The Role of Nontraditional Educational Pathways

An Introduction

In late 1999, when the idea for this research project was first crystallizing, the potential inability of the U.S. to meet its information technology/computer science (IT/CS) workforce needs threatened to become a serious national problem. There were real gaps between supply and demand that seemed to be growing rapidly as the IT sector was in full boom, generated by the promise of quick riches in Internet-based startup companies. This research was designed to address the severe and growing problem of the underrepresentation of women and many racial/ethnic minorities in the IT workforce by focusing on nontraditional educational pathways—specifically, earning a bachelor's degree in IT/CS—that appeared to be key for many Americans gaining access to skills and jobs.

Over the subsequent years that we have been gathering data for this project, much has changed in both the IT employment market and the IT/CS education market. This chapter explores the original goals of this study, as well as the changing environment that affected our conduct of the study. This serves as important background for our findings on nontraditional students in both educational institutions and the employment market. It also provides a more complete context in which our policy recommendations can be grounded.

Background to the Study

This research project was sparked by a surprising fact. The number one producer of bachelor's degrees in IT/CS fields in both 1996 and 1997 (the latest data available at the time we developed the concept for this study) was not MIT, the University of Illinois, Carnegie Mellon, or any other research university, but Strayer University, a for-profit university with numerous campuses located in the Washington, DC, metropolitan area. Not only was Strayer the top producer overall, but it was also the number one producer of women and African American graduates with baccalaureates in IT/CS.[1]

This remarkable finding evoked a host of questions. Given Strayer's major marketing emphasis on "nontraditional" students, does their market dominance suggest that these students are the dominant consumers of IT/CS education? If so, what does this mean for 1) area employers, 2) the IT/CS workforce in the area, 3) the women and minorities who choose this path into the IT workforce, and 4) government efforts to adequately invest resources to ensure the future of a strong U.S. IT/CS workforce that includes all segments of the population?

While we recognize that nontraditional pathways could include a number of different educational avenues—including associate's degrees, certificate programs, and adult education programs—for purposes of this study, only bachelor's degree recipients were included. The "traditional" route to a baccalaureate degree involves entering college immediately out of high school, attending full-time for four or five years, and graduating with a BA or BS at the age of 21–24 years old. The nontraditional pathway or nontraditional student is defined as beginning higher education later in life (at or after age 21) and/or taking longer to complete the degree (6+ years). (Further discussion of nontraditional students appears in Chapter 2.)

This was a three-part study. The first part involved a survey of the academic year 2000 IT/CS bachelor's degree alumni from 16 colleges and universities in the Washington, DC, Virginia, and Maryland area, to ascertain their experiences before and while pursuing a bachelor's degree and their employment status after receiving the degree (see survey instrument in Appendix A). The second part consisted of site visits to 20 area colleges and universities for in-depth interviews with faculty and students about their view of IT/CS education and the employment prospects in IT/CS in the area. The third part entailed onsite interviews with local area employers and employees.

We concentrated our research on a specific geographic region—the metropolitan DC (Maryland, Washington, DC, and Virginia) area. This area was chosen for its diversity. The region extends from Appalachia in the west to the rural Eastern Shore of Maryland and Virginia. In between, it includes the metropolitan areas of Baltimore, the District of Columbia, Richmond, and Norfolk, which have all become increasingly important hubs of high-tech industry and employment. By concentrating on one area of the country, we obviously lose generalizability. However, the inclusion of significant national-level comparative data helps support our findings, suggesting a certain degree of generalizability.

Of particular note is the variety of higher education institutions in the Maryland, Virginia, and Washington, DC, area, which encompasses all types of institutions—from historically black colleges and universities (HBCUs), to large research universities, to state institutions of various sizes, to private colleges and universities, to single-sex colleges, and, of course, for-profit institutions. Of the top 26 producers of IT/CS bachelor's degrees in 1996 located in the area, 20 agreed to participate in our study, including four major research universities (University of Maryland–College Park, University of Virginia, Virginia Tech, and Johns Hopkins), five HBCUs (Hampton, Howard, Morgan State, Norfolk State, and the University of the District of Columbia), and two liberal arts colleges affiliated with religious denominations that are retooling to take advantage of the adult education market (College of Notre Dame of Maryland and Columbia Union College) **(Table 1.1)**.

TABLE 1.1 Top Producers of Computer Science Bachelor's Degrees in the Washington, DC, Virginia, and Maryland Area, 1996, with Rank and Degrees Awarded in 2001

Academic Institution (national rank 1996) (national rank 2001)	Number of Bachelor's Degrees Awarded 1996	2001
1. Strayer University* (1) (1)	396	840
2. University of Maryland Baltimore County* (2) (4)	257	463
3. University of Maryland College Park** (9) (14)	152	273
4. James Madison University** (25) (10)	117	293
5. George Mason University** (32) (54)	104	153
6. Villa Julie College* (46) (56)	84	148
7. Virginia Commonwealth University** (80) (40)	67	180
8. Virginia Polytechnic Institute and State University** (88) (63)	64	138
9. University of the District of Columbia** (96) (210)	60	56
10. Morgan State University** (130) (143)	49	77
11. Howard University** (189) (138)	40	79
12. Hampton University** (195) (314)	39	37
13. University of Virgina, Main Campus** (204) (165)	37	68
14. Towson State University** (214) (100)	35	101
15. George Washington University** (235) (178)	32	66
16. American University** (258) (429)	28	26
17. Old Dominion University** (275) (351)	27	33
18. Christopher Newport University** (299) (182)	25	65
19. College of William and Mary** (381) (220)	19	55
20. College of Notre Dame of Maryland** (402) (470)	18	24
21. Bowie State University* (417) (630)	17	15
22. Salisbury State University* (447) (208)	16	57
23. Norfolk State University** (474) (323)	15	36
24. Johns Hopkins University** (495) (268)	14	46
25. Gallaudet University* (552) (645)	12	15
26. Columbia Union College** (937) (395)	3	29

*Was asked to participate in the study
**Agreed to participate in the study

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and the National Center for Education Stastics (NCES).

Notably missing from our study, however, is Strayer University, which declined to participate. The omission of Strayer University left us with little knowledge of students who choose Strayer's programs and their employment outcomes. We do have a wealth of data and knowledge, however, about nontraditional students who chose to attend traditional academic institutions. Indeed, we found that, unless institutions specifically target nontraditional students in their programs, this sizable population of students goes largely unnoticed and underserved by the more traditional programs.

Additionally, the geographic location we chose encompasses a large number of major types of employers—including the federal government, state and local governments, major IT employers, other major private businesses, service industries, and many nonprofit institutions. All employers competed fiercely for IT/CS talent in the late 1990s and the year 2000. In late 2000, the tech bubble burst and the subsequent recession dampened this frenzied competition, leaving employers and employees with a less rosy outlook and fewer opportunities. More recently, however, the Washington, DC, region's economy has rebounded and now is second in the nation for tech job opportunities, according to the Dice Report, a tech jobs clearinghouse. Job postings in the Washington region are up 60 percent this year. But, nationally, unemployment among IT workers exceeds the overall jobless rate.[2] This translates into increased competition for obtaining jobs for IT workers in 2004. Employers are increasingly cautious in hiring because of several factors including general economic conditions, enhancing productivity through cost cutting, the climbing cost of employee benefits, and the economic efficiencies presented through global sourcing. But competition is a concern not only to employees, but to employers as well. The Information Technology Association of America (ITAA) says, "To be successful, IT workers must make themselves as valuable as possible to hiring companies. They must also make themselves stewards of their own careers".[3]

But the changes in the employment sector during the course of our research (especially in 2001–2002, when most of our data-gathering took place) had a major impact on our study. As the area began to experience unemployment for the first time in the IT sector and many companies disappeared from the landscape altogether or severely cut back their workforce, employers were more and more reluctant to allow our interviewers access to employees. At the same time, increasing demand for IT/CS degrees, which seems to have peaked in 2002, made it somewhat difficult for us to negotiate with educational institutions for their participation when they saw no real need to increase their number of students. This was especially true of the number one producer, Strayer. In addition, several new educational institutions targeting nontraditional students entered the scene, including DeVry University, a reenergized University of Maryland University College, and the University of Phoenix. This apparent supply-and-demand disconnect was exacerbated by the growing trend for companies to export technology jobs overseas, further depressing our domestic IT labor market. The market provided fewer incentives for women and minorities to choose IT/CS, and, indeed (as discussed in the next section), IT/CS degrees have been awarded largely to Caucasian males. While the numbers of women and minorities pursuing IT/CS degrees has risen in the last several years, proportionally, they continue to lag far behind Caucasian and Asian males.

