THE OCCUPATIONAL OUTLOOK FOR INFORMATION-TECHNOLOGY PROFESSIONALS

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Executive summary

A detailed examination of occupational employment and degrees in information-technology (IT) disciplines reveals a striking mismatch between supply and demand for highly skilled IT professionals over the next several years. Although the Bureau of Labor Statistics projects that there will be an average of nearly 200,000 annual job openings in IT occupations that demand a BS or higher in computer science (or related disciplines such as management information systems), projections based on recent enrollment trends suggest that computer science degrees actually awarded in the United States will only be about one-quarter of the number of annual job openings.

Structure of the IT labor market

Table 1 outlines the major classes of IT occupations with a brief description of educational qualifications. In brief, IT professions can be usefully classified as those who design IT systems (systems engineers and analysts), those who program the code to operationalize those systems (programmers), and those who manage and support them (support specialists and administrators).
Prior to the Internet age, IT occupations had a strongly technical focus; that is, the role of IT professionals was to use their technical expertise to implement solutions to specific business problems (or improvements to specific business processes) that were typically circumscribed and overseen by corporate management.

Over the past decade, as the Internet has opened the possibility of coordination across a wide variety of processes both within and among companies, IT professionals are being asked more and more frequently to possess management knowledge and experience, so that the systems they implement are flexible enough to adjust to the changing information demands within corporations (as well as of customers and suppliers). For several occupations (notably software engineers, systems analysts, and database administrators), employers are increasingly seeking individuals with MBAs or relevant business experience in addition to superior technical abilities.

Table 1

Educational requirements of selected IT occupations

Occupational groups	Summary of education requirements
Computer and Information Scientists, Research	With few exceptions, doctoral degree in computer science or management information systems.
Computer Software Engineers; Computer Systems Analysts; Database Administrators	At least a bachelor's degree in computer science, information science, or management information systems (MIS). Employers are increasingly seeking individuals with a master's degree in business administration (MBA), with a concentration in information systems, as more firms move their business to the Internet.
Network and Computer Systems Administrators; Network Systems and Data Communications Analysts	For some network systems and data communication analysts, such as webmasters, an associate degree or certificate is sufficient, although more advanced positions might require a computer-related bachelor's degree.
Computer Programmers	Bachelor's degrees in computer science or a related field are commonly required, although some programmers may qualify for certain jobs with 2-year degrees or certificates. The associate degree is a widely used entry-level credential for prospective computer programmers. Most community colleges and many independent technical institutes and proprietary schools offer an associate degree in computer science or a related information technology field.
Computer Support Specialists	Some formal college education. A bachelor's degree in computer science or information systems is a prerequisite for some jobs; however, other jobs may require only a computer-related associate's degree. For systems administrators, many employers seek applicants with bachelor's degrees, although not necessarily in a computer-related field.

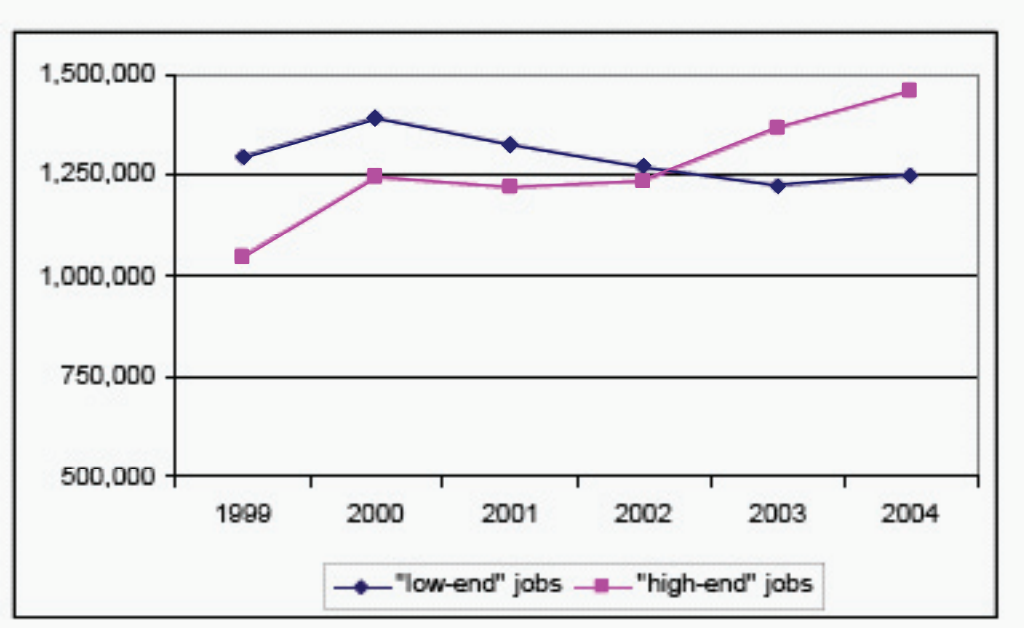
Source: U.S. Bureau of Labor Statistics, Occupational Outlook Handbook 2006-07.

