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IT employment prospects: beyond the dotcom bubble

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Abstract

In the 1990s, enrollments grew rapidly in information systems (IS) and computer science. Then, beginning in 2000 and 2001, enrollments declined precipitously. This paper looks at the enrollment bubble and the dotcom bubble that drove IT enrollments. Although the enrollment bubble occurred worldwide, this paper focuses primarily on U.S. data, which is widely available, and secondarily on Western Europe data. The paper notes that the dotcom bubble was an investment disaster but that U.S. IT employment fell surprisingly little and soon surpassed the bubble's peak IT employment. In addition, U.S. IT unemployment rose to almost the level of total unemployment in 2003, then fell to traditional low levels by 2005. Job prospects in the U.S. and most other countries are good for the short term, and the U.S. Bureau of Labor Statistics employment projections for 2006–2016 indicate that job prospects in the U.S. will continue to be good for most IT jobs. However, offshoring is a persistent concern for students in Western Europe and the United States. The data on offshoring are of poor quality, but several studies indicate that IT job losses from offshoring are small and may be counterbalanced by gains in IT inshoring jobs. At the same time, offshoring and productivity gains appear to be making low-level jobs such as programming and user support less attractive. This means that IS and computer science programs will have to focus on producing higher-level job skills among graduates. In addition, students may have to stop considering the undergraduate degree to be a terminal degree in IS and computer science.

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Introduction

The enrollment bubble

Enrollments in information systems (IS) and computer science plunged after the dotcom bubble burst in 2000 and 2001. To give one example, Figure 1 shows how enrollments soared and then collapsed in the undergraduate management information systems (MIS) program at the University of Hawaii. Almost all other IS programs experienced similar post-bubble enrollment declines.

We do not have comprehensive data on enrollments or graduations in IS. In computer science, however, which experienced a similar enrollment bubble, the statistical situation is far better, at least in the United States and the United Kingdom. Most importantly, the Computer Research Association's Taulbee Survey reports annually on the number of students who newly declare a computer science major in U.S. doctoral degree-granting

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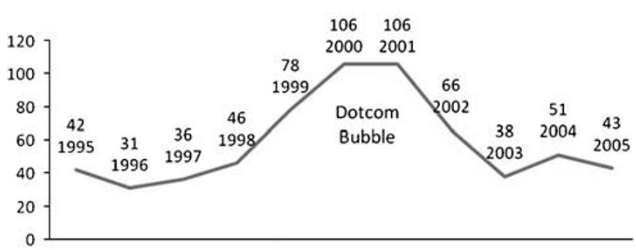

Figure 1 Enrollment in the University of Hawaii Undergraduate MIS Program, 1995–2005. *Source*: University of Hawaii.

institutions (http://www.cra.org/statistics/). Figure 2 shows that the number of new declarations peaked in autumn 2000 at about 16,000 students, then declined to about half that number in autumn 2005.

Figure 2 begins near the peak of the bubble and does not show the beginnings of the bubble's expansion. Looking farther back in time, Figure 3 shows U.S. National Science Foundation data for computer science *graduations* in the United States (rather than major declarations). The figure shows that computer science did see a rapid rise in enrollment in the 1990s. The drop-off shown in Figure 2 was not merely a collapse from a long-term average.

Figure 3 also shows that the recent bubble is not the first enrollment bubble that computer science departments experienced in the United States. Beginning about 1980, undergraduate computer science graduations grew very rapidly, peaking in 1986 at 42,195. Graduations then fell to about 25,000 and stayed there until the dotcom bubble drove enrollment upward again.

The IS/computer science enrollment bubble is not just a U.S. concern. It has been reported in several other countries as well. In the United Kingdom, there is especially good data from the Higher Education Career Services Unit. The unit surveys graduating students in the U.K. each summer. In 2005, the unit reported that the number of computer science degrees awarded in the U.K. fell by half from its peak (McCue, 2007).

For Ireland, we have limited data (Smith, 2008). Dublin City University graduated 224 students in its computer course in 2005; by 2007, it dropped to 78. At University College Dublin, the number of computer science graduates dropped from 76 in 2005 to 33 in 2007.

Even if IS enrollments have stopped falling, as some data indicate, many IS programs are concerned that they are at or below the enrollment levels they need for survival. In addition, IS and computer science programs may not be providing enough graduates to meet the needs of U.S. organizations. The end of the decline does not mean the end of enrollment worries.

Student job concerns

Since 2002, the author has conducted focus group studies with general business students and IS students at his university. (The author started his academic career

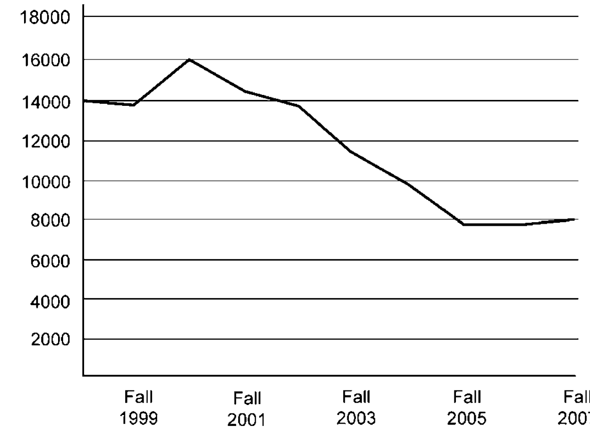

Figure 2 Newly declared computer science and engineering undergraduate majors. *Source*: Computer Research Association Taulbee Survey (Zweben, 2007).

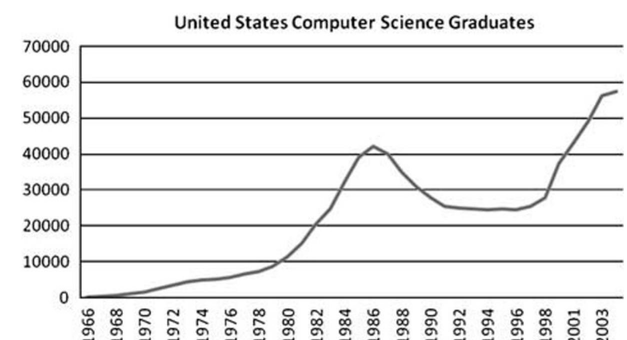

Figure 3 Computer science graduates in the United States. *Source*: National Science Foundation [undated].

teaching marketing research.) These focus groups indicated that there is a deep belief among both IS majors and non-IS students that the career outlook for IS professionals is poor. Students were frightened by poor employment opportunities right after the dotcom bust, and they were also concerned with the longer-term issue of job offshoring to less-developed countries. Of course, job concerns are probably not the only things preventing more students from selecting IS as a major, but the focus groups did suggest that beliefs about career prospects need to be addressed with high priority.

