**

| Department, Rank | Total Expenditure | | | |
|---|---|---|---|---|
| | Minimum | Mean | Median | Maximum |
| US CS 1-12 | $2,100,000 | $24,119,225 | $15,063,300 | $75,557,138 |
| US CS 13-24 | $4,752,325 | $8,300,568 | $8,119,672 | $12,946,329 |
| US CS 25-36 | $334,416 | $5,982,787 | $5,233,342 | $15,827,632 |
| US CS Other | $33,502 | $2,342,622 | $1,500,000 | $16,007,946 |
| Canadian | $66,980 | $2,198,134 | $1,052,775 | $12,187,974 |
| US CE | $238,266 | $5,696,186 | $2,500,000 | $34,736,794 |

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among departments that reported data for that rank is the interval ["minimum of the minima," "maximum of the maxima"]. The mean of the reported salary minima (maxima) in a given rank is computed by summing the departmental reported minimum (maximum) and dividing by the number of departments reporting data at that rank.

The median salary at each rank is the middle of the list if you order its members' mean salaries at that rank from lowest to highest, or the average of the middle two numbers if there is an even number of items in the set. The average salary at each rank is computed by summing the individual means reported at each rank and dividing by the number of departments reporting at that rank. We recognize that these means and medians are only approximations to the true means and medians for their rank.

U.S. average salaries increased between 2.5% and 3.3%, depending on tenure-track rank, and 4.0% for non-tenure-track teaching faculty. These increases are higher than the 1.9% to 2.5% levels experienced last year for tenure-track faculty and the 1.4% level for non-tenure-track teaching faculty. Top-ranked departments were more likely to give larger increases to senior faculty this past year, while departments ranked 25 and higher were more likely to favor junior faculty. Canadian salaries (shown as 12-month salaries in Canadian dollars) were 8% to 9%

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**Table 24-2. Total Expenditure from External Sources for CS/CE Research by Department Rank and Type**

| Department, Rank | Per Capita Expenditure (Tenure-Track Faculty Only) | | | | Per Capita Expenditure (Tenure-Track, Research, and Postdoc Faculty | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Mean | Median | Maximum | Minimum | Mean | Median | Maximum |
| US CS 1-12 | $102,439 | $510,249 | $366,407 | $1,623,912 | $89,362 | $427,051 | $310,526 | $1,623,912 |
| US CS 13-24 | $103,311 | $281,425 | $250,832 | $595,026 | $97,986 | $207,395 | $199,229 | $366,170 |
| US CS 25-36 | $16,720 | $209,315 | $211,312 | $427,154 | $15,201 | $176,497 | $173,989 | $326,647 |
| US CS Other | $2,083 | $126,992 | $84,500 | $1,227,800 | $1,961 | $113,176 | $80,355 | $1,181,991 |
| Canadian | $2,030 | $58,554 | $39,535 | $259,319 | $2,030 | $53,899 | $37,778 | $259,319 |
| US CE | $19,699 | $283,435 | $208,333 | $964,911 | $19,699 | $248,115 | $131,579 | $964,911 |

**Table 25. Graduate Students Supported as Full-Time Students by Department Type and Rank**

| Department, Rank | Number on Institutional Funds | | | | | | | | | | Number on External Funds | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Teaching Assistants | | Research Assistants | | Full-Support Fellows | | Graduate Assistants for Computer Systems Support | | Other | | Teaching Assistants | | Research Assistants | | Full-Support Fellows | | Graduate Assistants for Computer Systems Support | | Other | |
| US CS 1-12 | 477 | 20.8% | 335 | 14.6% | 128 | 5.6% | 1 | 0.0% | 33 | 1.4% | 0 | 0.0% | 1,071 | 46.6% | 214 | 9.3% | 0 | 0.0% | 37 | 1.6% |
| US CS 13-24 | 364 | 24.6% | 168 | 11.4% | 94 | 6.4% | 7 | 0.5% | 5 | 0.3% | 0 | 0.0% | 811 | 54.8% | 24 | 1.6% | 0 | 0.0% | 6 | 0.4% |
| US CS 25-36 | 332 | 29.6% | 74 | 6.6% | 51 | 4.5% | 10 | 0.9% | 9 | 0.8% | 1 | 0.1% | 570 | 50.8% | 40 | 3.6% | 0 | 0.0% | 34 | 3.0% |
| US CS Other | 1,976 | 39.0% | 556 | 11.0% | 169 | 3.3% | 70 | 1.4% | 81 | 1.6% | 39 | 0.8% | 2,036 | 40.2% | 125 | 2.5% | 5 | 0.1% | 13 | 0.3% |
| Canadian | 480 | 43.7% | 318 | 28.9% | 0 | 0.0% | 0 | 0.0% | 9 | 0.8% | 2 | 0.2% | 262 | 23.8% | 28 | 2.5% | 0 | 0.0% | 0 | 0.0% |
| US CE | 200 | 20.0% | 29 | 2.9% | 22 | 2.2% | 10 | 1.0% | 0 | 0.0% | 0 | 0.0% | 722 | 72.3% | 12 | 1.2% | 0 | 0.0% | 3 | 0.3% |
| **Total** | **3,829** | 31.7% | **1,480** | 12.3% | **464** | 3.8% | **98** | 0.8% | **137** | 1.1% | **42** | 0.3% | **5,472** | 45.4% | **443** | 3.7% | **5** | 0.0% | **93** | 0.8% |