Evolution of the IT labor market from 1999 to 2004

The IT labor market has undergone profound changes over the past five years. The defining event of this period was the bursting of the dot-com bubble in 2000 and 2001, which caused layoffs across a wide spectrum of computer-related jobs. However, those job losses were concentrated at the lower end of the skills spectrum (Chart 1). Such occupations, which include programmers, administrators and support personnel, fell by 12.1 percent (a loss of 170,000 jobs) from 2000 to 2003. Higher-skill jobs flattened out during the dot-com bust, but have grown by 18 percent (225,000 jobs) since 2002.

Chart 1

Employment in IT occupations by skill requirements, 1999-2004



Source: U.S. Bureau of Labor Statistics
Note: "Low-end" occupations include computer programmers, support specialists, database administrators and network/systems administrators. "High-end" occupations include software applications and systems engineers, computer scientists, systems analysts, and network/data communication analysts.

Thus, recent trends in IT job growth bode very well for high-end occupations. Even accounting for the 2000-2002 job slowdown, they have grown by 40 percent since 1999 (a 6.6 percent compounded annual growth rate). Furthermore, InformationWeek estimates that the unemployment rate among IT professionals fell to 2.5 percent in the first quarter of 2006, a sharp decline from the 3.7 percent a year ago and well below the 4.7 percent rate for the entire labor force.[1]

To understand why the labor market for IT professionals has evolved in this way, it is instructive to examined what actually happened prior to and during the dot-com collapse. With regard to IT hardware, the boom-bust cycle was concentrated in telecommunications and networking equipment. Construction of communication networks in the late 1990s were premised on a widely-reported statistic (publicized by WorldCom) that Internet traffic was doubling every three to four months, a figure which may have been true when reported but a severe overestimate of longer-term trends.[2] As a result, output of communication equipment doubled from 1997 to 2000. By the time network equipment manufacturers realized that this number was wildly optimistic, the fiber optic cable had already been laid, a large percentage of the new networks' capacity was unused, and communications equipment output fell 37 percent from 2000 to 2003.

[1] Eric Chabrow, "IT Employment Reaches Record High In U.S.," Information Week, April 18, 2006.
[2] Frank Rose, "Surviving the Fiber-Optic Fire Sale," Wired, November 2002.

With regard to IT services, the dot-com bubble was driven by the belief that commerce that had traditionally been done face to face or over the phone would move to the Internet very rapidly. This spurred development of thousands of startup companies, fuelled by venture capital, which sought to capitalize on the perceived business opportunities of selling via the Internet rather than via "bricks-and-mortar" stores. Consulting firms predicted that such e-commerce would increase much more rapidly that was actually the case.3 An emblematic example of the many startup companies that succumbed to this mania was Webvan, which sought to sell groceries over the Internet through proprietary distribution channels.[4]

This bubble drove demand for computer programmers and other occupations that emphasize technical skills rather than business processes and management, and the implosion of the dot-com boom in 2001 and 2002 coincided with a 15 percent decline in programming jobs. Employment opportunities for programmers continue to slide as a result of offshoring to India and other countries with lower labor costs, a trend which will be examined in more detail in a companion report.

But while the dot-com startups were imploding and telecommunications providers were trying to sell off their excess bandwidth, a transformation of business processes and supply chains under the moniker of "e-business" began sweeping through corporate America. Unlike many of the dot-com startups, large manufacturers and distributors saw the Internet not necessarily as an infrastructure to sell more products, but as a means to share information across the entire enterprise (and, eventually, throughout the supply chain). This revolution manifested itself in two distinct ways:

- Use internal networks to share information across departments. This trend gained momentum in the mid-1990s and is exemplified by the adoption of enterprise resource-planning (ERP) software systems such as SAP, Oracle and PeopleSoft. One study estimates that 40 percent of large manufacturers and 60 percent of small- and medium-sized manufacturers had implemented ERP systems by the end of the 1990s. Another estimate by AMR Research reckons that the U.S. market for ERP systems will grow 5 percent annually to reach $27 billion in 2009.