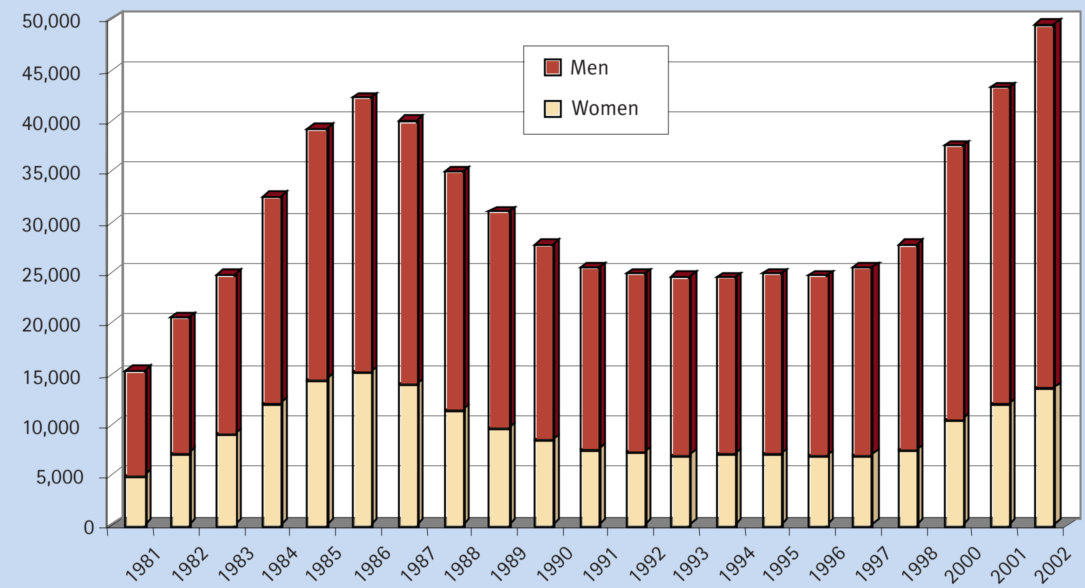
The Changing Educational Environment

When we began our study, the decade of the 1990s was closing and there was considerable uncertainty about what the new century would bring. In the 1990s, the U.S. experienced a rapid infiltration of information technology into every segment of society and economy, and demand for workers in this area expanded beyond anyone's prediction. At the same time, the U.S. supply of degreed workers in information technology was on a decade-long downward trend. From 1987 to 1997, the number of bachelor's degrees awarded in computer science dropped more than 36 percent (from 39,927 to 25,293). The decline for women was more than 50 percent (from 13,889 to 6,903). While it is possible that many IT/CS workers simply bypassed the bachelor's degree and entered the job market, it is unlikely, given the workforce statistics outlined in the next section, that many women did so.

The decline in IT/CS bachelor's degrees led many prognosticators in the year 2000 to predict a major shortfall of workers in these fields. Several studies warned of impending shortages and identified two possible sources of additional IT/CS workers.[4–6] The first source was from outside the country and involved raising visa quotas for foreign, high-skilled workers, the majority of whom work in IT/CS occupations. The second source required the engagement of populations within the U.S. who had traditionally been underrepresented in IT/CS, including women, minorities, and people with disabilities. Initiatives under this second recommendation would include efforts to expand educational and employment opportunities for these groups and encourage them to seek an IT/CS career.

A two-decade analysis of degree production in computer science shows a pronounced roller-coaster trend **(Chart 1.1)**. From 1981 to 1986, the total number of bachelor's degrees increased 177 percent, only to dive precipitously from 1987 to 1997. However, because of the high-tech boom of the late 1990s, more and more young people

CHART 1.1. Bachelor's Degrees Awarded in Computer Science by Sex, 1981–2002



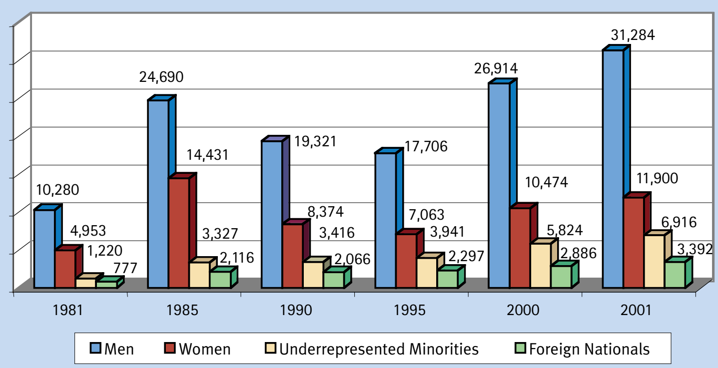
Source: CPST; data are derived from the National Science Foundation, WebCASPAR Database, and the National Center for Education Statistics.

started to pursue studies in computer science and related disciplines. Therefore, the number of IT/CS degrees increased by 60 percent from 1998 to 2001, reaching a record 43,184. Data from the National Center for Education Statistics indicate that bachelor's degrees in IT/CS increased another 14 percent from 2001 to 2002, reaching 49,404.

The number of degrees in IT/CS earned by women fell much more sharply between 1987 and 1997 than did the number of degrees earned by men. In 1986, women earned 36 percent of the total baccalaureates in IT/CS. In 1997, the percentage of women earning IT/CS bachelor's degrees stood at only 27 percent. The staggering increases in the last couple of years, as shown in Chart 1.1, were mostly dominated by males, for whom bachelor's degree production skyrocketed from 26,914 in 2000 to 35,814 in 2002. The increase for women was only from 10,474 to 13,590 over the same period.

For underrepresented minorities, the number of bachelor's degrees earned increased very slowly, but the numbers continued to go up even during the 1987–1997 slump. The number of IT/CS degrees earned by underrepresented minorities ranged from 1,200 in 1981 to 6,916 in 2001 **(Chart 1.2)**. During this period, the proportion of the total baccalaureates in computer science earned by underrepresented minorities doubled from 8 percent in 1981 to 16 percent in 2001.

CHART 1.2 Bachelor's Degrees Awarded in Computer Science by Sex, Race/Ethnicity, and Citizenship, 1981– 2001



Source: CPST; data are derived from the National Science Foundation.

There is some evidence from the Taulbee Survey sponsored by the Computing Research Association (CRA) that the period of explosive growth in undergraduate enrollment in computer science experienced for the last several years is over. Although this survey only tracks trends at the bachelor's level at doctoral-granting institutions, CRA reported that the number of new undergraduate majors plummeted 23 percent to 17,706 in

TABLE 1.2 Top Producers of Computer Science Bachelor's Degrees, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. Strayer University	840
2. DeVry Institute of Technology (Addison, IL)	477
3. CUNY Bernard Baruch College	465
4. University of Maryland Baltimore County	463
5. DeVry Institute of Technology (Phoenix, AZ)	440
6. DeVry Institute of Technology (Cty of Industry, CA)	349
7. Rutgers the State University of New Jersey	336
8. DeVry Institute of Technology (Kansas City, MO)	316
9. DeVry Institute of Technology (Long Beach, CA)	301
10. James Madison University	393

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

TABLE 1.3 Top Producers of Physical Science Bachelor's Degrees, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. University of CA–San Diego	133
2. University of CA–Berkeley	126
3. University of Virginia, Main Campus	119
4. University of CA–Irvine	118
5. North Carolina State University at Raleigh	117
6. SUNY Empire State College	113
7. Harvard University	104
8. University of Minnesota–Twin Cities	99
9. University of Washington–Seattle	92
10. University of North Carolina–Chapel Hill	91

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

TABLE 1.4 Top Producers of Biological Science Bachelor's Degrees, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. University of CA–Davis	873
2. University of CA–Los Angeles	855
3. University of CA–San Diego	841
4. University of CA–Berkeley	764
5. University of Washington–Seattle	591
6. Brigham Young University, Main Campus	515
7. University of CA–Irvine	505
8. University of Texas–Austin	501
9. Rutgers the State University of New Jersey	482
10. University of Wisconsin–Madison	480

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

TABLE 1.5 Top Producers of Engineering Bachelor's Degrees, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. Pennsylvania State University, Main Campus	1,221
2. Georgia Institute of Technology, Main Campus	1,169
3. University of Illinois–Urbana-Champaign	1,088
4. Purdue University, Main Campus	1,079
5. University of Michigan–Ann Arbor	1,036
6. North Carolina State University at Raleigh	982
7. Virginia Polytechnic Institute and State University	961
8. Texas A&M University, Main Campus	895
9. University of CA–Berkeley	750
10. University of Florida	749

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

2002–2003, from 23,033 the previous year. Total undergraduate enrollment fell 19 percent in 2002–2003, after an 11 percent increase in 2001–2002. This dramatic decline should affect BS degree production by 2006.