**Table 26-1. Fall 2004 Academic-Year Graduate Stipends by Department Type and Rank**

| Department, Rank | Teaching Assistantships | | | | Research Assistantships | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Mean | Median | Maximum | Minimum | Mean | Median | Maximum |
| US CS 1-12 | $9,400 | $15,925 | $16,569 | $19,800 | $14,238 | $17,676 | $17,820 | $25,200 |
| US CS 13-24 | $3,580 | $17,063 | $16,500 | $28,712 | $14,717 | $20,344 | $17,649 | $43,908 |
| US CS 25-36 | $11,655 | $14,970 | $14,659 | $20,303 | $13,455 | $15,256 | $14,659 | $21,523 |
| US CS Other | $1,450 | $12,849 | $13,025 | $25,000 | $1,500 | $14,210 | $14,150 | $25,000 |
| Canadian | $2,525 | $10,915 | $12,539 | $18,000 | $4,000 | $12,399 | $10,940 | $22,000 |
| US CE | $10,560 | $14,514 | $14,278 | $19,464 | $14,400 | $17,608 | $17,396 | $20,280 |

**Table 26-2. Fall 2004 Academic-Year Graduate Stipends by Department Type and Rank**

| Department, Rank | Full-Support Fellows | | | | Assistantships for Computer Systems Support | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Mean | Median | Maximum | Minimum | Mean | Median | Maximum |
| US CS 1-12 | $11,855 | $18,625 | $18,625 | $25,200 | * | * | * | * |
| US CS 13-24 | $10,143 | $19,466 | $17,798 | $30,000 | * | * | * | * |
| US CS 25-36 | $9,090 | $17,724 | $16,500 | $29,492 | * | * | * | * |
| US CS Other | $1,000 | $16,360 | $16,065 | $30,000 | $7,200 | $12,416 | $12,150 | $22,000 |
| Canadian | $14,666 | $24,925 | $18,000 | $54,000 | * | * | * | * |
| US CE | $13,788 | $18,906 | $18,200 | $28,080 | * | * | * | * |

*Numbers not reported due to low number of respondents

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higher than last year, after showing a slight drop last year. The Canadian figures are influenced much more by the specific departments reporting in a given year than are the U.S. figures.

Median salaries for new Ph.D.s (those who received their Ph.D. last year and then joined departments as tenure-track faculty) increased 1.7% from those reported in last year's survey (Table 34). This small increase follows a year when the median was unchanged, giving departments two consecutive years with some opportunity to adjust salaries of continuing faculty in order to reduce compression and inversion problems.

**Table 26-3. Fall 2004 Academic-Year Graduate Stipends by Department Type and Rank**

| Department, Rank | Other Assistantships | | | |
|---|---|---|---|---|
| | Minimum | Mean | Median | Maximum |
| US CS 1-12 | * | * | * | * |
| US CS 13-24 | * | * | * | * |
| US CS 25-36 | * | * | * | * |
| US CS Other | $6,000 | $10,842 | $9,400 | $16,532 |
| Canadian | $1,875 | $7,378 | $7,050 | $13,538 |
| US CE | * | * | * | * |

*Numbers not reported due to low number of respondents

## Concluding Observations

For the second straight year, we see significant reductions in average enrollments in the computer science major among U.S. departments. Particularly noticeable is the continued drop in new majors. This trend is observed in both the United States and Canada. While current enrollment levels still are higher than before the dot-com boom years, the decreased number of pre-majors in those departments that report pre-majors suggests that we still have not bottomed out in the current decline of majors.

While undergraduate enrollment is in decline, Ph.D. production is approaching an all-time high. With an improved economy and the drop in undergraduate enrollments, there should be an increase in the fraction of new Ph.D.s going to industry, but it is not clear how easily the large number of new Ph.D.s will be absorbed into the new economic environment. For example, we have not yet seen any trend toward new Ph.D.s going abroad.

Our field has enjoyed an abundance of job opportunities

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**Table 27. Nine-month Salaries, 153 Responses of 173 US Computer Science Departments**

| Faculty Rank | Number of Faculty | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Non-Tenure Teaching Faculty | 452 | $ 24,000 | $ 49,721 | $ 108,033 | $ 58,075 | $ 57,403 | $ 35,000 | $ 67,669 | $ 137,850 |
| Assistant Professor | 1,069 | $ 42,000 | $ 74,026 | $ 91,500 | $ 79,079 | $ 79,080 | $ 65,935 | $ 83,981 | $ 110,250 |
| Associate Professor | 978 | $ 42,887 | $ 78,761 | $ 124,750 | $ 87,918 | $ 87,829 | $ 66,272 | $ 97,186 | $ 132,700 |
| Full Professor | 1,416 | $ 63,360 | $ 92,753 | $ 126,000 | $ 114,188 | $ 111,272 | $ 86,348 | $ 148,570 | $ 295,000 |

**Table 28. Nine-month Salaries, 10 Responses of 12 US Computer Science Departments Ranked 1-12**

| Faculty Rank | Number of Faculty | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Non-Tenure Teaching Faculty | 36 | $ 33,494 | $ 36,837 | $ 39,564 | $ 65,057 | $ 67,353 | $ 57,100 | $ 86,488 | $ 114,164 |
| Assistant Professor | 119 | $ 56,000 | $ 79,402 | $ 91,500 | $ 85,693 | $ 85,155 | $ 86,388 | $ 93,649 | $ 110,250 |
| Associate Professor | 80 | $ 69,268 | $ 89,187 | $ 112,100 | $ 98,775 | $ 98,846 | $ 88,344 | $ 108,820 | $ 132,500 |
| Full Professor | 217 | $ 85,500 | $ 98,471 | $ 117,600 | $ 130,993 | $ 126,117 | $ 145,154 | $ 187,273 | $ 225,000 |