- Use the Internet as well as extranets to share information with suppliers and customers. This trend began coincident with the dot-com boom, but has persisted because these external data networks have delivered real value. The computerization and networking of supply chains is a fast-growing business. AMR Research estimates that the U.S. market for IT applications for supply chain, PCM and CAD will grow 8 percent annually to reach $22 billion in 2009.

These trends require IT professionals with a larger skill set than those who were writing the code to drive the e-commerce Web sites, and it is largely due to these trends that growth in high-skilled IT occupations continues to grow rapidly.

These dynamics are evident in the Bureau of Labor Statistics' ten-year projections of occupational employment, the relevant results of which are presented in Table 2. The BLS points out that computer related occupations are projected be the fastest-growing component of all professional groups, with the caveat that growth will be lower than the previous decade due to the offshoring of more routine work.

[3] Forrester Research predicted in 1998 that Web-based (as opposed to traditional EDI) business-to-business e-commerce would reach $1.3 trillion by 2003. In fact, data from the U.S. Department of Commerce suggest the actual figure was closer to $400 billion.
[4] Melanie Austria Farmer and Greg Sandoval, "Webvan delivers its last word: Bankruptcy," CNETnews.com, July 9, 2001.

Table 2

Outlook for IT-related occupations, 2004-2014

Occupation	Average annual job openings	Change in total employment	
		Number	Percent
Systems analysts	56,000	153,000	31.4
Application software engineers	54,000	222,000	48.4
Network systems/data communications analysts	43,000	126,000	54.6
Systems software engineers	37,000	146,000	43.0
TOTAL, "HIGH-END" IT	190,000	647,000	42.6
Support specialists	87,000	119,000	23.0
Network administrators	34,000	107,000	38.4
Programmers	28,000	9,000	2.0
Information systems managers	25,000	73,000	25.9
TOTAL, "LOW-END" IT	174,000	308,000	20.1

Source: U.S. Bureau of Labor Statistics
Note: Because the BLS does not provide projections for certain occupational groups, the occupations shown here are somewhat different from those listed in Table 1.

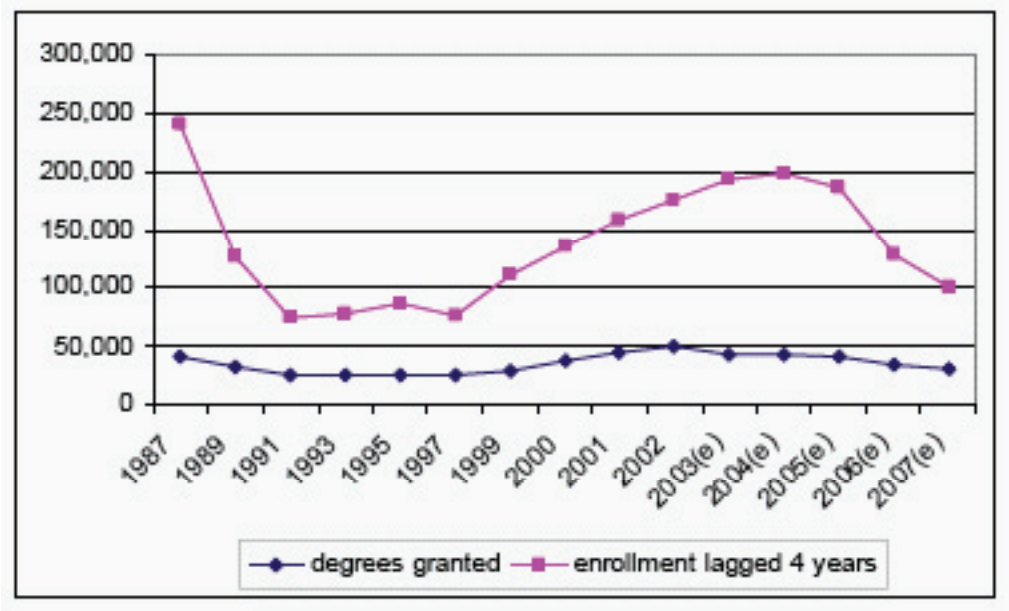
The projections in Table 2 are consistent with the preceding analysis. "High-end" IT occupations will create an estimated 190,000 job openings, of which well over half will be systems analysts and application software engineers. "Low-end" occupations will also see job creation, but aside from support specialists, it will be lackluster. As noted earlier, overseas outsourcing has darkened the outlook for programmers: employment is only expected to grow 2 percent.