Making the picture more complicated, there seems to be a good deal of misinformation about what happened to IT job opportunities during the dotcom bubble. For example, many believe that unemployment among IS professionals rose to very high levels. In fact, as we will see later, IT unemployment never even reached the level of overall U.S. unemployment. In addition, it is not common knowledge that the number of IS jobs actually surpassed their level at the dotcom peak in 2005 and that the U.S. Bureau of Labor Statistics (BLS) projects continued rapid growth in U.S. IT employment (as we will also see below). Unless IS programs could present an accurate picture of what happened to IS jobs and what is likely to happen in the future, it will be difficult to address student concerns about starting a career in the field.

IS programs also need to address the issue of offshoring. This is more difficult, but it is not impossible.

This paper

The remainder of this paper is divided into four parts.

- The next section deals with the dotcom bubble and what really happened in terms of the U.S. stock market, corporations, e-commerce, and jobs.
- The following section presents the BLS projections for computer specialty and computer management occupations for 2006–2016.
- Next, the paper discusses offshoring and its potential and likely effects on the IT workforce.
- The paper closes with a Discussion section that recaps key points, considers other issues related to student choice, and proposes both research and possible actions to take to increase enrollment.

The dotcom bubble

Most people believe that the IS/computer science enrollment bubble was driven by the general dotcom bubble, and this certainly seems to be true based on the enrollment bubble's timing. But it is important to understand the dotcom bubble in more detail and to understand its different impacts on various groups and economic variables.

Market bubbles

There is nothing surprising about industry bubbles in new markets that have great potential for wealth. For instance, when railroads began to appear in the 1840s, there were many corporate entrants. Then, from 1847 to 1858, there was a series of large shakeouts in the railroads industry around the globe (Grodinsky, 1999). More recently, we have seen several shakeouts in PC manufacturing and in various types of video equipment.

Market bubbles, while painful to many investors and employees, are not entirely bad. During the growth of the bubble, too many firms are competing for a limited market, and profitability is rare. After the bubble, however, there is a chance for the remaining firms to become profitable.

The dotcom stock market bubble

A good date for the beginning of the dotcom bubble is 1995. Even before then, the rapid growth of the internet had begun to attract interest from businesses and entrepreneurs. The internet was widely seen as a potential way to reach enormous numbers of customers. However, the backbone of the internet was the NSFNet, which prohibited commercial activity. Commercial ISPs connected to the NSFNet backbone had to respect the prohibition. In 1994, it became clear that NSFNet would soon be discontinued, and with it the prohibition against commercial activities. The internet would become wholly supported by commercial ISPs in the United States (and soon in most of the world).

When NSFNet finally ended service in April 1995, a land rush of commercial activity began. Familiar names such as Amazon.com and eBay.com opened for business, and traditional brick-and-mortar companies such as Dell and Cisco began to sell online.

Perhaps most notably, Netscape, which produced the first popular browser, went public in 1995 with an initial public offering (IPO) (Lashinsky, 2005). The Netscape IPO was planned to start at $14 per share, but this was raised to $28 per share just before the IPO was opened for sale. By the end of the first day, Netscape stock was selling for $58 per share. Spurred by Netscape's success, other IPOs soon followed. In 1995, the tech-heavy NASDAQ Composite Index passed 1000 for the first time.

Stock prices continued to grow rapidly as many more companies began to engage in internet business and as investors began to extrapolate what would be possible as the internet continued its exponential growth. Figure 4 illustrates how rapidly the NASDAQ Composite Index grew.

This rapid growth in stock prices concerned regulators. On 5 December 1996, the chairman of the U.S. Federal Reserve Bank, Alan Greenspan, warned in a speech that investors seemed to be engaging in 'irrational exuberance' in the prices they were paying for many stocks (Federal Reserve Board, 1996). Greenspan was specifically concerned that if stock prices became unrelated to value, then monetary policy would become ineffective. Greenspan's speech led to a small and brief market dip. The NASDAQ soon continued its explosive growth.

During 1999, the market grew even faster. The year ended with the NASDAQ at about 4000 – an 84% growth in a single year. In 1999, Webmergers.com reported that there were 457 IPOs (investopedia.com). Among this large number of firms going public, 117 doubled in price on the first day.

Although some investors believed that these soaring share prices were not sustainable, there was a widely held belief in 1999 that the world had entered a 'new economy' in which the rules had changed substantially. Investing unprecedented percentages of revenues in marketing in order to 'go big first' was widely viewed as an intelligent way to run internet businesses. Another factor generating enthusiasm was that the U.S. economy was going through a prolonged 10-year 'warm period' without a recession (National Bureau of Economic Research, 2008). This expansion period was the longest since World War II and was twice as long as the average expansion period after World War II. In fact, preceding the brief recession in 1990 and 1991, the end of which marked the beginning of this warm period, America had experienced the *second* longest expansion period since World War II (National Bureau of Economic Research,

Figure 4 The NASDAQ Composite Index. *Source*: NASDAQ.

2008). Some even speculated that recessions were a thing of the past.

In 1999, the U.S. Federal Reserve Board under Alan Greenspan began to increase interest rates. The Fed increased the prime rate six times, beginning in July 1999, raising it from 8 to 9.5%. Although the last two increases came after the NASDAQ bubble peaked, it was clear to investors that expected returns from investments had to increase. That could only happen if stock prices fell.

The NASDAQ continued to grow until 10 March 2000, when the NASDAQ Composite Index finished at 5046. The next day, it began to sink. It rallied a few times at lower levels, but these pauses were only temporary. By the end of the year, the index had fallen to half of its peak value and was continuing to fall. The NASDAQ Composite Index finally bottomed out at 1114. It did not recover to half of its peak value until 2007.

The dotcom failure had a devastating impact on investors. Although the loss of money was simply the loss of 'paper profits,' many households and corporate investors that formerly felt rich had to make sharp changes in their plans. In addition, real wealth was transferred from some investors to others. Some sold all of their stocks before the bubble burst, making large profits. Others, who started investing when prices were high, experienced devastating losses.

Impacts on companies

The market crash in March 2000 did not affect most dotcom companies immediately. Soon, however, internet companies that had been burning through their initial investments at astounding rates needed follow-on funding to continue their growth and sometimes even to support their basic operations. Given the low value of technology stock prices then, further stock offerings brought little money for the shares they cost. Very quickly, this 'mezzanine' financing became difficult to find and ruinously expensive where it could be found. A few months after the investment bubble burst, dotcom companies began to fail. According to Webmergers.com (D'Hippolito, 2001), 555 new internet companies failed between January 2000 and June 2001, with 75% of these failures occurring after November 2000.

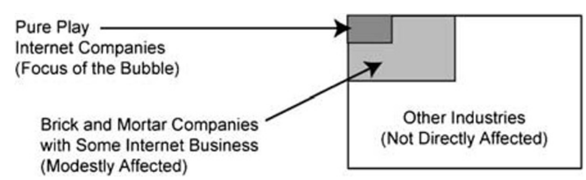

Figure 5 Impacts on corporations.