**Table 29. Nine-month Salaries, 12 Responses of 12 US Computer Science Departments Ranked 13-24**

| Faculty Rank | Number of Faculty | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Non-Tenure Teaching Faculty | 36 | $ 48,755 | $ 63,373 | $ 83,748 | $ 71,672 | $ 70,359 | $ 63,931 | $ 82,799 | $ 102,912 |
| Assistant Professor | 100 | $ 64,700 | $ 80,000 | $ 84,000 | $ 86,050 | $ 85,622 | $ 85,614 | $ 93,863 | $ 104,272 |
| Associate Professor | 77 | $ 68,667 | $ 91,093 | $ 103,400 | $ 99,731 | $ 99,457 | $ 94,925 | $ 109,142 | $ 127,400 |
| Full Professor | 208 | $ 76,402 | $ 96,656 | $ 115,250 | $ 135,382 | $ 129,000 | $ 166,400 | $ 198,733 | $ 295,000 |

**Table 30. Nine-month Salaries, 12 Responses of 12 US Computer Science Departments Ranked 25-36**

| Faculty Rank | Number of Faculty | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Non-Tenure Teaching Faculty | 44 | $ 40,400 | $ 53,748 | $ 78,458 | $ 66,107 | $ 64,417 | $ 62,000 | $ 82,091 | $ 137,850 |
| Assistant Professor | 101 | $ 68,000 | $ 76,813 | $ 81,600 | $ 81,570 | $ 81,500 | $ 79,379 | $ 85,784 | $ 90,249 |
| Associate Professor | 91 | $ 64,757 | $ 83,841 | $ 124,750 | $ 92,964 | $ 93,632 | $ 83,950 | $ 100,919 | $ 124,750 |
| Full Professor | 166 | $ 69,199 | $ 95,296 | $ 120,000 | $ 124,878 | $ 123,249 | $ 121,000 | $ 175,860 | $ 252,000 |

**Table 31. Nine-month Salaries, 119 Responses of 137 US Computer Science Departments Ranked Higher than 36 or Unranked**

| Faculty Rank | Number of Faculty | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Non-Tenure Teaching Faculty | 336 | $ 24,000 | $ 48,045 | $ 108,033 | $ 55,210 | $ 54,622 | $ 35,000 | $ 63,449 | $ 110,030 |
| Assistant Professor | 749 | $ 42,000 | $ 72,691 | $ 88,400 | $ 77,569 | $ 77,666 | $ 65,935 | $ 81,990 | $ 106,000 |
| Associate Professor | 730 | $ 42,887 | $ 76,196 | $ 104,340 | $ 85,375 | $ 85,216 | $ 66,272 | $ 94,703 | $ 132,700 |
| Full Professor | 825 | $ 63,360 | $ 91,623 | $ 126,000 | $ 109,561 | $ 107,030 | $ 86,348 | $ 137,507 | $ 262,452 |

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**Table 32. Nine-month Salaries, 10 Responses of 30 US Computer Engineering Departments**

| Faculty Rank | Number of Faculty | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Non-Tenure Teaching Faculty | 8 | $ 25,719 | $ 54,977 | $ 80,000 | $ 59,581 | $ 56,996 | $ 34,762 | $ 66,722 | $ 107,326 |
| Assistant Professor | 54 | $ 55,462 | $ 75,942 | $ 91,800 | $ 80,694 | $ 80,474 | $ 73,244 | $ 84,336 | $ 92,300 |
| Associate Professor | 26 | $ 65,050 | $ 80,187 | $ 97,100 | $ 85,679 | $ 83,954 | $ 71,697 | $ 91,344 | $ 115,000 |
| Full Professor | 73 | $ 78,650 | $ 93,918 | $ 118,000 | $ 111,846 | $ 106,544 | $ 94,132 | $ 144,968 | $ 187,500 |

**Table 33. Twelve-month Salaries, 19 Responses of 27 Canadian Computer Science Departments (Canadian Dollars)**

| Faculty Rank | Number of Faculty | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Non-Tenure Teaching Faculty | 76 | $ 40,455 | $ 60,667 | $ 76,640 | $ 69,106 | $ 69,551 | $ 53,470 | $ 77,795 | $ 107,378 |
| Assistant Professor | 212 | $ 51,035 | $ 76,202 | $ 99,609 | $ 84,579 | $ 84,515 | $ 70,454 | $ 92,556 | $ 122,637 |
| Associate Professor | 181 | $ 68,421 | $ 87,340 | $ 120,982 | $ 97,014 | $ 96,697 | $ 74,145 | $ 108,016 | $ 146,594 |
| Full Professor | 257 | $ 61,854 | $ 97,709 | $ 126,921 | $ 118,658 | $ 116,153 | $ 101,528 | $ 146,343 | $ 207,718 |

**Table 34. Nine-month Salaries for New PhDs, Responding US CS and CE Departments**

| Employment Position | Number | Reported Salary Minimum | | | Overall Mean | Overall Median | Reported Salary Maximum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Minimum | Mean | Maximum | | | Minimum | Mean | Maximum |
| Tenure-Track Faculty | 107 | $ 66,000 | $ 77,333 | $ 87,500 | $ 77,610 | $ 77,585 | $ 66,000 | $ 77,873 | $ 87,500 |
| Researcher | 9 | $ 30,000 | $ 53,638 | $ 97,000 | $ 55,566 | $ 55,566 | $ 30,000 | $ 57,494 | $ 97,000 |
| Postdoc | 44 | $ 25,000 | $ 43,989 | $ 69,500 | $ 48,476 | $ 48,573 | $ 35,568 | $ 52,608 | $ 69,500 |
| Non-Tenure Teaching Faculty | 5 | $ 45,000 | $ 54,250 | $ 67,000 | $ 56,125 | $ 56,125 | $ 50,000 | $ 58,000 | $ 67,000 |

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awaiting graduates of its academic programs in most years. The trends observed in this survey reflect student reactions to the job environment observed during the past two to three years. Academic departments are managing in a much different environment than just a few years ago. At the same time, the field as a whole is trying to understand the longer-term effect of this change in meeting the needs of industry, needs that also are changing in the wake of the dot-com crash and the increasing use of outsourcing, both on-shore and off-shore.

