Is There a High-Tech Worker Shortage? A Review of the Evidence

Michael Rose, Chief, UI Research, July 1998

Very low national unemployment rates (the 1997 annual U.S. average of 4.9 percent was the lowest since 1973) and relatively robust job growth (2.5 percent last year) have stirred fears of widespread labor shortages in the national economy. With U.S. population growth running at around 1 percent per year and the employment-population ratio currently at a near- record 64 percent, it is possible that the nation's supply of new workers will be insufficient to meet new demand.

Against this backdrop of tight labor markets a national debate has taken place over whether there exists a shortage or surplus of skilled science and engineering workers. Proponents of the shortage view say that output and innovation in some high-tech industries, particularly computer and software related design and manufacturing, is being restricted by a lack of qualified highly-educated workers. At the same time, persons in the labor shortage camp claim that a deficit of skilled employees is forcing up wages and benefits at such a pace that hiring and retention of workers has become problematic as offers of higher wages are bettered by competitors bidding for the same small group of workers. The shortage contention has tended to be propounded most vocally by computer industry and business trade groups.

Critics of this view argue that higher wages alone are not an indication of worker shortages, but may reflect some other market phenomenon, such as rising worker productivity, expanding product markets or high industry margins. They point to several studies indicating not a shortage, but instead, an overproduction of highly-educated science and engineering graduates (i.e., those with Ph.D.s). Additionally, they suggest that any shortages that do exist will be alleviated through market forces as higher wages attract more workers into those fields, thus expanding the available labor supply and driving down pay levels. The oversupply argument is one often expressed by academic researchers and scientists.

The debate has reached well beyond national borders. Supporters of the worker shortage perspective have pushed for the expansion in the number of immigration visas for those holding what they claim to be critical high-tech skills. Predictably, opponents argue that allowing more highly-educated workers into the country will simply add to an existing oversupply of such employees, adding unnecessary competition into the labor market.

In this article we take a brief look at both sides of the argument through a review of some of the research and evidence cited by each side to support its case. Like most hotly contested public policy issues, this one allows for no easy resolution, in part because concepts like labor shortages and underemployment are difficult in practice to identify and measure. As a result, many of the arguments made by both sides rely upon anecdotal and indirect evidence.

Background of the current debate. Public concern and discussion of scientific education is certainly not new. Some readers will recall that fears the U.S. was falling significantly behind the Soviet Union in space related research in the 1950s led to large increases in federal funding for scientific research and development. The spending included not only increased funds for federal laboratories and research, but the development of science related curriculum in educational institutions. Physicist David Goodstein calls the period from the 1950s to the 1970s a "golden age for American science," one in which young scientists were generally assured of adequate monies to support their research as well as high-quality and often, multiple, job offers.

The current debate has its roots in the late 1980s when the National Science Foundation (NSF) projected that a cumulative shortfall of 675,000 scientists and engineers would emerge over the next twenty years. Congress responded by increasing appropriations for science and engineering education as well as expanding the number of permanent visas for highly skilled immigrants.

However, the collapse of the Soviet Union and the concomitant paring of defense expenditures, along with a global economic slowdown in the early 1990s, restricted employment opportunities for science and engineering professionals. Restructuring and cutbacks in the computer industry during this time also took their toll on employment levels of highly skilled and educated workers. Finally, many states began experiencing lower revenue growth due to weak regional economies, and cut back on funding for higher education, thereby limiting the number of available university and college teaching positions. By the mid-1990s, a number of reports appeared claiming that economic prospects for advanced degree holders in science and engineering were declining due to a shortage of employment vacancies requiring advanced skills.

Too many Ph.D.s? In 1995, a study by researchers at the Rand Corp. and Stanford's Institute for Higher Education Research concluded that U.S. universities were producing something like 25 to 50 percent more new doctorates in some sciences, mathematics, and engineering than could find work requiring those skills. [1] The report, known as the Massy-Goldman study after its authors, found that the number of doctoral programs admissions were driven by the departments' need to produce teaching and research assistants rather than job opportunities for new graduates. Additionally, the authors questioned whether increased government research funding would do much to ameliorate the oversupply, suggesting instead that the glut would reappear as soon as funding leveled off.