The Supply Side: Enrollment and Degrees in IT degree programs

At the same time that the job outlook has brightened considerably for BS- and MS-level occupations (even taking account of the fact that high-end jobs never really declined that much), there has been a worrisome decline in enrollment and degrees in computer science, particularly at the undergraduate level (Charts 2 and 3). BS degrees in computer science will decline to an estimated 30,000 by 2007, a sharp decline from the nearly 50,000 awarded in 2002. Degrees and enrolment at the Masters and doctoral level are leveling off at record highs, but since they typically require a BS in computer science as a prerequisite, they are also likely to trend downward in coming years. Furthermore, one must bear in mind that 50 percent of graduate computer science degrees are awarded to foreigners, who are less likely to remain in the U.S. labor force.

Chart 2

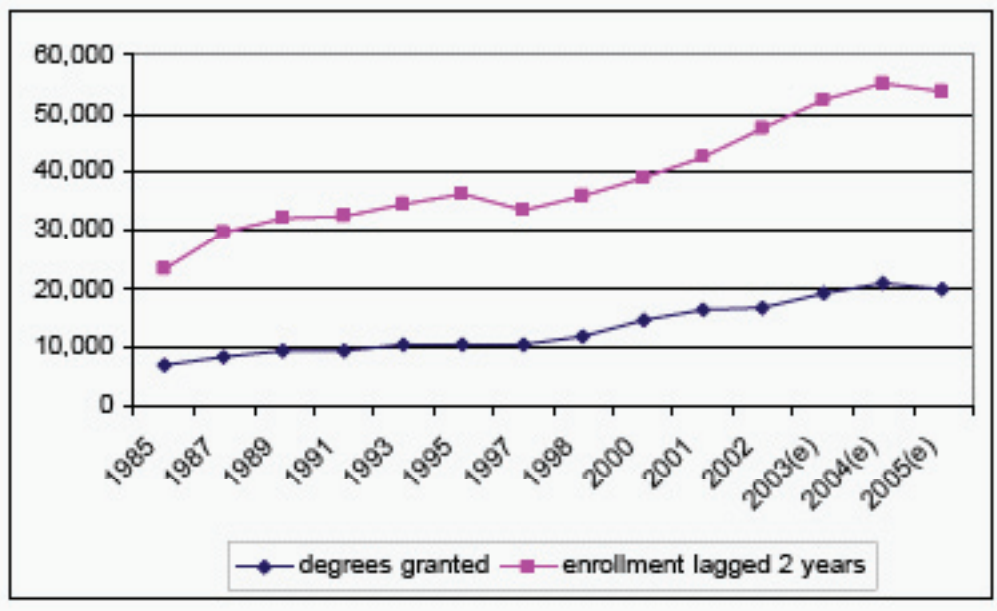
Freshman enrollment and degrees granted in computer science (undergraduate programs), 1987-2007



Source: U.S. Department of Education, National Science Foundation, and author's calculations.
Notes: Freshman enrolment is based on survey data indicating the percent of university freshman intending to major in computer science. Estimates of degrees granted for 2003 onward are based on historical statistical relationships between degrees and lagged enrollment.

Chart 3

Enrollment and degrees granted in computer science (graduate programs), 1985-2005



Source: U.S. Department of Education, National Science Foundation, and author's calculations.
Note: estimates of degrees granted for 2003 onward are based on historical statistical relationships between degrees and lagged enrollment.

Conclusion

There is a clear mismatch between supply and demand for high-skill IT employment in coming years. With only one computer science graduate for every four new jobs created, there will continue to be upward pressure on salaries, which are already growing at 5 percent per year. For students considering a degree in computer science or related field such as information systems, there are attractive financial reasons to do so, but they must be sure that they acquire the business and management knowledge increasingly sought by employers as well as superior technical skills.