## Rankings

For tables that group computer science departments 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 [see http://www.cra.org/statistics/nrcstudy2/home.html].

**The top twelve schools in this ranking are:** *Stanford, Massachusetts Institute of Technology, University of California (Berkeley), Carnegie Mellon, Cornell, Princeton, University of Texas (Austin), University of Illinois (Urbana-Champaign), University of Washington, University of Wisconsin (Madison), Harvard, and California Institute of Technology. All schools in this ranking participated in the survey this year.*

**CS departments ranked 13-24 are:** *Brown, Yale, University of California (Los Angeles), University of Maryland (College Park), New York University, University of Massachusetts (Amherst), Rice, University of Southern California, University of Michigan, University of California (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 (Chapel Hill), University of Rochester, State University of New York (Stony Brook), Georgia Institute of Technology, University of Arizona, University of California (Irvine), University of Virginia, and Indiana. All schools in this ranking participated in the survey this year.*

**CS departments that are ranked above 36 or that are unranked that responded to the survey include:** *Arizona State University, Auburn, Boston University, Brandeis, Case Western Reserve, City University of New York Graduate Center, Clemson, College of William and Mary, Colorado School of Mines, Colorado State, Dartmouth, DePaul, Drexel, Florida Institute of Technology, Florida International, Florida State, George Mason, George Washington, Georgia State, Illinois Institute of Technology, Iowa State, Johns Hopkins, Kansas State, Kent State, Lehigh, Louisiana State, Michigan State, Michigan Technological, Mississippi State, Montana State, New Jersey Institute of Technology, New Mexico State, North Carolina State, North Dakota State, Northeastern, Northwestern, Nova Southeastern, Oakland, Ohio, Ohio State, Oklahoma State, Old Dominion, Oregon Health & Science, Oregon State, Pace, Pennsylvania State, Polytechnic, Portland State, Rensselaer Polytechnic, Southern Methodist, State University of New York (Albany and Binghamton), Stevens Institute of Technology, Syracuse, Texas A&M, Texas Tech, Tufts, Utah State, Vanderbilt, Virginia Commonwealth, Virginia Polytechnic, Washington State, Washington (St. Louis), Wayne State, Western Michigan, Worcester Polytechnic, and Wright State.*

**University of:** *Alabama (Birmingham, Huntsville, and Tuscaloosa), Arkansas, Buffalo, California (at Davis, Riverside, Santa Barbara, and Santa Cruz), Central Florida, Cincinnati, Colorado (at Boulder, Colorado Springs, and Denver), Connecticut, Delaware, Denver, Florida, Georgia, Hawaii, Houston, Idaho, Illinois (Chicago), Iowa, Kansas, Kentucky, Louisiana (Lafayette), Maine, Maryland (Baltimore Co.), Massachusetts (at Boston and Lowell), Minnesota, Mississippi, Missouri (at Columbia, Kansas City and Rolla), Nebraska (Lincoln and Omaha), Nevada (Las Vegas and Reno), New Hampshire, New Mexico, North Texas, Notre Dame, Oklahoma, Oregon, Pittsburgh, South Carolina, South Florida, Tennessee (Knoxville), Texas (at Arlington, Dallas, El Paso, and San Antonio), Tulsa, Utah, Wisconsin (Milwaukee) and Wyoming.*

**Computer Engineering departments participating in the survey this year include:** *Georgia Institute of Technology, Northwestern, Princeton, Purdue, Rensselaer Polytechnic, and the Universities of Tennessee (Knoxville), California (Santa Cruz), Central Florida, Houston, and Southern California.*

**Canadian departments participating in the survey include:** *Carleton, Concordia, Dalhousie, McGill, Memorial, Queen's, Simon Fraser, and York universities. University of: Alberta, British Columbia, Calgary, Manitoba, Montreal, New Brunswick, Regina, Saskatchewan, Toronto, Victoria, Waterloo, Western Ontario, and Universite Laval.*

## Acknowledgments

I appreciate Betsy Bizot's able assistance with the data collection, tabulation, and analysis for this survey. Betsy Bizot and David Novick provided useful comments on an earlier draft of the report.

## 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 vs. CE programs. Every effort is made to minimize the inclusion of faculty in electrical engineering who are not computer engineers. ■

# Professional Opportunities

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*Senior Software Development Engineer*

Amazon.com's Digital Media Technologies team has an immediate opening for a talented and enthusiastic senior software engineer to create and support digital media-centric features for the Amazon web site. As a small team we work on an exciting and eclectic mix of services including the Search Inside the Book, rich media (audio/video/3D), digital music, software downloads, e-Books and e-Docs, online manuals, order contingent downloads, entertainment applications and interactive chat.

Successful candidates for this position will have a strong background in C/C++, Perl, SQL. Experience working with CGI, Mason, WebServices, XML, Apache services is desired. Equally important are the candidate's abilities to multi-task, quickly adapt to new development environments and changing business requirements, learn new systems, create reliable/maintainable code, and find creative and scalable solutions to difficult problems. The ability to communicate clearly and concisely (both written and orally) is a key competency as is being a self-starter. A Bachelor's degree in computer science or a relevant area is required.