The Taulbee Survey's bias toward doctoral-granting institutions may be misleading however. IT/CS fields have not exhibited the same trends as other sciences, mathematics, or engineering in that the biggest baccalaureate producers are not the doctoral-granting institutions. Of the top producers of baccalaureates in IT/CS fields in the year 2001, Strayer was number one, and five of the other top 10 were campuses of the DeVry Institute of Technology, a for-profit institution similar to Strayer with campuses all over the country **(Table 1.2)**. In fact, of the top 10 producers of IT/CS degrees in 2001, only Rutgers stands out as a research university. In comparison, the top 10 producers of bachelor's degrees in the physical sciences are dominated by doctoral-granting institutions, including three campuses of the University of California System, four flagship campuses of other state systems, and Harvard University **(Table 1.3)**.

Similarly, the top 10 producers in the biological sciences include five University of California System schools: the flagship universities of

TABLE 1.6 Top Producers of Business and Management Bachelor's Degrees, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. University of Phoenix	7,304
2. Texas A&M University, Main Campus	2,491
3. Pennsylvania State University, Main Campus	2,205
4. Arizona State University, Main Campus	1,703
5. Michigan State University	1,618
6. CUNY Bernard M. Baruch College	1,608
7. University of Florida	1,595
8. University of Central Florida	1,462
9. University of Georgia	1,344
10. California State University–Fullerton	1,304

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

TABLE 1.7 Top Producers of Computer Science Bachelor's Degrees for Women, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. Strayer University	347
2. CUNY Bernard Baruch College	210
3. University of Maryland Baltimore County	150
4. DeVry Institute of Techology (Phoenix, AZ)	129
5. DeVry Institute of Techology (Addison, IL)	126
6. Pace University New York Campus	119
7. DeVry Institute of Techology (Decatur, GA)	114
8. De Paul University	104
9. Villa Julie College	89
9. University of Texas at Dallas	89

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

TABLE 1.8 Top Producers of Computer Science Bachelor's Degrees for African Americans, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. Strayer University	298
2. DeVry Institute of Techology (Decatur, GA)	171
3. CUNY Bernard Baruch College	76
4. Grambling State University	73
5. Morgan State University	72
6. Florida A&M University	65
7. DeVry Institute of Techology (Irving, TX)	64
8. Howard University	59
9. CUNY Herbert Lehman College	52
10. North Carolina A&T State University	50

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

TABLE 1.9 Top Producers of Computer Science Bachelor's Degrees for Hispanic Americans, 2001

Academic Institution	Number of 2001 Bachelor's Degrees Awarded
1. Florida International University	113
2. DeVry Institute of Techology (City of Industry, CA)	69
3. CUNY Bernard Baruch College	69
4. DeVry Institute of Techology (Long Beach, CA)	64
5. CUNY Herbert Lehman College	58
6. Monroe College	40
7. New Mexico State University, All Campuses	39
8. University of Puerto Rico, Bayamon Tech University	37
9. Barry University	36
10. Strayer University	34

Source: CPST; data were derived from the National Science Foundation, WebCASPAR Database, and NCES.

Washington, Texas, and Wisconsin; Rutgers; and Brigham Young **(Table 1.4)**. Finally, for engineering, the top producers of bachelor's degrees in 2001 included Pennsylvania State University; Georgia Institute of Technology; the flagship universities of Illinois, Michigan, California, and Florida; Virginia Tech; and Purdue **(Table 1.5)**. The only other field that has a for-profit institution as the number one baccalaureate producer is business and management, with the University of Phoenix as the number one producer, graduating 7,304 bachelor's degree recipients in 2001. The University of Phoenix far outpaces the next leading producer, Texas A&M University, which produced 2,491 graduates in 2001 **(Table 1.6)**.

The top producers of bachelor's degrees in IT/CS for women in 2001 are listed in **Table 1.7**. They include Strayer as number one and three campuses of the DeVry Institute, as well as Villa Julie College, a private nonprofit college retooling itself for the adult market. Not one of the top 10 producers of IT/CS bachelor's degrees for women is a major research university. For African Americans, the top 10 producers include various DeVry campuses and Strayer and then are dominated by HBCUs **(Table 1.8)**. For Hispanics, Strayer drops to number 10; two DeVry campuses and various Hispanic Serving Institutions (HSIs) dominate **(Table 1.9)**. Across the other sciences, the top producers of bachelor's degrees for women include mostly top research universities; for African Americans, the HBCUs excel, and for Hispanics, various campuses of the University of Puerto Rico and other HSIs take the lead.

These data sources suggest that simply monitoring the doctoral-granting institutions is not enough when looking at the production of IT/CS bachelor's degrees. For-profit institutions dominate the market in IT/CS baccalaureates, implying a different consumer of these degree programs, including significant numbers of women and underrepresented groups. What remains unclear, however, is the comparability of the degree programs across institutions and whether they are all delivering essentially the same product, just to a different set of consumers. There is some evidence that the for-profit institutions are offering more occupational training than "foundational education."[7] For obvious reasons, this study did not directly address the question of comparability. Rather, we focus on nontraditional students at "traditional" universities, their motivations and experiences, the experiences of the faculty who teach them, and the employers who hire them.

The Changing Employment Market

The job market also changed dramatically during the course of our research. In early 2000, a report from the National Science and Technology Council[4] expressed strong concern that the United States may not be able to meet its future science and engineering workforce needs, particularly with the declining interest of U.S. students in preparing for opportunities in these fields. The report called upon the nation to draw on its full talent pool to maintain its position as a world leader in all areas of science and technology. In particular, the report said, attracting those groups who had not traditionally participated in science and engineering—women and underrepresented minorities—should become a national priority.

Meanwhile, businesses were continuing to complain about the allegedly insufficient supply of U.S. talent in information technology and urged higher and higher limits on the numbers of specialized talent that could be brought into this country to fill positions through a temporary visa program called the H-1B. Finally in 2000, Congress raised the number of allowable H-1B visas to 195,000 for 2001–2003, after which the limit would scale back to 65,000, the original H-1B ceiling.

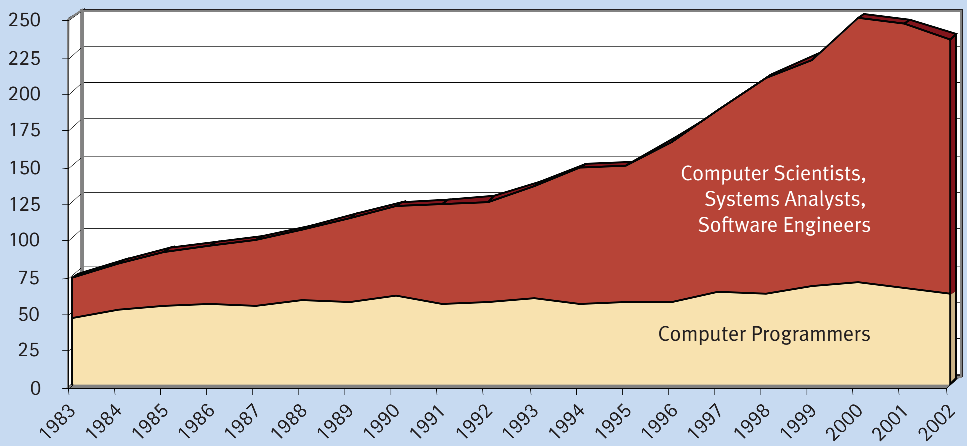
The "boom" labor market for IT/CS workers that existed in the late 1990s into early 2000 is somewhat reminiscent of a similar situation in the 1960s when aerospace/aeronautical engineers were in high demand. Industry could not find enough, and there were warnings of doom if special efforts were not made to interest more U.S. students in entering the field. Efforts at recruitment were successful, but just about the time these graduates emerged from higher education institutions as aerospace/aeronautical engineers, national priorities changed, and their services were no longer in such demand. Stories abounded about aerospace engineers working as taxicab drivers.

There is not much concern that a similar kind of situation would develop in IT/CS because these specialists are pervasive throughout all segments of our economy and not concentrated in just one industry. In sharp contrast to the aeronautical engineering scenario, where most individuals held at least a bachelor's degree, only slightly more than one-fifth of all IT/CS workers in the U.S. had a college degree in the 1990s.[8] Of those who did have a bachelor's degree, many were in fields other than IT/CS and even outside of science and engineering. At the same time, the number of IT/CS bachelor's degrees awarded soared dramatically.