Although the failure of many internet stocks was widely publicized, it was not as catastrophic as the media made it seem at the time. As Figure 5 shows, the bubble only affected a small number of firms directly. These were the 'pure-play' internet companies whose fate was completely linked to the internet. Pure-play companies were the focus on the dotcom investment bubble. These firms received a great deal of publicity, but pure-play internet companies were never a large part of the corporate universe.

Even within the internet world, pure-play companies were a small part of the story. Most firms involved in e-commerce were and still are brick-and-mortar companies that expanded into e-commerce, such as Dell, Cisco, and Sears. Few of these companies went out of business.

Third, most companies in the economy had little or no commercial activity on the internet. They were not directly impacted by the bubble at all.

The dotcom bust, then, was dramatic but limited in its impact on corporations. In fact, if most of the internet press had not been located in Silicon Valley, the impact on corporations probably would not have been played up as much as it was.

Even among pure-play internet companies, the rate of corporate shakeouts was not unprecedented. In 2004, researchers were given the records of a failed venture capitalist firm on the condition of anonymity (Goldfarb *et al.*, 2007). The records included information about 1142 internet firms in which the venture capitalist company had invested. These firms spanned a wide range of types, sizes, and focuses. A study analyzed the 788 firms that actually began operation by 2000 (Goldfarb *et al.*, 2007). It found that 48% of these firms were still in business in 2004. This represented about a 20% annual rate of decline, which the authors noted was normal in previous bubbles in other industries, including automobile manufacturing, tires, TV manufacturing, and the manufacturing of penicillin. In fact, it was among the lowest rate of decline among the industries they studied.

Why, then, had the decline seemed to be so dramatic? Goldfarb *et al.* (2007) found that declines were particularly strong in extremely large and well-known dotcom firms. (In fact, they suggest that not enough smaller dotcom companies, which were free of the 'get big fast' philosophy, were funded during the bubble.) Presumably, the news media focused especially on them.

Impacts on e-Commerce

Although many investors lost money and many dotcom companies failed, this had almost no impact on the growth of e-commerce. U.S. retail sales in recent years have grown about 3% per year on average (Shellock & Mackenzie, 2008). In 1999, e-commerce accounted for only 0.7% of all consumer retail sales (United States Census Bureau, 2008). Except for the recession year of 2001, when e-commerce growth stalled, e-commerce continued to grow much more rapidly than total consumer retail sales. In 2007, e-commerce had risen to 2.9% of total consumer retail sales. This was a compound annual growth rate of 19.5% in percentage of commerce and about a 23% rate of total increase. The dotcom bust was a corporate problem, not a market problem.

Impacts on the economy

As noted earlier, the U.S. economy enjoyed an expansion of unprecedented length during the 1990s (National Bureau of Economic Research, 2008). This expansion continued until March 2001 – roughly a year after the NASDAQ bubble began to burst. At this point, the economy experienced a recession that had an 8-month contraction period that ended in November 2001. Note, based on timing, that the recession did not cause the bubble to burst. In fact, the bubble could plausibly have been a factor leading to the recession.

In most expansions, employment picks up rapidly. The expansion that began in November 2001, however, was largely productivity-driven, and employment in general picked up very slowly (National Bureau of Economic Research, 2003).

Impacts on IT unemployment and employment

With the preceding information as prologue, we can now turn to the core concern of students after the dotcom bubble – job prospects. Many people believe that the dotcom bust created a deep and long-lasting crater in IT employment. Actually, this was never the case. Figure 6, which extends an analysis done in 2005 by Richard Baskerville at Georgia State University, shows that although IT unemployment did increase following the dotcom failures, it did not skyrocket. Although the IT unemployment rate roughly doubled, it never even reached the national unemployment rate. Note, by the way, that peak IT unemployment came in 2002 and 2003 – a year after most dotcom corporate failures. After that, unemployment quickly fell to its historically low pre-bubble levels, reaching these levels by 2005.

Turning from unemployment to employment, Figure 7 looks at IT *jobs* after the dotcom bust. It shows that total IT employment experienced only a moderate dip, which reached its minimum in 2002. Employment rebounded the next year. By 2005, IT employment actually surpassed IT employment at the peak of the bubble. By 2007, IT employment was 6.9% higher than at the bubble's peak. Again, the dotcom collapse had only been limited to certain industries. It would be good to have earlier data on IT employment, to see how much it grew during the dotcom bubble. Unfortunately, the data series began near the end of the bubble.

Although IT unemployment was never a national crisis, it was not moderate everywhere. Most importantly, it was particularly bad in Silicon Valley. Overall unemployment in San Jose jumped to 9.1% in January 2003 (Reynolds, 2004). However, in other locations, the impact was much

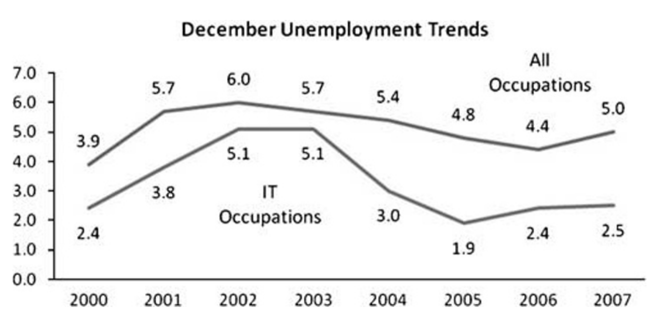

Figure 6 IT unemployment in the United States. *Source*: Bureau of Labor Statistics.

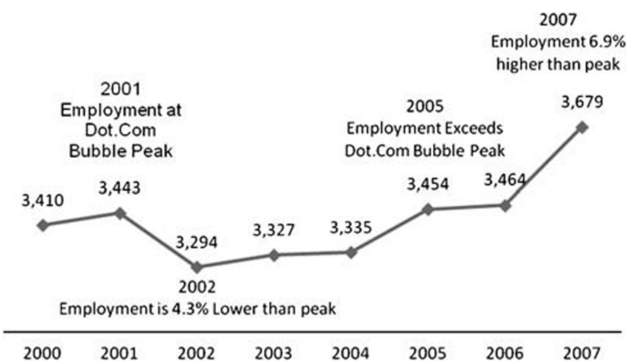

Figure 7 U.S. IT employment (in thousands). *Source*: Current Population Survey, Bureau of Labor Statistics.

smaller. In fact, Virginia, Maryland, and West Virginia saw increases in IT employment (Reynolds, 2004) during the same time. Of course, Silicon Valley, as noted earlier, is the home of the internet industry's main news media. So it is not surprising that the industry press focused myopically on the unique Silicon Valley situation.

While the overall job situation was never as bad as many believed, unemployment is always is highest among new hires, and that means new graduates. While the IT unemployment rate never became high in general, new graduates had a far more difficult time getting jobs. In addition, during and after the 2001 recession, many companies froze hiring just as they do in most recessions. In the U.K., unemployment among computer science graduates was still at 10.3% in 2005 (McCue, 2007).