Please submit application to:
Rakhel Wainey
Amazon.Com
Email: rakhel@amazon.com

## Harvard University

Division of Engineering and Applied Sciences

*Postdoctoral Positions in Collaborative Multi-Agent Systems*

We invite applications for two postdoctoral research positions in collaborative multi-agent systems, for research projects investigating decision-making in groups that include both people and artificial agents.

The first position involves development of negotiation models using game-theoretic, machine learning, and mechanism design tools to support coordination and collaboration between computer agents and people.

The second position involves design of methods for specifying and presenting plans of action and complex schedules. Further information about the positions, the two research projects funding them, necessary qualifications, and application procedure can be found at: http://www.eecs.harvard.edu/ai/cmadm-postdocs.html

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

## Penn State Capital College

School of Science, Engineering and Technology

*Assistant Professor*

Penn State Capital College, Harrisburg Campus, School of Science, Engineering and Technology is accepting applications for a tenure-track Assistant Professor position in Computer Science, effective Fall Semester 2005.

Experience and research interests in software engineering/software design, principles of programming languages, artificial intelligence, or computer architecture are required. Individuals with other areas of research interests may also be considered. Candidates will be evaluated on teaching and professional experience. Salary level is commensurate with qualifications and experience. Teaching includes courses for the B.S. and M.S. degrees in Computer Science. Faculty are also expected to pursue scholarly research and publication, contribute in curriculum development, participate in University/professional service activities, advise undergraduate and graduate students, and serve on graduate-level degree committees.

For information on Penn State Capital College, please visit our website at www.hbg.psu.edu.

Send letter of application, curriculum vitae, and the names, addresses and phone numbers of at least three references to:

Chair, Computer Science Search Committee
c/o Mrs. Dorothy Guy
Director of Human Resources
Penn State Capital College
Box CRA
777 West Harrisburg Pike
Middletown, PA 17057-4898

Applicant review will begin immediately and continue until the position is filled.

Penn State is committed to affirmative action, equal opportunity, and the diversity of its workforce.

## University of Virginia

Department of Computer Science

*Principal Scientist*

The University of Virginia, Department of Computer Science seeks a Principal Research Scientist to serve as the Executive Director of its federated research and education program in secure and dependable computing systems.

The ideal candidate for this position will have the following qualifications: (1) a Ph.D. in computer science or closely related field, with specific knowledge of computer security, software engineering with a focus on dependability, or distributed systems with a focus on dependability; (2) outstanding communication skills in all dimensions; (3) the willingness and ability to discover major research funding opportunities; (4) the ability to work closely with faculty to develop research proposals in response to such opportunities; (5) the willingness and ability to perform day-to-day management of a federated research program; (6) a willingness and ability to interface with all involved faculty, doctoral students, research sponsors, and industrial collaborators; (7) and a willingness and ability to serve in a public relations and outreach capacity, including creation and dissemination of public relations materials and the organization and management of conferences and workshops on secure and dependable systems.

To apply for this position, please send a cover letter, resume, and at least three references to the following address:

Virginia Program on Secure and Dependable Systems
Attn: Ms. Ginny Hilton
Department of Computer Science
151 Engineer's Way
P.O. Box 400740
Charlottesville, VA 29904-4740

The position will remain open until filled.

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

## Wayne State University

Department of Computer Science

*Research Assistant/Associate position*

A full time Research Assistant/Associate position is available immediately in the area of image processing and analysis of PET and MRI images. This is a collaboration between the Positron Emission Tomography (PET) Center and the Department of Computer Science. Software development will be carried out using Linux and VTK / Qt toolboxes. The project includes:

- 3D surface rendering/merging of MRI and PET image volumes
- Assessment of PET abnormalities using a fractal based method
- Merging of PET data with EEG electrode information

Applicants should have a strong background in image processing, excellent knowledge of the Unix/LINUX operating system as well as C++. Knowledge of the VTK / Qt toolboxes is highly advantageous, but not necessary.

Salary: $30k (trial period - Research Assistant), 60k+ (full time - Research Associate) + benefits.

This is a full-time, permanent position. Wayne State will support an application for an H1B visa or permanent residency status, if necessary.

Contact: Sorin Draghici, PhD (sod@cs.wayne.edu) or Otto Muzik, PhD (otto@pet.wayne.edu)

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In a More Balanced from Page 2

Contrary to the findings of the earlier studies, our snapshot of students' perceptions revealed that the confidence of most women in our cohort had increased by their senior year and had not been "extinguished." One woman in the transition class made this very clear: "I see myself as one of the best of the best now." A woman in the 2004 class acknowledges "bumps along the road, but overall I think I'm pretty happy with the way it went." Another woman in that class gives a roadmap for her increased confidence: "Once you start working on different projects or having more projects under your belt you just feel a little better… Public speaking and having a more professional front is all part of it. And joining a group like Women@SCS really helps because there are plenty of chances to speak, talk and, I think, just growing more as an individual."

## Conclusion

We believe that fundamental misconceptions about computer science, rather than gender differences, are a root cause of gender under-representation as well as the current crisis in the field, i.e., the diminishing interest in computer science on the part of all students [Morris and Lee 2004] [Vegso 2005].