Even today, it is difficult to determine whether there were insufficient supplies of IT workers to fulfill the demand. In 1999, the IT Workforce Data Project was funded by the Alfred P. Sloan Foundation to identify and disseminate trustworthy statistics on IT workers in the United States. During the project, the principal investigators, Richard Ellis and Lindsay Lowell, issued four reports in the following areas: 1) what occupations comprise the IT workforce, 2) the production of U.S. degrees in IT disciplines, 3) foreign-origin persons in the U.S. IT workforce, and 4) assessing the demand for IT workers.[9]

Overall, the researchers concluded that there were no signs of an inadequate supply of IT workers. To the contrary, there were rising numbers

CHART 1.3 Employment in Core IT Professions, 1982– 2002 (numbers in thousands)



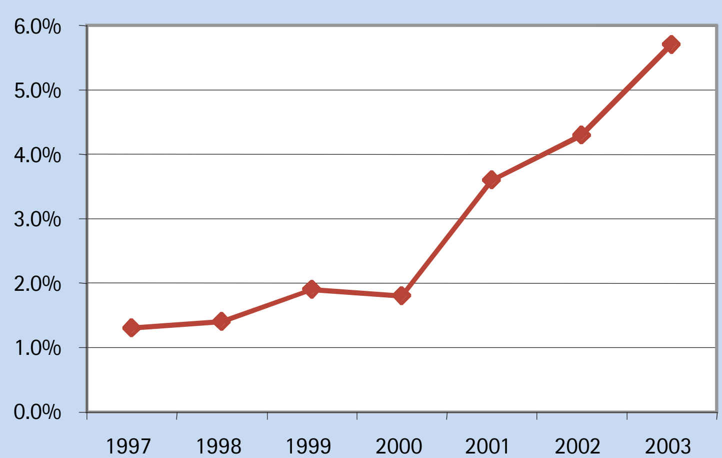
Source: CPST; data are derived from annual estimates from the U.S. Bureau of Labor Statistics, based on data from the Current Population Surveys.

of experienced unemployed workers, compensation for IT workers continued to be flat, and enrollments in computer science started to increase. All of these factors suggested that demand on the available supply had started to ease. In addition, there was increasing use of foreign talent—both in the U.S. and in offshore job shops.

There were still some difficulties in the IT job market, however, for both employers and job candidates. Ellis and Lowell found that while there was no general national shortage of workers, many employers still could not find the people they sought, and some individuals with IT training and experience had difficulty finding work. These researchers suggest that there were signs of a strong preference for recent graduates in the IT job market. Employers seemed to prefer young workers who were trained in the current technology, probably more likely than others to be willing to work the long hours and give the total commitment that some IT employers demanded, and cost less. So some of the older workers, who were more experienced but probably not up-to-date on all the current technology, were finding it difficult to land jobs.

In 2003, following the above IT Workforce Data Project, but now under the sponsorship of the Commission on Professionals in Science and Technology, Richard Ellis updated *The Outlook in 2003 for Information Technology Workers in the USA*.[9] He reported that the number of U.S. jobs in core

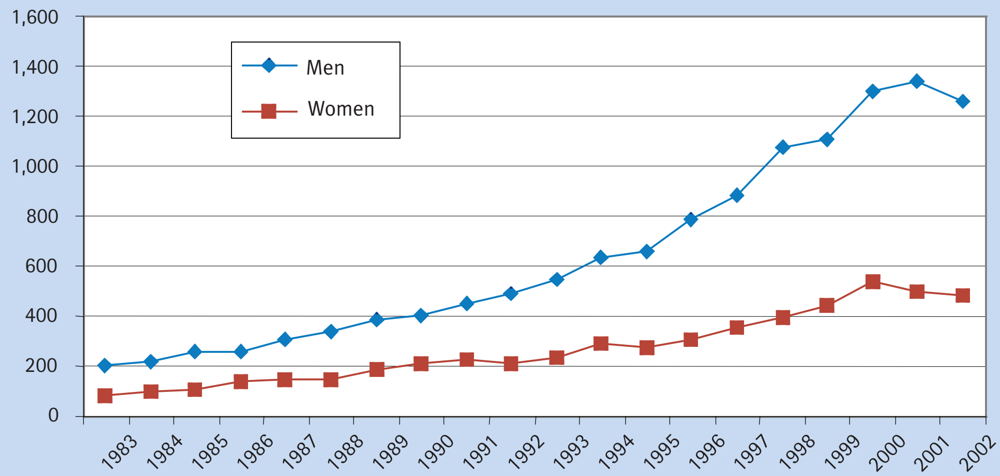
CHART 1.4 Recent Unemployment Rates for Core IT Professionals
(computer scientists, systems analysts, software engineers, and programmers; annual data for 1997–2002; preliminary 2003 trends from data for the first two quarters)



Source: CPST; data are derived from the Bureau of Labor Statistics, Current Population Surveys (unpublished data).

IT occupations (which include computer scientists, systems analysts, software engineers, and programmers) more than tripled from 719,000 in 1983 to 2,498,090 at the sector's peak in 2000 **(Chart 1.3).** This was a unique situation, because no other broad area of employment in the United States experienced such growth. But in 2001–2002, about 150,000 jobs in these core occupations were lost, almost two-thirds of them in programming. As Ellis points out, "the occupational title of 'pro-

CHART 1.5 Employment of Computer Systems Analysts and Scientists by Sex, 1983–2002 (numbers in thousands)



Source: CPST; unpublished data from the Bureau of Labor Statistics, Current Population Survey.

grammer' has become ambiguous, encompassing both relatively low-level coders whose work may easily be shipped overseas, and relatively high-level developers of new systems, who have suffered in the collapse of high-tech investment markets. Such conditions help explain why programming has been especially vulnerable to losses of jobs" during 2001 and 2002.

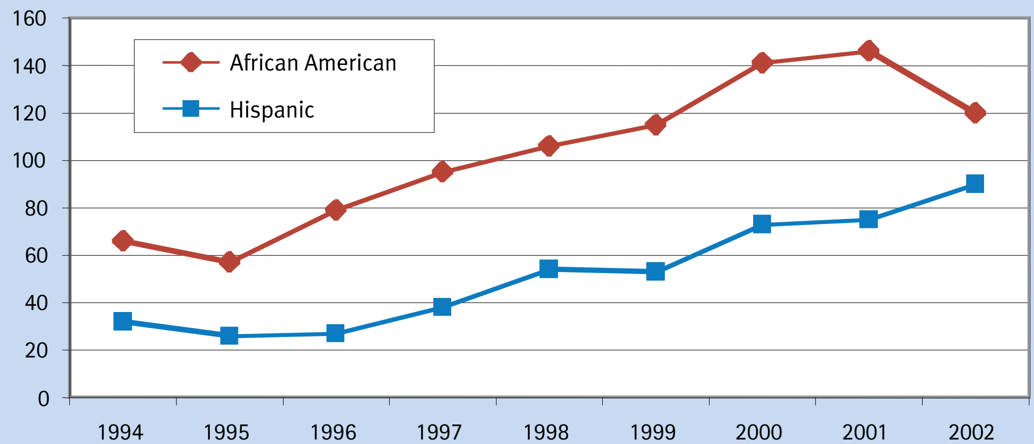
Unemployment of IT workers in the core occupations began to rise in 1997, well before the peak years of the technology bubble, rising from 1.2 to 1.9 percent between 1997 and 1999. Whereas unemployment remained at just under 2 percent during 2000, it jumped to 3.6 percent in 2002 and an average of 5.9 percent for the first two quarters of 2003 **(Chart 1.4).**

At the same time, the number of foreign-born individuals in the core IT occupations doubled from about one-tenth of the labor force in 1994 to over one-fifth of it in 2001. Much of this increase was facilitated by legislation that expanded the number of allowable admissions of persons with H-1B visas. The number of immigrants in IT occupations did not drop as much between 2001 and 2002 as did the number of U.S. citizens in the IT workforce; thus, the immigrant share of IT jobs continued to increase during the recent economic slowdown. Ellis also pointed out that immigrants in the IT workforce are both younger and better educated than their native counterparts. In 2002, 53.3 percent of immigrants with core IT jobs were under the age of 35, compared to just 41 percent of natives, and 41.1 percent of immigrants had graduate degrees, compared to just 16.2 percent of American IT workers. Despite their age and advanced educations, however, immigrants still were more likely to be unemployed than their U.S. citizen counterparts.

Exacerbating this reliance on foreign workers in our IT/CS workforce is the dominance of Caucasian males in the science and technology workforce as a whole. U.S. Census data show that the segment of the population we rely on most for our IT workforce is Caucasian males. Whereas Caucasian males make up 35 percent of our overall population, they constitute 63 percent of the science and technology workforce. Even more problematic, this population is aging and declining in number compared to other segments of the population.