Immediately after the bubble collapsed, new graduates told lower-level students about their problems finding jobs. The shock wave quickly propagated back to freshmen and even to high school students. However, IT's aura was deeply tarnished.

The 2006–2016 BLS employment outlook study

What does the future hold? The best source of information about future jobs in the United States is the BLS, which is the data gathering and analysis arm of the U.S. Department of Labor. The BLS has many programs and conducts a large number of surveys (http://www.bls.gov/bls/proghome.htm). Together, these programs and surveys give the Bureau rich and detailed data on U.S. employment.

Every 2 years, the BLS creates 10-year employment growth projections for employment growth as a whole and for employment within various occupational categories. In this section, we will discuss the 2006–2016 projections, which were released in December 2007 (Dohm & Shniper, 2007; Franklin, 2007). A good source for information about these projections is the BLS's press release, which is found at http://www.bls.gov/news.release/ecopro.toc.htm.

Occupational categories

The projections use the U.S. Department of Labor's Standard Occupational Classification system (SOC). SOC divides all occupations into 23 major groups. These groups are listed at http://www.bls.gov/soc/soc_majo.htm. That webpage also has a link to the user's guide, which has more detail on the classification system. Below the level of the major groups, there are 96 minor groups, 449 broad occupations, and 821 detailed occupations.

We will focus on detailed occupations under the minor group 15-1000 (computer specialists). Data for this minor group are available at http://www.bls.gov/soc/soc_c0a0.htm. We will also consider 11-3021 (computer and IS managers).

Logically, we might be expected to focus on the broad occupational categories under the computer specialists minor group, but most broad occupational categories in this minor group consist of a single detailed occupational category. Consequently, we will focus on detailed occupational groups.

Programming and systems analysis Traditionally, IS majors became programmers and eventually systems analysts. This career path is still very common, but it is no longer dominant. In addition, it has become somewhat more complex.

- *Programmers (15-1021)*. The SOC 'programmers' category counts lower-level software developers who create programs from specifications created by others.
- *Computer software engineers (15-1030)*. This category is for higher-level software developers who use advanced software engineering tools and disciplines. SOC divides computer software engineers into computer software engineers, applications (15-1031), and computer software engineers, systems software (15-1032). Only the former jobs are likely to be attainable for IS graduates.
- *Computer systems analysts (15-1051)*. These computer specialists analyze the current system, design a new system, and create specifications for programmers and software engineers.

While the distinction between programmers and computer software engineers is sharp in theory, it is often murky in practice. Some companies, for instance, routinely call new hires with few software engineering skills 'software engineers' for morale purposes. Nevertheless, the basic picture appears to be fairly robust: programming jobs require fewer skills than software engineering jobs.

Other IT occupational categories

- *Database administrators (15-1061)*. In addition to teaching students to be programmers and analysts, IS programs usually cover other functional specialties, such as database and networking. SOC has a minor category for database administrators.

- *Network systems and data communications analysts (15-1081)*. SOC has a minor category for network systems and data communications analysts.
- *Network and computer systems administrators (15-1071)*. There is also a category for network and computer systems administrators. These are systems administrators and people who manage networks on an ongoing basis. These are lower-level occupations than network systems and data communications analysts. Although database administrators are also called 'administrators,' database administrators require a higher level of training and education than network and computer systems administrators.
- *Computer support specialists (15-1041)*. These IT specialists primarily are help desk employees. Although this is a large occupational category, it only requires low-level knowledge.

Computer and IS managers So far, we have looked at the 15-1000 minor occupational group for computer specialists. Of course, computer specialists need managers. As noted earlier, *computer and IS managers* are counted in 11-3021.

Limitations of the SOC system The SOC system is very good, but it has two significant limitations for IS educators. The first is that SOC does not make distinctions between the types of jobs that typically go to IS graduates and those that typically go to computer science graduates. For some occupations, reasonable inferences can be drawn, but this is not generally the case. The other limitation is that SOC does not fit emerging specialties in IS, most notably IT security.

A new version of SOC is scheduled for 2010. It may change occupational definitions among computer specialists.

Projection methodology

The BLS has developed 10-year employment projections biennially since the 1970s. The core methodology, which is described in the *BLS Handbook of Methods* (http://www.bls.gov/opub/hom/home.htm), has not changed fundamentally since the late 1970s. As Chapter 13 of the Handbook discusses in some detail, the BLS takes a series of six steps to arrive at its employment projections (http://www.bls.gov/opub/hom/homch13_a.htm). These steps involve Bureau of the Census data and data from many other sources, including the monthly Current Population Survey.

- The BLS first develops a projection for the size and demographic composition of the labor force during the projection period. This involves census data, immigration data, projected retirements, and changes in labor force participation rates among important groups. Importantly, the 2006–2016 period will see the retirement of many of the 'Baby Boomers' born after World War II. This first step gives the size of the available labor force by the end of the period.
- Second, the BLS projects growth for the aggregate economy.
- Based on the first two steps, the BLS projects the final demand for the gross domestic product (GDP) at a finer level of detail by consuming sector and product.
- The BLS then projects inter-industry relationships in terms of which industries consume the outputs of other industries. This relies on a sophisticated input–output matrix.
- Next, industry output determined in the previous step is linked to employment in these industries.
- Finally, the BLS uses information from the previous two steps to project employment growth by occupation.

The Bureau attempts to be transparent about the assumptions it makes in its analysis. For instance, it has documented its assumed productivity growth rate in detail. It also discloses in detail its assumptions about what conditions will and will not change in the economy during the projection period.

How good are the BLS projections? The BLS does periodic retrospective analyses on its projections. These are published occasionally in the *Monthly Labor Review*. The most recent review found that the 1988–2000 projections had been quite good, although a little conservative (Alpert & Auyer, 2003). Similar conclusions were also reported by Rosenthal (1992) in an earlier study.

The projections

Having looked at the methodology used in the projections, we will now turn to the projections themselves, beginning with the information shown in Figure 8.

Computer specialist job growth rates The BLS projects that the total number of jobs of all types will grow by 10.4% during the 10-year period between 2006 and 2016. The number of computer specialty jobs is expected to increase more than twice as quickly – by 25.2%.

Five computer specialist occupations are projected to grow even more rapidly during the period. On a percentage growth basis, the first four are among the 30 fastest-growing occupational categories of all types, and the fifth is only slightly behind.

- *Network systems and data communications analysts* have the fastest projected percentage growth rate among all 821 detailed occupational categories in the SOC system (not just among computer specialists). Jobs in this category are projected to grow by 53.4% – almost five times faster than total employment.
- *Computer software engineers, applications* are expected to grow almost as quickly, by 44.6%. This growth rate is fourth among all detailed occupational categories.
- *Computer systems analysts* place 23rd among all detailed occupations in percentage growth rate, with a projected growth rate of 29.0%.