The fundamental misconception, of course, is that computer science equals programming. One of the biggest offenders here is the College Board's advanced placement (AP) tests in "computer science." Unlike AP tests in other fields—for example in biology, physics, and economics, where the tests (and the high school AP courses preparing for them) cover deep and even cutting-edge topics in the field—the AP computer science test is almost devoid of intellectual content. Indeed, a perusal of sample tests provided by the College Board (http://apcentral.collegeboard.com/) shows that, for the most part, the tests focus on the idiosyncrasies of the programming language du jour. A student observing the content of the most advanced CS course in high school could hardly be blamed for thinking computer science is programming. With the dot-com bust, why would a bright high school student be excited by a future in programming? AP computer science should be replaced[6] by a course exposing the breadth and depth of computer science, perhaps along the lines of Andrew's Leap,[7] a summer program for high school students. Such a course would attract many of the high school students taking advanced mathematics, half of whom today are female.

Very few of the pioneers and current professors of computer science were "hackers." Many were motivated by their interest in logic and in understanding intelligence and problem-solving. Today, in the twenty-first century, with the increasing ubiquity of computing, women and men with a broader and diverse vision and a deeper perspective are critical for the field and will drive its future. Let's make sure our educational programs reflect that.

### End Notes

1. Research supported by a grant from the Alfred P. Sloan Foundation. This article is based on "The Evolving Culture of Computing: Similarity Is the Difference," forthcoming in *Frontiers* 26:1 (Spring 2005), a special issue on *Gender and Information Technology*.
2. These changes were a result of Allan Fisher pointing out to the Admissions Office that "prior programming" was not a predictor for success in the CS major and Raj Reddy requesting Admissions to develop criteria to select for "future visionaries and leaders in CS" [Margolis and Fisher 2002].
3. Over a period of three years (1997-99), 240 high school AP CS teachers participated in gender gap discussions led by Allan Fisher and Jane Margolis held in Mark Stehlik's summer workshops [Margolis and Fisher 2002]. The subsequent increases of women in our program can be directly correlated with these workshops.
4. See, http://www.women.cs.cmu.edu and [Frieze and Blum].
5. In 2002, 17 (of the 24) women and 16 (of the 129) men in the graduating class were interviewed. In 2004, 32 (of the 52) women and 23 (of the 104) men were interviewed.
6. At a minimum, the current AP test (and AP course) should be re-named "AP Programming."
7. Andrew's Leap was created at Carnegie Mellon by Merrick Furst and developed by Steven Rudich to interest bright high school students in computer science. The Roboleap component is run by Matt Mason. Through special classes and independent projects, students are exposed to the frontiers of computer science. See: http://www.cs.cmu.edu/~leap/

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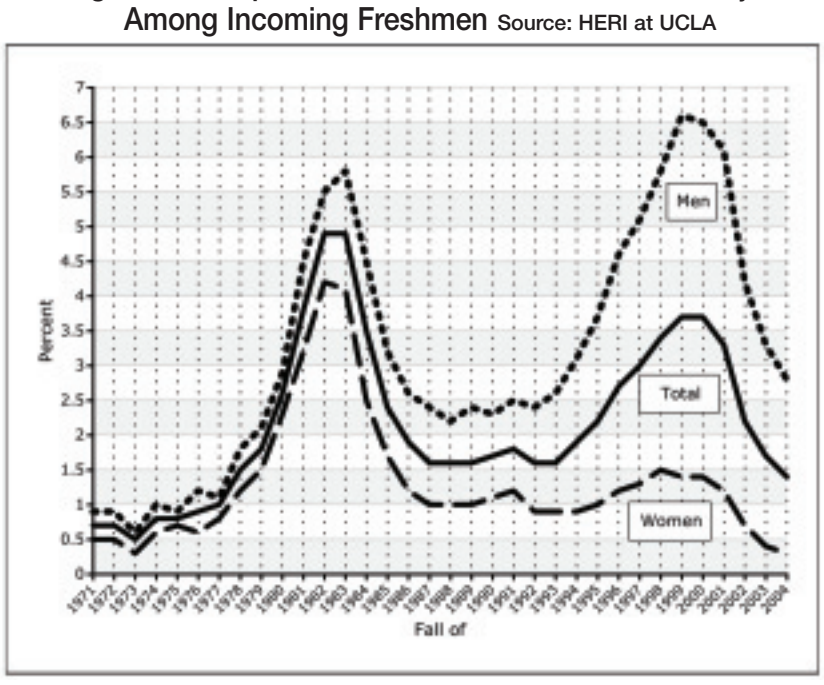
# Interest in CS as a Major Drops Among Incoming Freshmen

**By Jay Vegso**

Survey results from the Higher Education Research Institute at the University of California at Los Angeles (HERI/UCLA) show that the popularity of computer science (CS) as a major among incoming freshmen has dropped significantly in the past four years. Alarmingly, the proportion of women who thought that they might major in CS has fallen to levels unseen since the early 1970s.

The percentage of incoming undergraduates indicating that they would major in CS declined by more than 60 percent between the fall of 2000 and 2004, and is now 70 percent lower than its peak in the early 1980s (Figure 1).