Whereas our IT workforce specifically may not be quite as old as the rest of the science and technology workforce, it is still predominately male. As **Chart 1.5** shows, although the numbers of those employed in computer systems analysis and computer science occupations have increased dramatically over the last 20 years, women have not kept pace with men in the field. Even more troubling, the evidence appears to show that the number of women in the field peaked in 2000, declining in 2001 and 2002. The decline for men, however, did not begin until mid-2001, indicating that women

CHART 1.6 Employment of African American and Hispanic Computer Systems Analysts and Scientists, 1994–2002 (numbers in thousands)



Source: CPST; data are derived from the Bureau of Labor Statistics, Current Population Survey (unpublished data).

were hit earlier and harder by the tech bubble burst and subsequent unemployment.

African Americans and Hispanic Americans continued throughout this period to be a small, although growing, segment of the IT/CS workforce. **Chart 1.6** shows this increase, although the growth in IT/CS employment among these groups is not nearly as dramatic as among the entire IT/CS workforce. African Americans show a pronounced decline in employment as computer systems analysts and computer scientists of nearly 17 percent between 2001 and 2002. While it is unclear if all of those people were simply left unemployed, clearly it is a larger exodus than among the general population of computer scientists. Hispanic Americans, on the other hand, while a smaller portion of the computer systems analyst and computer science workforce, actually gained in the field during the 2001 and 2002 slump.

Other organizations echoed some of Ellis' findings. For example, ITAA in a 2002 study reported that U.S. companies shed over 500,000 IT workers during 2001, but that demand during 2002 would increase substantially. ITAA, at that point, believed the IT workforce would bounce back, and it has somewhat, but not as much as predicted.

ITAA also warned that the future success of the U.S. IT industry will depend on the availability of a deep pool of talented IT workers, noting that U.S. IT workers are now and must continue to be the best in the world. ITAA noted that "best" and "cheapest" are not "synonymous concepts, nor should they be." Whereas the low cost of labor is driving some companies to send IT services offshore, there is some question about whether this approach is likely to produce sustainable economies and the overall "best value" for the customer. Companies make workforce decisions based on numerous considerations, including labor cost.

The Changing Policy Context

The growing numbers of nontraditional students, the dominance of for-profit institutions in bachelor's degree production in IT/CS, the cyclical patterns of IT/CS baccalaureates, and the fluctuating job market have real implications for policymakers. Policymakers make decisions about where to invest our nation's tax dollars to best serve our national needs. Such needs, and responses to them, cannot favor all individuals equally. Several policy initiatives are currently being debated that would affect higher education institutions, including for-profit institutions and our scientific and technical workforce.

The annual *The Chronicle of Higher Education* survey on public attitudes about higher education shows an American public with a strong and abiding trust in academic institutions.[10] Ninety-three percent of the survey respondents in 2004 agreed or strongly agreed with the statement, "Colleges and universities are among the most valuable resources to the U.S." Four-year private colleges and universities ranked second highest in the public's level of confidence in various U.S. institutions (48 percent said they had a great deal of confidence in these institutions) behind the U.S. military (with 68 percent indicating a great deal of confidence), but ahead of churches and religious organizations (44 percent) and the executive branch of the U.S. government (28 percent). Four-year public state-supported colleges and universities had 40 percent of respondents indicating a great deal of confidence in them, slightly behind community colleges with 41 percent. In general, the Americans who answered the *Chronicle* survey felt that the general quality of education is better at private nonprofit universities.

While 52 percent of the American public thinks that a four-year college degree is essential for success in society, nearly 47 percent indicated that they thought it more difficult to gain admission to a four-year college or university today than it was 10 years ago. In addition, 88 percent believed that college students were incurring too much debt, 65 percent thought Congress should appropriate more money for student grants, and 74 percent indicated that the amount of money available to students in the form of loans should be increased. Nearly 70 percent believed that colleges and universities could reduce their costs without compromising the quality of education they provide.

With the reauthorization of the Higher Education Act being debated in Congress, lawmakers are considering many of these public ideas and concerns. Issues that especially affect nontraditional students, however, were not addressed in the *Chronicle* survey. The survey does not ask about for-profit institutions, public confidence in them, or the quality of education they provide, although 88 percent of respondents agreed or strongly agreed with the statement that colleges and universities should "provide education to adults so they qualify for better jobs." For-profit institutions and nontraditional students make up a growing segment of the educational market, especially in the critical field of IT/CS. How are the policy debates addressing the specific issues of for-profit institutions and nontraditional students?

For-profit institutions versus traditional colleges and universities

The *New York Times* reports that nearly one in twelve college students attends a for-profit institution and that enrollments in for-profits are growing at three times the rate of nonprofit colleges and universities.[11] These numbers, obtained from Eduventures, an education market research company, include all Title IV–eligible for-profit postsecondary institutions ranging from less than two-year certificate and diploma-granting vocational schools to degree-granting four-year and doctoral institutions. Eduventures estimates there are 1.5 million students in these institutions, but only about 17 percent, or 255,000, of these are in four-year bachelor's degree–granting institutions. The National Center for Education Statistics at the U.S. Department of Education reports 2001 enrollment data at four-year for-profit institutions at about 3.3 percent of total enrollments, or about one in every 30 college students. Either way, there is no denying that for-profits are a growing provider of college education. But are for-profit colleges and universities offering the same education as their more traditional private and public counterparts? Do nontraditional students seek the same from their education as their traditional counterparts?

Educational equivalency has always been hard to determine among institutions, and accreditation is not necessarily a good measure. While accreditation is voluntary, the vast majority of colleges and universities, including for-profits, are accredited, mostly because their students cannot qualify for federally funded student aid without accreditation. Strayer is accredited by the Middle States Commission on Higher Education, the same accreditation agency for all schools in Maryland and the District of Columbia participating in our study. Strayer is not accredited by the Accreditation Board for Engineering and Technology, Inc. (ABET), which grants accreditation to specific computer science and IT programs. Not all departments of computer science or information technology at the various colleges and universities where we conducted our study, however, are ABET accredited (including Johns Hopkins, the University of Virginia, and the University of Maryland). Accreditation itself is a slippery concept, and Congress is debating new measures that would open accreditation agencies to greater scrutiny.[12]

One indication that for-profit and nonprofit colleges and universities are different may be the language used to describe their activities. Analyses of traditional institutions discuss tuition and endowments, academic reputation, educational programs that offer general as well as specific knowledge, and competition for admission to a limited number of available seats. Analyses of for-profit institutions, on the other hand, emphasize rates of revenue growth, stock prices, expanding operating margins, and growing enrollments rather than selective admissions. The focus is on attracting more students to programs while minimizing the costs of the actual educational experience. And for-profit institutions have recorded phenomenal gains in enrollments, especially in online ventures that have little overhead costs, thus maximizing profits.[13]

As noted earlier, many claim that for-profit institutions provide more technical training than broad-based education. Most hire professors on a course-by-course adjunct basis, usually providing no office space and issuing curriculum guidelines and textbooks that instructors must follow. Very few for-profit universities offer tenure or the kind of freedom to design courses that faculty on traditional campuses take for granted. For-profits focus primarily on growing enrollments, and they do this through highly visible advertising, unlike traditional institutions that focus on college fairs and name recognition. They concentrate on growth in revenues, with the academic experience a secondary consideration, and they seem to forgo altogether the academic mission to produce research that creates new knowledge. In short, it is as if for-profit colleges and universities and traditional colleges and universities inhabit different universes.

Many of these differences can be explained by the fact that for-profits and nonprofits may be tapping into very different markets. The *New York Times* describes what nontraditional students want as quick-and-to-the-point coursework, customer service, small classes, convenience, and an education that leads to employment. What they don't care about are "fancy campuses, dormitories, athletic complexes, tenured faculty, and the pond that shows up in every brochure." In other words, they don't crave those things that increase the costs at traditional institutions or that they regard as unnecessary for their academic experience. Indeed, more and more nontraditional students are willing to forgo the campus altogether and opt for an education done completely online. Online education is a major part of the growth in for-profit education enrollments, expanding beyond even the expectations of education market analysts. In 2003, for example, the University of Phoenix's online division posted a revenue growth of 61 percent, which was down from 2002's 70 percent and 2001's 81 percent growth rates, but is still substantial.[13]

While traditional colleges and universities have tried to tap into the lucrative and growing nontraditional market, they have not always had success. In the late 1990s and early 2000, many major universities, notably New York and Columbia Universities, attempted to build for-profit online subsidiaries, only to have them fail utterly. Some succeeded, such as the University of Maryland University College, which built upon an existing distance learning program. But even those successful online programs at traditional universities are often seen as second-rate or inferior education by those teaching in the more traditional programs at the same universities. At the root of this seems to be a clash of cultures between traditional programs that emphasize a broad education based in part on theory and the production of knowledge and nontraditional programs that focus on skills, employability, and maximizing profits.