The study was attacked on technical and methodological grounds. After adjusting for what they considered to be problems with the use and interpretation of data, critics suggested that the overproduction of Ph.D.s, if it occurred at all, was much lower than the Massy-Goldman report indicated, perhaps something on the order of 5 percent. They also noted that the report relied upon simulated models of supply-demand, rather than actual labor market surveys of Ph.D. recipients regarding their work history. Lastly, some critics took issue with an aspect of the Massy-Goldman model which considered Ph.D.s to be underemployed if they were employed outside academe. [2,3]

A 1997 report by The National Science Foundation's Science Resources Studies Division examined employment trends of scientists, engineers, and technicians in the portion of the services sector that includes trade, transportation, communications, and utilities (SICs 40-59). [4] Using data from the Bureau of Labor Statistics Occupational Employment Statistics survey, it found that between 1988 and 1994, the total number of employed scientists, engineers and technicians in this subset of services declined from 472,500 to 422,700, a drop of 10.5 percent. Little change occurred between 1988 and 1991, with virtually all of the reduction taking place after 1991.

The study found that technicians fared worse than scientists and engineers over this time with employment drifting down from 270,500 to 258,900 between1988 and 1991 before slipping

further to 237,500 in 1994. On the other hand, both scientists and engineers saw employment gains between 1988 and 1991. However, after 1991 each occupational group experienced declines, with scientists suffering a drop from 63,900 to 55,400 and engineers a loss from 155,100 to 129,800.

While the report did not directly address the labor force status of Ph.D.s it did seem to suggest that the employment prospects of that group diminished in the early 1990s. Another NSF issue brief around the same time dealt more directly with the question of labor market outcomes of persons with science and engineering doctoral degrees. [5] This report noted the strong inverse relationship between education level and joblessness, i.e., unemployment tends to decrease as education level rises. The report also observed that not only were Ph.D. unemployment rates lower than other unemployment rates, but overall unemployment fluctuated less for persons with Ph.D.s than other groups. Finally, the summary noted that little correlation seemed to exist between jobless rates for science and engineering Ph.D.s and overall unemployment rates.

For the period 1973-95 jobless rates for persons with science and engineering Ph.D.s was extremely low, ranging between roughly 1 and 1.5 percent, and peaking at 1.6 percent in 1993. In comparison, the rate for the general population during the same period was considerably higher, varying between about 5 and 10 percent. However, the historically high rate for Ph.D.s in 1993 agrees with the notion that the labor market for skilled science and engineering graduates had worsened during the early 1990s. A separate survey of new mathematics Ph.D.s also supported the idea that labor market conditions had deteriorated for highly-educated workers during the first half of the 1990s. The survey found that the jobless rate for mathematics Ph.D.s jumped from 2.5 percent in 1990 to 13.2 percent in 1994. [6]

Not enough high-tech workers? While the market for high-tech workers appeared to soften during the late 1980s and early 1990s some recent studies have again raised the specter of worker shortages in the information technology (IT) field. Although defined in a variety of ways, IT is generally considered to include a combination of industry groups such as communications equipment manufacturing, communications services, software and computer design, sales, and services, and computer and electronic manufacturing.

According to *The Emerging Digital Economy*, U.S. Department of Commerce, April 1998 which documents the expanding impact of technology on the U.S. economy, IT industries as defined by Commerce currently account for roughly 8 percent of national GDP. [7] More important, it is estimated that anywhere from 25 to 40 percent of the nation's overall real economic growth since 1995 can be attributed to information technology businesses. Moreover, high-tech industry wages are much higher than total private sector annual wages-- $48,000 compared with $28,000 in 1996νν and have been increasing at a faster pace since the mid-1980s. Finally, it is suggested that investments in information technology have been responsible for much of the recent productivity increases in the U.S. economy, thereby allowing wages to rise even within non high-tech sectors and occupations while acting to restrain prices.

Based upon data from the Bureau of Labor Statistics (BLS), the Commerce Department projects that employment in IT sectors will grow at a 3.0 percent annual rate from 1996 to 2006, more than twice as fast as the U.S. average of 1.4 percent. The BLS estimates that 4.2 million people worked in IT-related occupations in 1996 and that by 2006 this number will expand to 5.6 million, an increase of 33 percent. Overall employment growth, in contrast, is expected to gain 14 percent over the same period.

The BLS predicts that the demand for higher-skilled IT jobs (those requiring at least a four-year degree) will climb rapidly between 1996 and 2006 while growth in lesser-skilled IT jobs should decline. For example, the three fastest growing occupations according to the BLS will be computer scientists, computer engineers, and systems analysts, which are expected to more than double in size from 934,000 to 1,937,000 by 2006. [8] At the same time, lesser-skilled jobs like computer operators, requiring a high school diploma, are expected to shrink from 481,000 to 342,000.