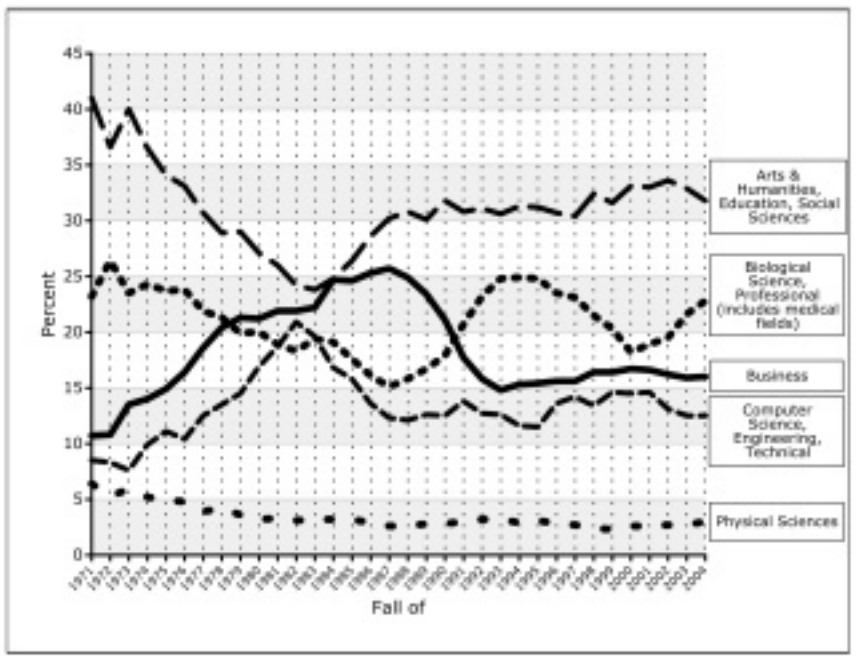
**Figure 1. Computer Science Listed as Probable Major Among Incoming Freshmen** Source: HERI at UCLA




Freshmen interest levels at any given point have been an accurate predictor of trends in the number of degrees granted four to five years later. It therefore seems likely that there will be a sharp decline in the number of bachelor's degrees granted in CS in the coming decade. Results from CRA's Taulbee Survey of Ph.D.-granting CS departments reinforce this: the number of newly declared CS majors has declined for the past four years and is now 39 percent lower than in the fall of 2000. Enrollments have declined 7 percent in each of the past two years (see: www.cra.org/info/taulbee/bachelors).

Figure 2 provides a sense of changing interests among incoming freshmen. The majors included within the groupings can be found with the online version of this article on CRA's website (see below).

**Figure 2. Probable Majors Indicated by Incoming Freshmen**
Source: HERI/UCLA

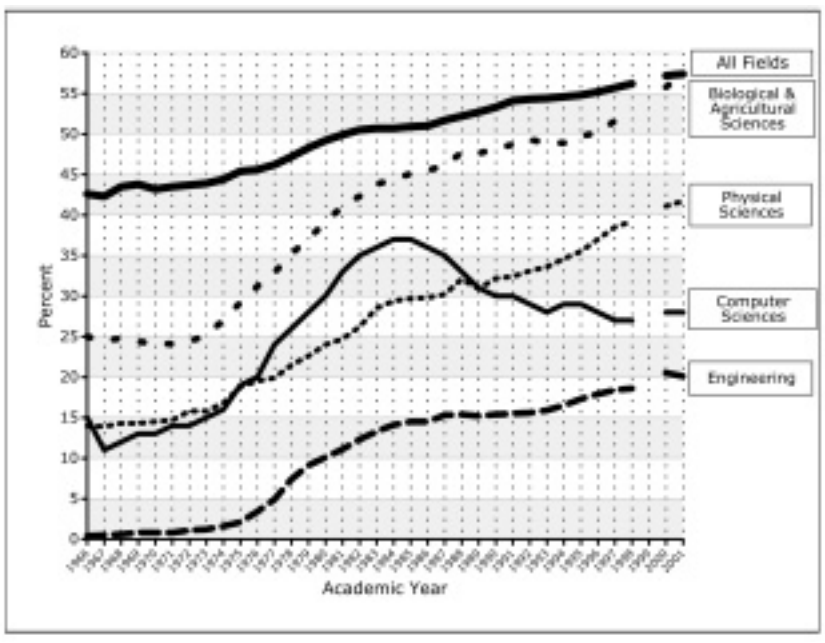



The upcoming drop in CS degree production will highlight the field's inability to appeal to incoming female undergraduates. Overall, interest in CS among women fell 80 percent between 1998 and 2004, and 93 percent since its peak in 1982.

Although newly enrolled women have always been less likely than men to indicate CS as their probable major, the gap between them remained relatively narrow through 1980 (Figure 1). During the surge and drop in interest that occurred in the 1980s, however, the difference between men and women more than doubled. While their interest levels continued to parallel each other, it was at this time that CS appears to have lost its ability to attract incoming undergraduate women. During the second surge of interest in CS that occurred in the mid- to late 1990s, women's interest in the field did not grow at the same rate as that of men. As a result, the gap between men and women who thought that they would major in CS tripled between the early and late 1990s. Although the difference might appear to have narrowed in recent years, this is because the percentage of women interested in CS was low to begin with, whereas men's interest levels have had room to fall.

Unsurprisingly, freshmen women's dwindling interest in CS has affected degree production trends (Figure 3). Unlike most other fields, which have seen women's representation increase over time, the portion of CS degrees granted to women fell in the late 1980s and has yet to return above 30 percent. With a fall in degree production looming, it is difficult to see how CS can match expected future demand for IT workers without raising women's participation at the undergraduate level.

**Figure 3. Portion of Bachelor's Degrees Granted to Women**
Source: National Science Foundation, Data were not reported for 1999.




Note: Sources and further information: HERI/UCLA's "CIRP Freshman Survey" is an annual survey of the characteristics of students attending colleges and universities as first-time, full-time freshmen: www.gseis.ucla.edu/heri/freshman.html. National Science Foundation data on degree production are available at www.nsf.gov/statistics/ and on CRA's website at www.cra.org/info/education/us/. Further information relating to this article can be found on CRA's website at www.cra.org/CRN/articles/may05/vegso.html.