Since the failure of many of their online ventures, most traditional colleges and universities have relinquished the nontraditional student market to the for-profits and to some state and private schools that have built programs specifically for nontraditional students. As one faculty member at an elite state university told us, "That's not our mission [to teach nontraditional students]." In addition, movements by many state governments and the federal government to hold universities more accountable for outcomes, including tracking graduation rates and time-to-degree statistics, have forced many colleges and universities that educate many nontraditional students to abandon their night classes and focus on traditional student populations who will graduate in four to five years.

Skill-building has usually been considered the purview of community colleges, and, traditionally, adult education has centered on these institutions. But nontraditional students are finding more and more competition for increasingly limited community college slots from traditional students.

Traditional-age students have begun to use community colleges as cheaper alternatives for the first two years of their education before transferring to a four-year institution or are forgoing four-year institutions altogether for community college degrees. Throughout the 1990s, the median age of community college students dropped from 26.5 in 1991 to 23.5 in 1999. As competition for admission to traditional institutions increases and finances become increasingly tight at state universities, more traditional-age students are likely to pursue studies at community colleges.[14] But traditional-age students are also feeling the pinch of budget cuts that have left fewer and fewer available seats in community college classes.

Nontraditional students may soon find their classes filled with more traditional-age students at for-profit institutions as well. In the drive to keep enrollments growing and revenue streams increasing, for-profits are searching for new markets and eyeing the traditional-age college student.[15] To keep costs down, for-profits are also beginning to increase their class sizes and encourage students to take more of their classes online.

But if increasing numbers of students—both traditional and nontraditional—choose convenience, skill-building, and fast programs over theory, broad-based, academic education, are their degrees the same? If they are significantly different, should they be called the same thing? Is everyone awarded a "bachelor's degree" regardless of the emphasis of their educational institution? Should we encourage more nontraditional students to attend traditional colleges and universities? Or should we direct nontraditional students away from the traditional education market, where available slots are dwindling, and funnel them into institutions that are designed to offer what they seem to want? Are the degrees treated the same by employers? Finally, if traditional-age students increasingly opt for skill-building and convenience over the traditional university experience, will the financing of programs at traditional universities that include as part of their mission the creation of new knowledge through research be affected?

Reauthorization of the Higher Education Act

The major debates surrounding the reauthorization of the Higher Education Act (HEA) involve access, aid, and accountability. Current proposals dealing with all three of these issues have major implications for nontraditional students attending both nonprofit and for-profit institutions.

The access issue within the HEA has been dominated by concerns about rising tuition costs, though the subject of who is admitted to some of the nation's most elite private and public universities has also come under some scrutiny. In the past several years, tuition at many state and private universities, and even some community colleges, has risen at what are perceived by some to be alarming rates. In some instances, tuition increases have even occurred mid–school year, prompting many students and their families to cry foul. The outcry is especially great when state-funded institutions raise tuition in response to dramatically falling state contributions.

Congress has threatened repeatedly to try to limit allowable tuition increases, or at least to monitor them and place colleges and universities that raise tuition above a certain percentage of the inflation rate on a government watch list. So far, those proposals have met stiff resistance, and lawmakers have been forced to back down from the most controversial measures, threatening colleges and universities that have considerably raised their tuition rates with ineligibility for certain federal student aid programs.

Interestingly, for-profit institutions are not cheap. Their tuition rates are generally more expensive than what state universities charge in-state students, although they are a bargain compared to private colleges and universities. However, there has never been a public or political outcry when for-profit universities increase their tuition rates. The raising of tuition rates seems not to be an issue at all for for-profit institutions whose mission is to create and protect shareholder profits. Yet, for-profits make the lion's share of their revenue from federally financed student aid payments. *The Chronicle of Higher Education* reports that the Apollo Group, which owns the University of Phoenix, the nation's largest for-profit higher education provider, received 62 percent of its annual revenues from Pell Grants and federally subsidized student loans in 2003. Strayer University collected 55 percent of its revenue from federal sources, the same as DeVry. The highest reported percentage of revenue from federal sources, 82 percent, went to Corinthian Colleges.[16]

There are several provisions in the HEA reauthorization that would affect for-profit institutions. Republicans would like to see eliminated the 90/10 rule that restricts for-profits from receiving more than 90 percent of their revenue from federal sources, requiring them to generate at least 10 percent of their income from other sources. Democrats claim that the 90/10 rule is fair and reduces the prospect that fly-by-night institutions or other for-profits would fraudulently use federal student aid to pad shareholders' returns. In addition, the reauthorization would also (re)define institutions of higher education. Republicans would like that definition to include for-profits, whereas Democrats want to continue excluding them. Inclusion in the government definition would allow for-profits to compete for federal monies in departments outside of the Education Department, including Agriculture, Homeland Security, and Health and Human Services, possibly diverting more money from traditional colleges and universities.[17]

The access issue is intimately tied to financial aid and is probably the most contentious of all the issues covered by HEA. Indeed, *The Chronicle of Higher Education* reports that the reauthorization of the Act has been tabled altogether this year (2004) because the debates over student loan provisions have become "too partisan."[18]

The federal government gives three types of student financial aid—grants that do not have to be repaid, loans, and campus-based student aid. The largest federal grant program is the Pell Grant, which currently is appropriated to award up to $4,050 per year to students who qualify based on need, although it is authorized to award up to $5,800. Plagued by chronic underfunding, the Pell Grant is largely recognized as inadequate to meet the needs of the low-income students it is meant to serve. One provision under debate limits the Pell Grant awards to students attending the lowest-cost colleges, rendering them ineligible to receive the maximum amount.

The most controversial student loan issues involve loan consolidation and variable interest rates for loan recipients after graduation. More salient for nontraditional and low-income students are proposals to increase student loan limits, which were set more than a decade ago and are now perceived as inadequate for needy students. However, critics charge that raising loan limits would encourage colleges and universities to increase tuition even more, forcing students into greater debt.

Campus-based student aid programs include College Work-Study, the Perkins Loan program, and Supplemental Educational Opportunity Grants. They are allocated to colleges and universities based on a guaranteed minimum amount set in the 1970s. This formula helps large state and private universities, for whom the guaranteed minimum was originally set, and hinders community colleges and for-profit institutions. Proposals for changing this minimum formula are based on arguments that community colleges and for-profit institutions enroll more needy students and therefore should receive more campus-based aid resources. Large state and private universities counter that campus-based aid is distributed to the neediest students on their campuses and that, without that aid, these students would be forced to borrow more or attend less expensive and/or prestigious universities.

The most potentially damaging issue for nontraditional students currently being addressed in the HEA reauthorization, however, is accountability. Similar to the No Child Left Behind Act that sets up accountability standards for K-12 education, many in Congress would like to devise standards that would hold colleges and universities accountable for student outcomes. The most talked-about measure of accountability for these institutions is graduation rates—the portion of students entering an institution who actually graduate with a degree. While this may sound like a simple calculation, graduation rates are in fact much more complicated than they appear. Student populations are highly mobile. Students may begin at one college and transfer to another, and maybe graduate from a third institution altogether. An analysis by Clifford Adelman shows that one in five college students graduates from a college or university other than the one where they had first enrolled.[19] Our data show that nontraditional students are especially likely to attend several institutions over their educational lifespan. Some populations also drop in and out of the higher education system for reasons completely unrelated to the academic institution—family needs, financial difficulties, employment opportunities, geographic relocation, etc.

Also being discussed is the use of time-to-degree as an accountability measure. For obvious reasons, this measure is problematic for universities that serve nontraditional students. The bottom line is that many of the provisions for holding colleges and universities accountable for outcomes rely on choices that *students* make rather than on practices and quality measures that educational institutions can control. Moreover, such measures may force institutions to change their programs to accommodate more traditional-age students at the expense of nontraditional students.

Workforce Policy and Issues

The policy issues dealing with the IT/CS workforce largely affect whether students will find work once they finish their education. But they also have implications for those who might be contemplating a four-year degree. Three broad areas currently under debate are of relevance to our study: H-1B visas, offshoring, and the science and engineering workforce debates.