Occupation	SOC Code	Actual 2006 Jobs (x1000)	Projected 2016 Jobs (x1,000)	Growth Rate	Growth Rate Rank (1)	Jobs Added	Jobs Added Rank (1)	Jobs Decreased Rank (1)
All occupations	00-0000	150,620	166,220	10.4%		15,600,000		
All computer specialties	15-1000	3,200	4,006	25.2%		806,000		
Network systems and data communications analysts	15-1081	262	402	53.4%	1	140,000	23	
Computer software engineers, applications	15-1031	507	733	44.6%	4	226,000	15	
Computer systems analysts	15-1051	504	650	29.0%	23	146,000	26	
Database administrator	15-1061	119	154	28.6%	24	35,000		
Computer software engineers, systems software	15-1032	350	449	28.2%	25	99,000		
Network and computer systems administrators	15-1071	309	393	27.0%		83,335		
Computer and information scientists, research	15-1011	25	31	21.5%		5,440		
Miscellaneous Computer Specialists	15-1099	136	157	15.1%		21,000		
Computer support specialists	15-1041	552	624	12.9%		71,176		
Programmers	15-1021	435	417	-4.0%		(18,000)		22
Computer and information systems managers	11-3021	264	307	16.4%		43,134		

Figure 8 Employment projections: 2006–2016. *Source*: Bureau of Labor Statistics. (1) Out of 821 detailed occupational categories. *Source*: U.S. Department of Commerce Bureau of Labor Statistics, Employment by Occupation, 2006 and Projected 2016, http://www.bls.gov/emp/emptabapp.htm.

- *Database administrators* are also in the top 30, with a projected growth rate of 28.6%, ranking them 24th.
- *Computer software engineers, systems software* rank one step lower, with a projected growth rate of 28.2%.
- *Network and computer systems administrators* are just below the top 30, with a projected 27% growth rate.

Overall, the BLS expects most computer specialist occupations to continue to grow very rapidly between 2006 and 2016.

However, not all computer specialist occupations are expected to grow as rapidly. Computer support specialist jobs are projected to grow by only 12.9%. This is still faster than the growth rate for the overall economy, but it is slow by IT standards.

Then there is programming, which is expected to *decline* by 4.0% during the 2006–2016 period. This is the only computer specialist occupation expected to have negative growth.

In software development, in other words, continuing rapid growth is expected in jobs that require higher-level skills. The same is not true for lower-level computer support professionals and plain vanilla programmers, however.

Growth in number of jobs Percentage job growth rates are important. However, if the projected growth rate is large for an occupation that has few jobs in total, the number of jobs added will be fairly small. Figure 8 lists the number of jobs that are projected to be added between 2006 and 2016.

Gratifyingly, three occupations that are likely to employ many IS students come to the top of the job growth list. Computer software engineers, applications will add 226,000 jobs. This is not merely large when compared to other computer specialty occupations. It ranks 15th among all 821 detailed occupations. Systems analysts come next at 146,000 jobs. This ranks it 26th among all occupations. Also ranking in the top 30 in terms of number of jobs to be added are network systems and data communications analysts. Computer specialist occupations have long grown rapidly, and after many years of rapid growth, these occupations are no longer small relative to total employment.

On the downside, while programming is expected to decrease by just 4% on a percentage basis, there are many programmers. The number of projected jobs to be lost in programming, 18,000, places it 22nd among the 30 detailed occupations with the largest projected job losses.

Perspective According to the BLS employment projections, most computer specialist occupations will continue to see rapid growth both on a percentage basis and on the basis of number of jobs added. Although there are two unattractive occupations – computer support specialists and programmers – there will be plenty of job opportunities for IS and computer science graduates.

Offshoring

The author's focus groups found that IS students and potential IS students are concerned that offshoring will devastate the job market for IS jobs. In outsourcing, a company contracts for IT services with a company that specializes in IT. Outsourcing can lower costs, and it definitely makes costs predictable, which is almost as important to firms. Offshoring, in turn, is outsourcing in which the IT services company is located in another country, most commonly India or China. Actually, there is another form of offshoring – when a company shifts some of its employment to an overseas location, laying off local workers in the process. However, this second type of offshoring is uncommon.

The Forrester and Gartner projections

Just as the dotcom collapse was filling newspapers and other media, Forrester (2002) said that the offshoring of U.S. jobs to other countries was already large and would grow rapidly. Forrester forecast that 590,000 U.S. jobs would be offshored by 2005 and that this number would swell to 3.3 million in 2015. Two years later, Forrester (2004) increased its projections, saying that the number of offshored jobs would reach 830,000 in 2005 and 3.4 million by 2015.

These forecast losses were for all jobs. For computer jobs, the Forrester forecast was far lower; Forrester (2002) forecast that IT offshoring would grow from 27,121 in 2002 to 472,632 in 2015. This is a loss of about 34,000 IT jobs per year.

In 2004, Gartner added to the offshoring discussion. Gartner said then that 5% of U.S. IT jobs had already been offshored and that 25% of IT jobs would be offshored in 2010 (McDougall, 2005).

Assessing offshoring through the mass layoff statistics data

These forecasts certainly seem alarming. IS programs need to address offshoring with their students and potential students. Unfortunately, it is difficult to discuss offshoring rationally. Quite simply, there is no good statistical data on job offshoring or even revenues for service companies outside of the United States. While this means that there is no way for Forrester, Gartner, and others to verify their numbers, it also means that there is no way for others to refute them in a comprehensive way. As Kirkegaard (2007) summarized the situation, 'Unfortunately, the near complete absence of valid empirical evidence on the phenomenon has allowed entrepreneurs and consultants to frame the debate to promote their own interests, thus fueling public anxiety.'

However, we do have a solid source of employment data that should showcase offshoring losses if these losses really are substantial. This is data from the BLS Mass Layoff Statistics (MLS) program. Mass layoffs occur when 50 or more jobs are lost for more than a month. When state unemployment insurance programs detect such mass layoffs, they contact the BLS, which conducts a structured telephone interview with the company making the layoffs. This interview has specific questions about whether jobs were moved to another location and whether this other location was inside or outside the United States. The survey uses the term *outsourcing* to refer to job movements within the United States and uses the term *offshoring* to refer to job movements to locations outside the United States.

Figure 9 shows the results of an analysis of the 2004 MLS data by Brown & Siegel (2005). As you read the table, keep in mind that mass layoffs represent a small fraction of all job losses to begin with. In a typical year, the U.S. economy loses 18.7 million jobs (Lindsey, 2004). Only about a million are lost each year in mass layoffs. Among these mass layoffs, only 7.6% of the events and 5.5% of the job losses involved a movement of jobs domestically or to another country. More importantly, *offshored* job movements to other countries only occurred in 2.1% of the cases and 1.6% of the separations. Only 16,197 jobs in total were offshored in mass layoffs in 2004. The number of offshored IT jobs is not reported but must have been much smaller.

