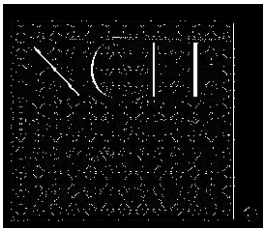

Software Industry Trends

Peter E. Carlson
December 2006

The software industry has changed significantly since its inception in the 1950s, and its boundaries have gotten blurry as software has become a key facilitating technology in many other industries. In the early years of the computer industry, manufacturers bundled software with their mainframe computers as a package deal. Following the unbundling of software by IBM in 1969, and the advent of the personal computer in the 1970s, the software industry grew rapidly as new firms entered the market with packaged applications and customized services for businesses, and increasingly with packaged applications for homes. The internet revolution in the 1990s spurred the development of new web-based applications and new services to businesses. Employment in this sector of the industry is currently estimated at around 1 million, and is projected to be the fastest growing sector of the economy over the next decade.[1]

In addition to stand-alone software publishing and services firms, many firms develop software for their own internal use. This is particularly true in banking and finance, telecommunications, retail, and manufacturing, where information technologies now provide critical support to business processes. Employment in this segment of the industry is estimated at around 2 million, twice the number of jobs in stand-alone software firms.[2]

The digital revolution is further expanding the scope of software development, as the chips, software, and network connections associated with computers are now being built into phones, hand-held devices, and other consumer electronics. Increasingly, these products are defined more by their software, which supports innovation in features and functions, than by their hardware. Although there is no available estimate of the number of jobs in this rapidly growing sector, the market for these products is currently more than twice the size of the market for more traditional forms of computers and software.[3]

This report describes the key trends and the global dynamics that are reshaping the US software industry, and the implications for employment in the US.

---

[1] Jay M. Berman, "Industry Output and Employment Projections to 2012," *Monthly Labor Review*, February 2004.
[2] "The Outlook in 2003 for Information Technology Workers in the USA," A Report by the IT Workforce Data Project, August 28, 2003.
[3] Stephen Baker and Heather Green, "Big Bang!" *Business Week*, June 21, 2004.

Key Trends

Within the sector of traditional stand-alone software firms, there are several trends that are reshaping the industry.

Consolidation. The first trend is the consolidation of large software firms that serve corporate customers. Underlying this trend is corporate frustration with trying to make all of the software applications they have purchased work together. Their focus is shifting away from increasing productivity within vertical functions and shifting toward better integrating functions horizontally across the entire corporation. As corporations make that shift, they are reducing the number of software suppliers they work with and are counting on them to provide a broader range of capabilities. Software firms are responding by offering integrated packages of products and services on a common platform to make them easier to use.[4] Since most software firms have traditionally specialized in specific areas, they are merging with other companies to broaden the scope of what they have to offer.

These mergers are taking place at two different levels. The mergers that are getting the most attention are those among the big players like Oracle and PeopleSoft. Oracle already has 60 percent of the market in database software, which they believe offers the platform for an integrated system. SAP, Microsoft, and IBM are also competing to establish a common platform for all other business applications to run on.[5]

At the same time, start-up software companies are constantly bringing new applications to market. With their corporate customers increasingly demanding that their applications be integrated into larger packages, start-up companies are finding that they need to build close alliances with the big players through partnerships and technical integration.[6] The pattern that is emerging looks a lot like what's going on in the biotech industry, where established pharmaceutical companies provide the funding for start-up efforts, and in return get the benefit of innovative new products to add to their portfolio.

Web Services. A second trend is the delivery of software over the internet. Traditionally, software has been a licensed product sold in a box with a fixed life cycle and installed on a specific computer. But increasingly, consumers are downloading the software they need over the internet and paying for it on a subscription basis. This new model has less up-front costs for the customer, and it means that they get updates more frequently, since the people who wrote the software are the ones who are also running it.[7] Some analysts estimate that by the end of this decade, as much as half of the software sold to corporations will be paid for on a subscription or pay-per-use basis.[8]

---

[4] Steve Mills, "In the Shadow of Software's Titans," *Business Week*, March 17, 2005; Steve Lohr, "Software Sector Finally Enters a Merger Phase," *The New York Times*, December 15, 2004.
[5] "Softwar or Hard?" *The Economist*, March 23, 2005.
[6] Martin LaMonica, "Survival of Software's Fittest," www.news.com, August 16, 2004.
[7] Jim Kerstetter, "So, What the Heck are Web Services?" *Business Week* Special Report, February 8, 2005.
[8] Jim Kerstetter and Jay Greene, "Software: Pay-As-You-Go is Up and Running," *Business Week*, January 12, 2004.