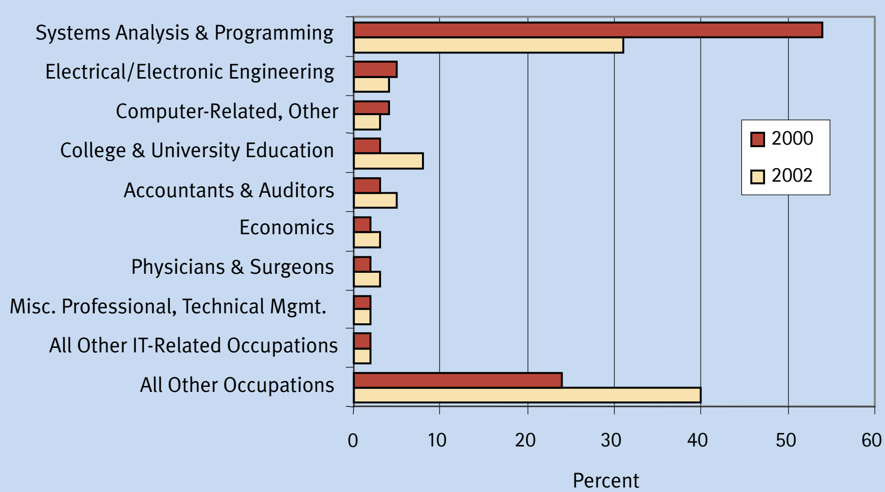
H-1B visas

Although there are some industry proponents urging new increases in the H-1B visa cap from its current 65,000, not much movement toward that objective has occurred. Phil Bond, undersecretary for technology at the U.S. Department of Commerce, said in early June 2004 that H-1B supporters will need to make a strong case for an increase, particularly in light of the record levels of unemployment that engineers and some core IT professionals are facing. For example, the jobless rate for computer scientists and systems analysts in the U.S. reached 6.7 percent in the first quarter of 2004.[20]

Fiscal year 2004's cap of 65,000 H-1B visas was reached in February and companies began submitting applications for fiscal year 2005. The cap of 65,000 for fiscal year 2005 was met on October 1, 2004, in just one day.[21] A number of high-tech companies urged the 2005 passage of a bill introduced by congressman Lamar Smith (R-Texas) that increased the cap by 20,000 visas by exempting U.S. university graduates with a master's degree or higher from the limits.[20,22]

The United States Government Accountability Office (GAO) found that the number of approved H-1B visas decreased by more than 50 percent in one year, from 163,000 in fiscal year 2001 to 79,100 in fiscal year 2002. In 2000, 65 percent of

CHART 1.7 Top Occupations H-1B Beneficiaries Were Approved to Fill, 2000 and 2002



Source: CPST; data derived from the U.S. General Accounting Office.

H-1B beneficiaries were approved to fill IT-related positions, but in 2002, the percentage approved to fill IT-related positions fell to 40 percent. The drop was most evident in systems analysis and programming, which accounted for 54 percent of all H-1B visas in 2000, but only 31 percent in 2002 **(Chart 1.7).**

The GAO reports that there is a real need to improve the tracking of foreign workers in the U.S. to determine what effect the H-1B visa program has on the U.S. workforce. Not much information is available on H-1B workers, e.g., entries, departures, and changes in visa status. The Department of Homeland Security (DHS) does not know how many H-1B workers are currently in the U.S. and has no idea how many H-1B workers have become permanent residents or have remained in the U.S. on other types of visas. What information the GAO does have comes from the former Immigration and Naturalization Service and from site visits and telephone interviews with 36 H-1B employers in six states.[23]

But should we continue to rely on temporary guest worker programs to meet employer needs for skilled professionals in high-demand industries? Or should we take the longer view of our science, technology, engineering, and mathematics (STEM) workforce challenge and expand our own talent base, since these short-time fixes have been disrupted by unexpected domestic and foreign events, such as the September 11th tragedy? Overreliance on temporary guest worker programs in technology-critical industries can jeopardize America's further economic growth and national security and may make STEM careers less attractive to U.S. students, including underrepresented women and minorities.

Offshoring and its effects on IT employment

Another recent lightening-rod issue in the U.S. is offshoring, or the transfer of jobs previously done in the U.S. to overseas locations. In the past year, this has become a growing and highly visible workforce trend, particularly in fields such as information technology, reported often in the media and talked about in IT circles. Outsourcing, says Ron Hira, an assistant professor at Rochester Institute of Technology, is the classic "make or buy" decision. Do you decide to make it yourself internally, or do you decide to buy it from a supplier? When outsourcing takes place with a supplier outside the country, it is referred to as "offshoring." There are two different kinds of offshoring. Businesses may outsource certain services to suppliers in other countries who then are contracted to do the labor. Similarly, multinational corporations might offshore work by setting up facilities in other countries and then importing the products. Either way, businesses and corporations do this to save money on production costs.[24]

So how widespread is this? A widely cited report by Forrester Research predicted that 3.3 million white-collar jobs, worth $136 billion in U.S. wages, would be shifted out of the U.S. by the end of 2015.[25] This forecast included 473,000 IT positions over and above those already lost to earlier movements of this kind. In May 2004, Forrester Research updated their forecast, saying that the movement of U.S. services jobs offshore will accelerate a bit faster than originally projected, from 3.3 to 3.4 million U.S. services jobs being offshored by 2015, with the increase due in part to updates in the base-level numbers for 2002 made by the U.S. Bureau of Labor Statistics.[26]

However, Forrester's estimates have been dwarfed by estimates by Gartner, Inc., a Connecticut consulting firm that reported that 10 percent of all U.S. professional jobs in IT services firms would be transferred overseas by the end of 2004, along with 5 percent of the IT positions in other types of organizations.[27] Gartner said that offshore outsourcing had become the fastest growing IT industry segment.

Whether offshore outsourcing will help or hinder the U.S. economy depends on who is talking. According to a report by the AeA (formerly called the American Electronics Association),[28] some people may be hurt by the trend, but offshore outsourcing is exaggerated as the primary cause of lost jobs in the U.S. AeA puts the blame for lost jobs on the decline in the world's economy, the end of the high-tech bubble, and dramatically improving productivity rates. AeA concludes its report with several recommendations, including conducting a national summit on the training, retraining, and education of workers; increasing federally sponsored basic research in the physical sciences; giving green cards to all foreign nationals who receive master's degrees and PhDs from U.S. universities; and opposing protectionist legislation intended to prohibit or reduce offshore outsourcing.

Another report released in March 2004 by the Information Technology Association of America (ITAA-USA) agreed with many of the points raised in the AeA report. The ITAA study said that worldwide outsourcing of computer software and services increases the number of U.S. jobs, improves real wages for American workers, and pushes the U.S. economy to perform at a higher level, among many other economic benefits.[29]

ITAA reported that worldwide outsourcing of IT services and software generated an additional 90,000 U.S. jobs in 2003; by 2008, net new jobs created will total 317,000. In the software and services area, the economy will create 516,000 jobs over the next five years in an environment with global outsourcing, but only 490,000 jobs without it. Of these 516,000 new jobs, 272,000 will go offshore and 244,000 will remain onshore. The ITAA study, similar to the AeA report, concludes that raising barriers to worldwide outsourcing would adversely affect U.S. workers and U.S. firms by slowing the U.S. economy and actually reducing the number of new jobs available to American workers.

But not everyone agrees with the conclusions of the AeA and ITAA reports. John Steadman, president of the Institute of Electrical and Electronics Engineers–USA (IEEE-USA), points out that both the AeA and the ITAA reports are the products of organizations that speak for the IT industry not the IT worker. Both reports assume that the savings from offshore outsourcing will be used to create new jobs in the U.S., when it's "not absolutely clear that will happen," Steadman says. Companies can "invest overseas and the new jobs get created elsewhere and not help U.S. workers."[30]

Lee Price, research director of the Washington-based Economic Policy Institute, adds, "When overseas manufacturing led to the loss of textile jobs, there was a shift in the U.S. to more productive, higher-paying jobs." But "the opposite is happening [with] computer software offshoring," he said. "This trend to offshore productive jobs in the U.S. economy is making us less productive and not stimulating the economy," said Price. "We are giving up some of the most productive jobs in our economy."[30]

In a new report, summarized by Paul Blustein in the July 2, 2004, issue of *The Washington Post,*[31] the Boston Consulting Group (BCG), which counts among its clients many of the biggest corporations in the U.S., is exhorting U.S. companies to speed up "offshoring" operations to China and India, including high-powered functions such as research and development. The report warns American firms that they risk extinction if they hesitate in shifting facilities to countries with lower costs. That is partly because the potential savings are so vast, but the report also cites a view among U.S. executives that the quality of American workers is deteriorating. "The largest competitive advantage will lie with those companies that move soonest," the BCG report states. "Companies that wait will be caught in a vicious cycle of uncompetitive costs, lost business, underutilized capacity, and the irreversible destruction of value."

The report, released in May 2004, has gone almost unnoticed amid generally upbeat news, as strong economic growth has begun fueling an increase in jobs, diminishing public debate about offshoring. However, economists who contend that offshoring benefits the U.S. economy in the long run voiced dismay over the report, which they fear could help revive the political clamor for protectionist measures that erupted in 2003 when the media focused public attention on the loss of high-tech jobs to India.

Such anti-offshoring measures could have a big effect on state governments as their IT workforce ages. For example, Rock Regan, chief information officer for the State of Connecticut, said that up to 35 percent of his state's IT workers will reach retirement age in the next five years.[31] Many other states face similar problems and may be forced to look at different alternatives, including offshoring.