In *America's High-Tech Workforce*, the American Electronics Association (AEA), an industry trade group, expresses the concern that a shortage of skilled science and engineering workers either already exists or will soon emerge. [9] Given the vital contributions to the nation's economic health, the AEA report contends that anything that threatens to slow the information technology industry's growth will likely be harmful to the overall economy. This scenario implies fewer high-wage jobs, higher inflation, and lower levels of productivity and output.

The AEA summary essentially compares recent trend decreases in the number of U.S. science and engineering graduates with BLS projected occupational growth rates and argues that demand will shortly exceed the supply of available qualified high-tech workers. For instance, the report notes that the number of U.S. engineering graduates with bachelor's degrees declined from nearly 77,000 in 1985 to 65,000 in 1997. The measure of other U.S. science related degrees awarded since the mid-1980s has fallen sharply as well. Between 1985 and 1995, the number of bachelor's degrees earned in mathematics and computer science dropped from 54,510 to 38,620 while the number of degrees earned in electrical engineering fell from 23,742 to fewer than 15,000.

Another 1997 study by the Commerce Department uses a similar methodology to advance the skilled labor shortage idea. [10] In addition, this report cites rising wages and a large number of unfilled IT jobs as evidence of a labor shortage. Quoting from a variety of compensation surveys, the report indicated that for some groups of IT professionals salaries have risen between 10 and 20 percent since 1995. Finally, a survey of employers conducted by the Information Technology Association of America (ITAA) placed the number of vacant IT-related jobs at 190,000 in 1996.

However, Norman Matloff, a computer scientist at UC Davis, counters that, at least for computer programmers and software engineers, there is no shortage. Using anecdotal evidence from technology industry hiring managers, Matloff believes that hiring rates for programming applicants run in the 2 to 5 percent range. [11] He argues that such extreme hiring selectivity points to a glut of qualified workers rather than a shortage.

Still, the combination of a declining number of science and engineering graduates, brisk IT job growth, and sharply rising wages would seem to lend compelling support to the idea of a skilled labor shortage. The U.S. General Accounting Office (GAO) recently criticized such an approach to identifying skilled labor shortages. [12] The GAO noted that information technology workers, like those in other industries, have a wide variety of educational backgrounds and training. For this reason using the number of science and engineering graduates as an indicator of the availability of IT skilled labor is both unproven and unreliable.

The GAO criticized other aspects of the Commerce study as well. Although rapidly increasing

wages might indeed be symptomatic of an undersupply of IT workers, the GAO distinguished between long-and short-term labor shortages. In particular, they mention that weekly earnings for persons in computer occupations rose at about the same rate as for other skilled professional occupations between 1983 and 1997. The GAO also found fault with the ITAA employer survey used to approximate the extent of unfilled job vacancies in IT industries. The survey's low response rate and the lack of information regarding the nature of the unfilled positions led the GAO to conclude that the survey's findings were highly unreliable.

The role of foreign workers. The use of foreign workers has assumed increasingly greater importance in the labor shortage discussion. About one-half of all engineering Ph.D.s in the U.S. are awarded to non-U.S. citizens; the percentage is about the same in mathematics, physics, chemistry and computer science. [9,13] With the number of temporary visas issued to highly-skilled foreigners capped at 65,000 per year, there was concern that many of these individuals would be unable to find employment in the U.S. The nation would thus lose a valuable source of training, education and expertise at a time when such skills are growing more scarce. Swayed by arguments by the IT industry that foreign workers are necessary to compensate for the lack of skilled U.S. labor, the U.S. Senate recently voted to increase from 65,000 to 95,000 the number of temporary visas issued to highly skilled foreign workers.

For many who believe no shortage exists, the use of foreign workers represents an attempt by the IT industry to reduce pay levels or save employers the cost of retraining workers skilled in different technologies. [11,12] The Institute of Electrical and Electronics Engineers (IEEE) supports retraining technical and professional workers laid off in previous industry cutbacks rather than loosening immigration restrictions for IT workers. Some analysts support liberalized immigration rules for highly skilled workers while conceding that there may be some adverse affect on wages. [13]

Conclusion. It has been said that the Forecasters Hall of Fame is an empty room. As a 1993 Federal task force charged with examining the supply of science, engineering, and mathematics professionals stated "It is not currently possible-- and will probably never be possible to predict with a high degree of accuracy-- quantitative shortages or surpluses of scientists and engineers several years into the future." [14]

A review of the evidence on the supply and demand for high-skilled IT workers suggests that labor market conditions for this group eroded during the late 1980s and early 1990s. The end of the Cold War, a national recession, and a cyclical downturn affecting IT related businesses all contributed to weak job markets for these workers. However, even during this slack labor market, overall unemployment rates for science and engineering professionals remained very low.