In addition, a follow-up to the Brown and Siegel study found that average wages actually *rose* following mass layoffs (Brown & Spletzer, 2005). This means that the jobs that were shed from the company tended to be the firm's *lower-paying* jobs rather than the company's higher-paying jobs.

The MLS data are certainly not perfect. In particular, it ignores all offshoring that does not produce at least 50 layoffs. Still, if offshoring really is massive, it should show up strongly in the 2004 MLS data. It does not. So in the one data source in which the hypothesis that IT offshoring is massive can be tested at least roughly, there is no support for the idea that enormous numbers of IT jobs

Category	Mass Layoff Actions	Percent of Total Actions	Mass Layoff Separations	Percent of Total ML Separations
All Mass Layoff events	5,010	100%	993,511	100%
Events involving domestic outsourcing or offshoring	382	7.6%	55,122	5.5%
Events involving offshoring	103	2.1%	16,197	1.6%

Figure 9 Outsourcing and offshoring in the mass layoff statistics data. *Source*: Brown & Siegel (2005).

are being offshored. This does not mean that offshoring is negligible – only that it does not appear to be large compared to total employment or total IT employment.

European Union data

Offshoring has been a concern in the European Union as well. To assess the impacts of offshoring, the European Commission created the European Restructuring Monitor program, which began collecting data in 2002. This program produces weaker data than the MLS. It monitors news reports for indications of layoffs involving 100 or more employees. There is no follow-up with the companies involved in the layoffs. Like the MLS data, the European Restructuring Monitor data indicate that offshoring has involved only about 3.4% of all job losses in major restructurings during 2005 (Rüdinger, 2007). Again, the European Restructuring Monitor program only looks at large layoffs, but large offshoring events are likely to be captured in these data.

The fundamental error of focusing on job losses and ignoring inshoring

Several authors (e.g., Lindsey, 2004; Kirkegaard, 2007) have argued that the biggest problem with the Forrester and Gartner analyses is that these studies only look at job *losses* due to international trade in IT services (which is what offshoring really is). They ignore job *gains* due to international trade in IT services.

This is important, because even in a healthy economy, there always are both massive job losses and massive job gains. Between 1993 and 2002, for example, 309.9 million employees lost their jobs in the U.S. private sector, but there also were 327.7 million hires during the same period. In the net, 17.8 million jobs were added to the total economy (Lindsey, 2004). Very few of these job gains and losses were due to international trade (Lindsey, 2004). Job churn simply is a normal part of organizational life. As noted earlier, even when the employment rate holds steady, 18.7 million people lose their jobs each year; but there are even more hires (Lindsey, 2004). Large IT job losses are not a problem unless there are not also large job gains. By looking at only one side of the picture – job *losses* due to offshoring – Forrester and Gartner probably created a highly distorted picture.

It might be argued that offshoring job losses are dead losses. However, international trade in IT services works in both directions. Improving and less-expensive technology is making it possible for U.S. and Western European firms to contract for services from IT firms in low-wage countries. However, this same technology also allows U.S. and Western European firms to sell high-level IT services to firms in less-developed countries (Lindsey, 2004; Kirkegaard, 2007).

In fact, the United States does have a large surplus in IT services (Lindsey, 2004; Jensen & Kletzer, 2005). In 'computer and data processing services,' U.S. exports were already $2.4 billion in 1995 and rose to $5.4 billion in 2002. In contrast, imports during this period only rose from $0.03 billion to $1.2 billion. In other words, in IT services, the United States has enjoyed a growing surplus, again indicating that inshoring may be more important than offshoring.

Given the size of this trade surplus in favor of the United States, it is possible that the United States is actually gaining more jobs from international trade in IT that it is losing to international trade. Unfortunately, as in most things dealing with outsourcing, there is no way to tell for certain because we simply do not have sufficient data. However, it certainly is incorrect to focus myopically on job losses in the face of evidence that job gains can also come from international trade in IT.

The assumption that most offshoring goes from high-wage countries to distant low-wage countries also runs counter to the fact that the United Kingdom purchases four times as much computer service from Germany as it does from India (Rüdinger, 2007). In turn, an International Monetary Fund study (Amati & We, 2004) ranked the top recipients of global offshoring pacts in decreasing order as the U.S., the U.K., Germany, France, the Netherlands, and India. The OECD's European Employment Outlook, 2007 also states that the impact of offshoring is negligible or even positive (Rüdinger, 2007). While India has been experiencing strong growth in supplying IT services, and while visits to Indian high-tech sites are eye-opening, this must be seen in the broader context of global IT services.

It seems likely that while India, China, and other low-wage countries have been successful in offering lower-end IT jobs such as programming and computer support, the U.S. and Western Union have very strong positions in high-end IT services.

Although general data on inshoring are lacking, one study looked in detail at both offshoring and inshoring in a single country, Denmark (Jensen *et al.*, 2006). The study found that both inshoring job gains and offshoring job losses were less than 1% of all job gains and losses. More significantly, the study also found that inshoring job gains exceeded offshoring job losses.

Productivity

One problem in assessing the impact of offshoring is that productivity is growing rapidly in many IT-related fields. Job losses from productivity are difficult to separate from job losses due to offshoring, as are job gains from productivity and inshoring (Kirkegaard, 2007). Levy and Murnane (2006) found that there was a strong overlap between jobs threatened by offshoring and those threatened by productivity. Van Ark (2005) noted that U.S. productivity in information and computer technology-using services increased by 5.3% per year between 1995 and 2003. This indicates that productivity is a much larger destroyer (and creator) of jobs than offshoring. It is even possible that many offshored jobs are precisely those that would be lost eventually to productivity gains (Kirkegaard, 2007). For instance, while running a customer service call service may be cheaper in India than in the United States, providing web-based support is far cheaper than either (Kirkegaard, 2007).

Offshoring in the BLS projections

If the offshoring forecasts of consulting firms are correct, then the 2006–2016 BLS occupational projections would seem to be highly optimistic. However, the BLS has considered offshoring in its projections.

Most obviously, the BLS projections are based heavily upon historical trends. If offshoring is increasing rapidly, as Forrester and Gartner claim it is, then the consequent growth rate decline will be captured from recent employment data, and this decreased rate of growth is likely to be captured in future projections.

More importantly, the BLS has been *explicitly* considering offshoring in its employment projections for several years. The remainder of this section is based on the U.S. Department of Labor's (2006) report on its offshoring analysis efforts.

Aware of potential impacts from offshoring, some occupational analysts in the Bureau first explicitly included offshoring in their projections for 2002–2012. However, offshoring was not considered in a consistent way across occupations in that projection.

While preparing for the 2004–2014 projection, the BLS developed a specific methodology for identifying occupations susceptible to offshoring. After studying private and public data sources and analyses, the BLS identified conditions that would cause an occupation to be most likely or least likely to be affected by offshoring. Based on this analysis and subsequent refinements, the BLS identified 40 susceptible occupations out of a total of 754 detailed occupations. The 2004–2014 projections explicitly considered offshoring for these 40 occupations.