*Jay Vegso (jvegso@cra.org) is a member of the CRA Staff.* ▮

## Invitation for Participation

**CRA-W Distinguished Lecture Series and Graduate School Recruiting Panels**

Applications now being accepted to host recruitment events designed to attract female students to graduate school. Applications from all educational institutions, including minority institutions, are solicited.

See: http://www.cra.org/distinguished.lecture/
Contact Program Coordinators:
Renée J. Miller (miller@cs.toronto.edu)
Joann Ordille (joann@avaya.com)

# All Aboard the CRA Train!

For some people, trains are a mode of transportation; for others, a life-long passion. Pictured above is CRA director Andy Bernat (also a railway buff) presenting retiring CRA board chair Jim Foley with an addition to his backyard railroad. As befits the chair of such an august institution as CRA, we have provided Jim with a Business Car with the CRA name and logo. In order that he may travel when necessary for CRA business, we also contracted with the Pennsylvania Railroad for a locomotive, which they have named the James C. Foley in recognition of his service. The gift from CRA is in recognition of Jim's many contributions as an active board member since 1996, during which he served as treasurer from 1998-2001 and as chair from 2001-05. ▮

Participants in CRA-W's recent Career Mentoring Workshop in Washington, DC are shown above (l to r): Cristina Nita-Rotaru (Purdue University), and committee members Renée Miller (University of Toronto) and Joan Ordille (Avaya Labs).

## Cary Cherng Receives CRA Undergraduate Award

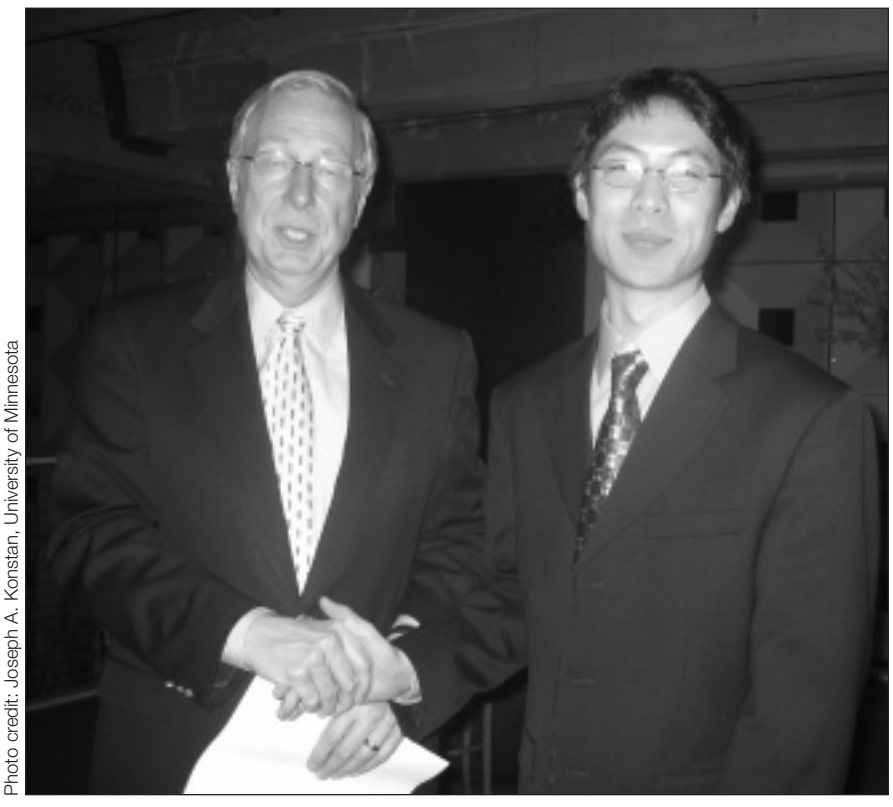


Photo credit: Joseph A. Konstan, University of Minnesota

**Cary Cherng**, University of Washington, a Finalist in the 2005 CRA Outstanding Undergraduate Awards 2005, receives his award from board chair, Jim Foley. The award was made at the Conference on Human Factors in Computing Systems (CHI) in Portland, Oregon, on April 4.

**Richard Tapia**
**Celebration of Diversity**
**in Computing Conference 2005**

**October 19-22, 2005 in Albuquerque, New Mexico**

**See: http://www.ncsa.uiuc.edu/Conferences/Tapia2005/**

# Popular Workshop Scheduled

CRA's Academic Careers Workshop for new faculty and advanced graduate students in computing-related disciplines will take place on **February 27-28, 2006**, in Washington, DC.

This highly successful workshop focuses on practical methods for having a successful and fulfilling academic career, including topics such as "Planning Your Research Career," "Preparing a Tenure Dossier," and "Time Management and Family Life."

The workshop also includes talks on the operations and funding programs of government agencies, as well as a reception with CRA board members and CRA Leadership Summit attendees.

Additional information will be posted on CRA's website (http://www.cra.org) and in *Computing Research News* as plans develop. ▮

# CRA Participates in Tisdale Fellowship Program

Daniel Rothschild, a recent graduate of the University of Michigan's Master of Public Policy Program, will spend seven weeks with CRA this summer as a Tisdale Fellow working with CRA's Director of Government Affairs.

The Tisdale Fellowship Program ( http://www.tisdalefellowship.org) has been bringing college students to Washington, D.C. for internships that explore current public policy issues of critical importance to the high technology sector of the economy. Other participants in the program include HP, Agilent, Dell, Computer Systems Policy Project (CSPP), Business Software Alliance (BSA), and Infotech. ▮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