There is no easy answer to the offshoring issue. The U.S. must continue to compete globally on the basis of "better jobs," not just "jobs." Its technical workers will have to compete on value-added quality and productivity and will have to increase their skills base. But if future workers are receiving a signal that IT/CS is not a stable profession or that they may be competing for fewer jobs at lower wages, the profession is not going to attract its share of the talent. The future prosperity of the U.S. will depend on the availability of a deep pool of talented IT workers.

The Science and Engineering Shortage Debates

One of the largest debates within the scientific and technical education community that has caught the attention of policy makers at all levels is whether the nation will have sufficient numbers of scientists and engineers to remain globally competitive. Why this concern? It is because these workers, while only comprising about 5 percent of our nation's 138 million–person workforce, have accounted for more than half of America's sustained economic growth in the past 50 years.[32] The reservoir from which America has traditionally drawn most of its science and engineering (S&E) talent, however, is changing dramatically and in important ways. Attention must be paid to both the internal and external drivers that propel that change if we are to sustain global leadership. These include demographic, educational, economic, and cultural forces.

The concern of many analysts is that insufficient supplies of our scientists and engineers will hamper our ability to continue to create new technologies, make scientific breakthroughs, and thus slow down our innovation, just when America's competitors are beefing up their numbers. Part of the problem is simple demographics. The traditional talent pool (Caucasian, non-Hispanic), from which our nation has drawn heavily for its scientists and engineers, is projected to stop growing completely by 2030 and then slowly decrease. In contrast, the African American, Asian, American Indian, and Hispanic populations are projected to increase at varying speeds. By far, the greatest population change will be among the Hispanic population, which is projected to contribute 44 percent of the population growth from 2000 to 2020 and 62 percent from 2020 to 2050.[33] These demographics clearly point out that the talent base is changing and suggest that the nation must work to make its domestic workforce more inclusive.

Although about one-third of the current school-age population in the U.S. consists of underrepresented minority students (African Americans, Hispanic Americans, and Native Americans), over three-quarters (77 percent) of the working population in science and engineering occupations is Caucasian, with a fair representation of Asians (about 12 percent), but only about 11 percent African American, Hispanic, and Native American participants. Similarly, whereas women comprise about half of the school-age population, and over 50 percent of those in higher education, they represent only about one-quarter of the S&E workforce.

Another demographic concern of many leaders in academia, government, and industry is the decline in the share of science and engineering doctorates earned by U.S. citizens. In 1973, U.S. citizens earned 77.5 percent of all S&E PhDs. In 2002, they earned 58.3 percent. The primary reason for this proportional drop is the decline of men, who earned 86 percent of all the doctorates awarded to U.S. citizens in 1973, dropping to 57 percent in 2002. Even more disturbing is the fact that over the most recent five years for which we have data, 1998–2002, the number of Caucasian men earning PhDs in science and engineering who are U.S. citizens dropped 19.1 percent.[33] Who will make up for this decline?

Added to this anxiety over a decreasing supply of U.S. citizens entering the STEM fields, particularly at the doctorate level, is the fact that about one-quarter of our current scientists and engineers will reach retirement age by 2010.[32] How will we replace those workers? Can we continue to rely on international talent to fuel our economy? That prospect becomes more of a concern as our nation institutes policies that decrease the flow of foreign talent entering our colleges and universities and as the home countries of many international students and scientists raise their standards of living and place greater value on their own technical innovation. In the wake of our more restrictive visa procedures, other countries, including Australia and European nations, are taking up the slack and aggressively recruiting international students.

Many of these concerns were well publicized in a report from the National Science Board (NSB) in May 2004.[34] According to the report, "current trends of supply and demand for S&E skills in the workforce indicate problems that may seriously threaten our long-term prosperity, national security, and quality of life." The NSB recommends a five-prong national policy imperative to increase the number of U.S. citizens pursuing careers in science and engineering. Some of their specific recommendations included providing new financial support for undergraduates, investing in innovative approaches to graduate education, assembling information on the skill needs of the S&E workforce, and compensating pre-college science, math, and technology teachers on par with S&E professionals in other sectors.

Even before the final NSB report was issued, however, there were substantial criticisms. A number of organizations, including IEEE-USA thought the report was overly focused on the pipeline and ignored the most important U.S. S&E resource—those Americans already in the S&E workforce. Many current S&E workers, particularly in engineering and IT/CS, are experiencing high unemployment levels that have little connection to the current business cycle and that ought to be examined more thoroughly before encouraging more people to pursue careers in these fields.

A *Science* magazine editorial in February 2004 asked, "Why do we keep wishing to expand the supply of scientists even though there is no evidence of imminent shortages, and most jobs are in the private sector, where they are immune to management by policy fiat?"[35] The authors offer a number of reasons, including 1) since economic progress depends on science and technology, let's have more of a good thing; 2) policies are set mainly by elders who, like the institutions who employ them, have little incentive to change; 3) current academic reward structures and government funding priorities tend to perpetuate the status quo of "training more"; and 4) by producing more knowledgeable workers than can be employed, a labor excess economy is created that keeps labor costs down and productivity high. They suggest that universities provide applicants with placement histories of recent graduates so that potential graduate students can make realistic decisions based on the current job market. Policy makers should also take a hard look at the balance between supply and demand before advocating for more scientists and engineers. Government efforts to drastically increase science budgets, moreover, such as the doubling of National Institutes of Health's budget, should more carefully consider the job market implications.

Others express similar concerns about the lack of data to support claims that there is a shortage of scientists. "Despite recurring concerns about potential shortages of STEM personnel in the U.S. workforce, particularly in engineering and information technology, we did not find evidence that such shortages have existed at least since 1990, nor that they are on the horizon," concluded a 2002 RAND Corporation report.[36]

Michael S. Teitelbaum of the Alfred P. Sloan Foundation argues that if we focus on increasing supply without somehow generating a comparable increase in demand (e.g., by increasing investment in scientific research positions), we will create more scientists than we can employ. Under that scenario, salaries will fall, working conditions will deteriorate, and young scientists—those who have not yet managed to entrench themselves in the workforce—will be hurt the most.[37]

What will this do for the cause of diversity? Many of the policy makers who are calling for workforce expansion admit that a key reason that certain groups are underrepresented in science is that the "effort-to-reward ratio" for entering science is so poor. The best and brightest women and African, Hispanic, and Native Americans (not to mention many Caucasian men) can make more money with less uncertainty and aggravation by working in other fields—most notably medicine, business, and law. Increasing the supply of scientists will only make this situation worse, rendering it harder, not easier, to increase the diversity of the scientific workforce, argue Teitelbaum and others.

Developing a domestic workforce requires addressing demand, not supply, argues Jim Austin.[38] He notes that if the U.S. wants to produce more American scientists, more demand for these scientists must be created by investing in science and by providing incentives for the private sector to do the same. Simultaneously, more faculty and permanent staff positions in university science departments must be created, and the mechanisms—such as extended postdocs and other "training" phases—that artificially depress wages for professional scientists must be disassembled. If this can be done, Austin concludes, wages will rise, employment conditions will improve, and more Americans, including those currently underrepresented in the workforce, will be drawn into science.

Finally, the most recent and in-depth analysis of "Is There a Science Crisis? Maybe Not" comes from Richard Monastersky, writing in the July 9, 2004, issue of *The Chronicle of Higher Education*. He notes that while leaders in academia, government, and industry warn of a labor shortage in the U.S., current indicators point to an oversupply. Indeed, an earlier prediction of shortage in the mid-1980s turned out to be inaccurate and resulted in an oversupply of "frustrated researchers" who became stuck in postdoctoral positions at low wages because of insufficient jobs in academe or industry. Current data, Monastersky says, suggest that the new predictions may replicate the earlier result.

Monastersky identifies the real crisis as not one of quantity but of quality. "Academic institutions need to change to educate students in a much broader context than they do now," says Warren M. Washington, chair of the National Science Board. "You'll be hearing enlightened university presidents talking about this. But down at the department level, there's this focusing only on the narrow sort of discipline objectives. That's where it's going to be hard to make changes."[39]

No one can accurately predict how many scientists and engineers the nation will need over the next couple of decades. But everyone should agree that we must ensure that every U.S. citizen is provided an opportunity to gain the skills and knowledge necessary to compete in the STEM workforce. By so doing, America not only potentially broadens the participation of her citizenry, but the nation also enriches the quality of scientific discoveries and technological advances made by infusing intellectual diversity of perspective throughout the scientific enterprise.[40] But without specific policies and programs that aggressively support greater participation and advancement by all members of the U.S. talent pool, this goal cannot be achieved.

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