There were five computer occupations on the list of 40. These were computer software engineers, applications; computer software engineers, systems software; computer support specialists; programmers; and computer and information scientists, research.

Although the 2004–2014 projections included offshoring to a degree considered successful by the BLS, the 2006–2016 projections marked the first time that offshoring was explicitly considered throughout the analysis and projection process. In addition, the occupational analysts probably became more experienced in their consideration of offshoring.

For the 2006–2016 projections, the BLS did not limit itself to the 40 occupations marked as susceptible to offshoring. It specifically considered offshoring for all occupations in the 15-1000 (computer specialists) minor occupational group. Ben Wright, who was the BLS specialist in charge of the offshoring-related part of the computer specialist projections, told the author that offshoring was negligible in the projections for all computer specialist occupations except for programmers and computer support specialists. For computer support specialists, the offshoring impact was present but very small, while for programmers, offshoring had a significant impact on the projection. However, many other factors were taken into account, so even the decline in programming jobs should not be taken as being primarily due to offshoring.

Comparing recent projections

The BLS projects occupational employment every 2 years. Naturally, we have focused on the most recent projections that deal with the 2006–2016 period. However, we should compare these projections with the 2002–2012 and 2004–2014 projections to see if the 2006–2016 projections vary much from previous projections. Figure 10 does exactly that. To account for the fact that the projected growth in total employment was different in the three projections, normalized growth rates were created by dividing the category growth rate by the total employment growth rate.

For computer specialists as a whole, the normalized projected growth rate is almost dead constant across the three projections. Computer specialist employment is projected to grow a bit less than two and a half times as rapidly as total employment in all three. For most detailed computer specialist applications, in turn, the projected growth rate varies little across the projections. For two occupational categories – network systems and data communications analysts and computer software engineers, applications – the projected growth rate actually increased across the three projections. These patterns do not indicate that offshoring is growing so rapidly that it is likely to lead to catastrophic job losses.

Occupation	SOC Code	2002-2012 Projected Growth Rate	2004-2014 Projected Growth Rate	2006-2016 Projected Growth Rate	2002-2012 Normalized Projected Growth Rate	2004-2014 Normalized Projected Growth Rate	2006-2016 Normalized Projected Growth Rate	Pattern
All Occupations	00-0000	14.8%	13.0%	10.4%	1.0	1.0	1.0	Level
All Computer Specialists	15-1000	35.8%	31.4%	25.2%	2.4	2.4	2.3	Level
Network systems and data communications analysts	15-1081	57.0%	54.6%	53.4%	3.9	4.2	4.9	Significant † Increase
Computer software engineers, applications	15-1031	45.5%	48.4%	44.6%	3.1	3.7	4.1	Significant † Increase
Computer systems analysts	15-1051	39.4%	31.4%	29.0%	2.7	2.4	2.7	Level
Database administrator	15-1061	44.2%	38.2%	28.6%	3.0	2.9	2.6	Decrease
Computer software engineers, systems software	15-1032	45.5%	43.0%	28.2%	3.1	3.3	2.6	Decrease
Network and computer systems administrators	15-1071	37.4%	38.4%	27.0%	2.5	3.0	2.5	Level
Computer and information scientists, research	15-1011	29.9%	25.6%	21.5%	2.0	2.0	2.0	Level
Miscellaneous Computer Specialists	15-1099	36.5%	19.0%	15.1%	2.5	1.5	1.4	Significant † Decrease
Computer support specialists	15-1041	30.3%	23.0%	12.9%	2.0	1.8	1.2	Significant † Decrease
Programmers	15-1021	14.6%	2.0%	-4.0%	1.0	0.2	-1.7	Significant † Decrease
Computer and information systems managers	11-3021	36.1%	25.9%	16.4%	2.4	2.0	1.5	Significant † Decrease

Figure 10 Comparison of the three most recent occupational projections for computer occupations. *Source*: Bureau of Labor Statistics. *Out of 821 detailed occupations.

For two important detailed computer specialist occupations, however, the projected growth rate declined over the last three projections. The biggest decline in projected growth rate came in programming. In fact, as noted earlier, programming is projected to have slightly negative growth during 2006–2016. The projected growth rate also declined, although less so, for computer support specialists. As noted earlier, these two occupations were the only two computer specialist occupations for which offshoring was a factor in the projections. Yet even for these occupations, the declines were not entirely due to offshoring.

Overall, although offshoring will undoubtedly be important, it does not appear to be the crisis that consultants have portrayed it to be.

Discussion

Recap of key points

The most important conclusion of this paper is that the enrollment bubble was just that – a bubble. It is pointless to think fondly about enrollments at their artificial peak and bemoan subsequent losses. After World War II, some cargo cults began in the Pacific islands. Participants in these cults built airplane models in the hope that the goods brought in by the United States military would reappear again. The dotcom enrollment bubble was just that, a temporary bubble. We need to get over it and look to the real future.

This does not mean that our current graduation levels are acceptable. In the years since 1995, employment in IT jobs has risen substantially, so going back to 1995 enrollments is not attractive. In addition, falling enrollments now threaten the continuation of some IS programs. Given difficulties that firms are having recruiting IT professionals, we need to increase our enrollments at least moderately.

Our students are obvious concerned about jobs. The analysis in the paper shows that the post-bubble job losses and unemployment growth was very short-lived and was not as bad as many people believed. The IT unemployment rate never reached the national unemployment rate, and it fell back to its traditional low level by 2005. In addition, total IT employment in 2005 surpassed IT employment at the bubble's peak and has continued to grow since then. There is no reason for today's graduates to be concerned unless a recession causes hiring to be frozen temporarily, and even that would not be a concern for students making long-term career choices.

It is more difficult to ease offshoring fears because a lack of solid data makes it impossible to strongly refute consultants who have said that IT offshoring is already large and will soon get far larger. However, in the few cases where we should be able to measure offshoring job losses, there is no evidence that massive job losses have occurred.

More importantly from a theoretical point of view, real economies have both large numbers of job losses and large numbers of job gains at all times. It makes no sense to focus only on job losses in an economy with both high job gains and high job losses.

Fundamentally, offshoring is really about trade in services – buying services from other countries instead of hiring or retaining national workers. The technology that supports international IT services works in both directions, and the U.S. has long had a strong surplus in IT services, indicating that inshoring (job gains) may be a considerable degree larger than offshoring. In the one study that looked at inshoring and offshoring, it was found that Denmark had higher inshoring than offshoring. In addition, while IT offshoring is certainly costing an unknown number of lower-level jobs, the number of higher-level jobs may actually be increasing.

The best data for talking about the future come from the BLS' detailed biennial 10-year employment projections. The 2006–2016 projections, which both implicitly and explicitly deal with offshoring to the extent possible, still project that IT jobs will grow more than twice as fast as all jobs, and most of this growth will be in high-paying high-end IT jobs.