The extent to which the market for IT employees has since recovered is unclear. Part of the confusion arises from lumping together academic and non-academic professionals since the labor markets for these two broad categories of workers are often distinct. It is possible that demand for certain types of science and engineering Ph.D.s in higher education has remained relatively soft while private sector demand for Ph.D.s has increased. Moreover, workers can move across occupational categories with relative ease, making judgments about supply and demand more difficult. Because many IT workers have backgrounds other than science and engineering, it is difficult to determine how closely the supply of IT employees is linked to the number of science and engineering graduates.

With jobless rates hovering at twenty-five year lows and relatively low labor force growth, it is not surprising that both IT and non-IT businesses alike are reporting difficulties in attracting and retaining workers. In particular, the high-tech labor market is likely to be influenced by recent developments in Asia. Many high-tech U.S. firms rely upon growing demand in Asia and other emerging global markets to support their continued expansion. The Asian financial crisis threatens to significantly curb demand for high-tech U.S. products and slow employment growth within these sectors, thereby helping to ease fears of IT labor shortages.

Endnotes (Dates in parentheses are access dates for online sources)

[1] Stanford University Press Release. "Doctorate surplus in science, engineering is ongoing, researchers say." Available: http://physics.ucsc.edu/users/noc/Links/native/massyreport.html. (March 24, 1998).
[2] "Massy-Goldman report alleging 50% CSE Ph.D. overproduction to be re-issued due to flawed data." Available: http://www.cs.washington.edu/homes/lazowska/production.html. (March 24, 1998).
[3] Syverson, Peter D. "When Simulation Becomes Reality." Available: http://www.cgsnet.org/vcr/CCTR508.htm. (May 14,1998).
[4] Morrison, Richard E. National Science Foundation, Science Resources Studies Division Data Brief, NSF 97-322. Available: http://www.nsf.gov/sbe/srs/databrfsdb97322.htm. (April 9, 1998).
[5] Shettle, Carolyn F. National Science Foundation, Science Resources Studies Division Data Brief, NSF 97-318. Available: http://www.nsf.gov/sbe/srs/databrfsdb97318.htm. (April 9, 1998).
[6] Davis, Geoff. "Mathematicians and the Market." Available: http://www.cs.dartmouth.edu/`gdavis/policy/papers/html/market.html. (March 24, 1998). Unemployment rates are from surveys conducted by the American Mathematical Sociey and the Mathematical Association of America.
[7] U.S. Department of Commerce, The Emerging Digital Economy, April 1998. The Appendix pp. 1-44 contains estimates of information technology's contribution to economic growth as well as differences between the Commerce Department's definition of high-tech and that used by other groups, such as the AEA.
[8] Silvestri, George T. Monthly Labor Review, "Occupational employment projections to 2006," November 1997.
[9] American Electronics Association, "America's High-Tech Workforce," April 1998.
[10] U.S. Department of Commerce, America's New Deficit: The Shortage of Information Technology Workers, September 1997. Available: http://www.ta.doc.gov/otp/Reports.htm. (May 27, 1998). A more recent survey by the ITAA puts the number of vacant IT positions at 346,000.
[11] Lardner, James. "Too Old to Write Code?" Available: http://www.usnews.com/usnews/issue/980316/16soft.htm. (March 24, 1998).
[12] U.S. General Accounting Office, "Information Technology: Assessment of the Commerce Department's Report on Worker Demand and Supply," April 1998. Available: http://www.gao.gov/new.items/bysubject.htm#8. (May 26, 1998).
[13] Bhagwati, Jagdish and Rao, Milind. "The Economics of Academic Immigration Explained by Pro-Immigration Economists." Available: http://www.mit.edu/afs/athena.mit.edu/user/e/r/erw/Public/BhagwatiFull.html. (March 24, 1998).
[14] Report of the Ad Hoc Working Group on the Supply of Science, Engineering and Mathematics (SEM) Professionals. Available: http//www.nsf.gov/sbe/srs/fccset/htmstart.htm.

(April 9, 1998).