Research on the choice of a major

While concern about jobs is an important issue facing students when they decide to select a major, there are many other issues that came into play. The author knows of only one recent study that looked at IS major choice. This was Zhang's (2007) study at the University of Massachusetts, Boston. That study used past research and theory on how students select majors and applied it specifically to IS major choices. In general, it found that students planned to base their choice on job availability, genuine interest, difficulty of the curriculum, and the opinions of family and friends. The study also found that there were important differences in the selection of a major by gender.

Although it was a good study, its external validity is somewhat weakened by its sample, which consisted of 70% foreign students. Also, its survey instrument asked specifically about IS major choice instead of asking neutrally about major choice and letting students assess multiple possible majors in the business school. This is a concern because revealing the researcher's interest in IS may have skewed results.

We need to build upon Zhang's research. We need to focus especially on gender. Figure 11 shows that there is a large gender gap in computer-related occupations. Only a quarter of all employed computer specialists were women, and in some specialties, the percentage is even lower.

There is some evidence that IS has long had a higher percentage of women students than Figure 11 indicates. Figure 12 shows some results of an ISWORLD post asking for gender breakdowns. The four programs that responded had all seen a sharp drop in the percentage of female students after the bubble. If these data are representative of IS programs in general, then we need to do research on why IS programs no longer have broad appeal to female students.

We also need to understand how students have changed since the bubble began more than a decade ago. Most students coming into our programs today are what U.S. sociologists call 'Generation Y' or 'Millennial' students. These students grew up with technology from their infancy. We need to respect and leverage the IT skills that many of them bring to our programs, including Web 2.0, AJAX, and mashup skills. More subtly but also more fundamentally, they appear to have different motivations than earlier students (and employees) [60Minutes, 2007], so we need to consider their particular characteristics in our programs.

	Total	Male	Female	Total	Male	Female
Selected "computer-related" occupations, total	3,758	2,815	940	100%	75%	25%
Computer and information systems managers	467	337	130	100%	72%	28%
Computer scientists and systems analysts	825	601	224	100%	73%	27%
Computer programmers	526	396	130	100%	75%	25%
Computer software engineers	907	719	188	100%	79%	21%
Computer support specialists	332	232	99	100%	70%	30%
Database administrators	104	66	37	100%	63%	36%
Network and computer systems administrators	214	182	31	100%	85%	14%
Network systems and data communications analysts	383	282	101	100%	74%	26%

Figure 11 Gender in computer-related occupations.

University of Hawaii Ray Panko Networking Course		Miami of Ohio John Benebati MIS Degrees Awarded		Georgia State Carl Stucke Ephraim McLean MIS students		Michigan Tech Chelley Vician Database Course	
1996-1997	38%			1996	39%		
1997/1998	NA			1997	42%		
1998-1999	37%			1998	42%		
1999-2000	36%			1999	44%	1999/2000	33%
2000-2001	34%	2000	33%	2000	44%	2000/2001	53%
2001-2002	50%	2001	35%	2001	45%	2001/2002	31%
2002-2003	36%	2002	34%	2002	40%	2002/2003	26%
2003-2004	44%	2003	28%	2003	36%	2003/2004	19%
2004-2005	28%	2004	19%	2004	32%	2004/2005	5%
2005-2006	15%	2005	21%	2005	28%	2005/2006	10%
2006-2007	10%	2006	22%	2006	29%	2006/2007	18%
2007-2008	9%	2007	11%	2007	26%	2007/2008	28%

Figure 12 Percentage of women in IS programs.

We may also need to explore how maths abilities correlate with major selection. There is anecdotal evidence among faculty members that maths skills have fallen considerably in recent years. This may make IS less attractive because it is technically difficult.

We need to bring in our colleagues in marketing departments to help us do this research. To give just one example, marketing campaigns have to be designed differently for people who are interested in a product, merely aware of a product or are unaware of a product. Researchers in marketing can help us understand where potential students are along this dimension and other important behavioral/knowledge dimensions.

In particular, we need to do critical research on how students react to the term, 'information systems.' The terms 'computer science,' 'computer,' 'IT,' and even 'tech' mean something to today's students. The term 'information systems' may not. We use the term 'information systems' to emphasize that you cannot simply deal with hardware and software but also must bring humans and organization into the picture. Certainly, that is a good insight. However, we need to study our students to see if this is such a stunning insight that we give the entire field a name that draws blank stares when we say it.

Possible practical actions

There are several obvious things we can do to increase the number of students going into IS. The most pressing concern appears to be getting the word out that there are good jobs available and will be for a long time. The data from this study should help toward that end. We need to contact potential students, news media, parents, and especially school counselors.

We also need to see if what we are teaching is still relevant to the job market. The BLS data have shown that there have been strong shifts in the types of IT jobs in industry. Are we reflecting these changes in our curriculum?

Political actions

It may also be desirable to seek support from national policy makers. In the United States, for instance, the H1B visa program allows a limited number of skilled foreign workers to obtain jobs in the United States. These H1B visas tend to take away potential jobs from our students, but they also provide the high-level people we need to keep a strong balance of trade in IT services and to keep the lead in IT despite lukewarm interest from U.S. students.

At the same time, one concern in the BLS data is that we may be losing low-end jobs overseas. This means higher average pay, but if this trend reduces entry level jobs in the long term, our students may not have good ways to get into the workforce so that they can build their skills toward those needed in high-level jobs.

A modest change in U.S. H1B visa apportionment methods might help in this area. If firms that apply for H1B visas are prioritized at least in part on how well they create and keep open entry-level jobs for new hires, this could broaden the number of jobs available to graduates.

Upgrading IS education

The data in this study indicate that we may need to upgrade IS education. The biggest lesson from the BLS employment projections is that our students will increasingly need higher-level skills to function in the marketplace.

Specifically, given that higher-level jobs such as software engineering and network analysis and design require strong analytical skills, we can focus more on these skills in our courses. This may mean increasing mathematical competencies in our students, many of who lack the ability to do quantitative analytical analysis.

There is a danger that schools will start to address enrollment drops by 'dumbing down' their curricula, that is, making classes easier. Indeed, this may have already started to happen. Reducing content and rigor may bring short-term enrollment benefits for these IS programs, but downgrading required learning will hurt our students in tomorrow's increasingly skilled marketplace.

Given that undergraduate IS programs can only be improved to a moderate degree, it is time to stop thinking of undergraduate IS degrees as terminal degrees. Our students will need to take masters degrees, and we will need to provide masters degrees that provide the analytical skills needed in systems analysis, software engineering, and network analysis and design, among other higher-level analytical skills. The IS masters degree may even be an entry point for both employees with IS degrees and those without IS degrees, much as MBA programs are for non-business students today. It may take workers with good basic technical skills and give them the higher analytical skills they need to succeed. If this is the case, an IS masters degree that focuses on analytical skills may be the growth tip for IS programs in the future.

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