This new business model changes the relationship software firms have with their customers. In the old model, the relationship was distant, with little interaction except providing service or support. In the new model, software companies are constantly interacting with customers, so security and trust become big issues, particularly when it comes to the use of personal data and the reliability of the services being provided.[9]

For this system to work, different types of software need to be able to talk to each other over the internet, without human intervention. The World Wide Web Consortium is managing the development of standards to support that process, similar to the Hypertext Markup Language (HTML) that is the common face of much web programming, and is not owned by anyone.

This trend is further blurring the definition of what constitutes a software company. For instance, is Google a software company? Or Yahoo? Or eBay? They are web-based and provide the same kind of service that software running on PCs or corporate servers used to provide. But the code happens to reside on a remote server, rather than on a local computer.

Open Source. A related trend is the movement toward open-source software, which makes it possible for others to view and improve on the source code of software, rather than patenting it and licensing its use by others. The open source model is a direct challenge to existing licensing arrangements, and especially to companies like Microsoft, which has denounced these developments as a threat to intellectual property, and has embarked on a campaign to acquire as many software patents as possible.[10]

Here in the US, IBM once led the nation in amassing patents and licensing them, but in recent years Big Blue has made open-source software a key part of its business strategy, giving strong support to the Linux operating system, an open-source alternative to Microsoft's Windows. Recently, IBM announced that it is giving away rights to 500 of its patents to spur growth of the open-source movement. Other software companies are also getting on the bandwagon, or at least hedging their bets. With 25 percent of its deployments on the Linux operating system, Oracle has announced its unwavering support for the open source model.[11]

Overseas, there is a growing movement in support of open-source software, partly in reaction to the domination of US software firms, particularly Microsoft, and also as a way to introduce modern information technologies on limited budgets. Led by Brazil, a number of governments have passed legislation requiring government agencies, and in some cases government-owned companies, to use open-source software. In China, the government has chosen to install the Linux operating system on its computer systems as part of a strategy to avoid reliance on US software companies.[12] This has opened up opportunities for IBM, already the biggest player in China's business computer market, to also expand its software services.[13]

---

[9] Fred Hoch, "Brave New World," *Upgrade*, August/September 2003.
[10] Paul Festa, "Governments Push Open-Source Software," www.news.com, August 29, 2001; Jonathan Krim, "IBM to Help Open-Source Developers," *The Washington Post*, January 11, 2005.
[11] Michael Singer, "IBM, Oracle Lean on Open Source for Grid," www.internetnews.com, April 6, 2005.
[12] Festa, 2001.
[13] "IBM Eyes 50% Market Share," *China Business Weekly*, September 24, 2004.

Global Dynamics

U.S. firms lead the world in the development and production of software-related goods and services. Of the top ten software firms in 2003, eight were American (Germany's SAP and Japan's Softbank were the two non- U.S. firms). These ten firms earned about one-third of total global sales, and employed nearly 180,000 people.[14] Microsoft's revenues alone accounted for more than 15 percent of the global software market.

One of the first service sectors to shift significant activity overseas, the software sector has become highly globalized. The rapid growth in packaged software during the 1980s helped fuel the spread of high-technology industries across the major industrialized economies.[15] During the past two decades, financial incentives, the availability of skilled labor, and low wages helped trigger dramatic growth in the software sectors of many emerging economies. The most celebrated newcomers—Ireland, Israel, and India (the "3Is")—have become major software exporters, reaching sales in the tens of billions and growth rates in the double-digits.[16] Numerous other transitional and developing economies have developed extensive software sectors, and some are poised to become significant software exporters, especially China and Russia, but also Brazil, the Philippines, and Mexico.[17]

Each of these countries has followed its own path. Ireland, for example, was very successful in luring multinational corporations with tax breaks, a highly skilled workforce, the overhaul of their communications system, and access to the European market. During the 1980s, U.S. multinational companies like Microsoft focused mainly on manufacturing and distributing off-the-shelf products, including work like duplicating disks, printing manuals, and shrink-wrapping packages. During the 1990s, some of these companies also began to provide customized software development services for client companies. Although some indigenous Irish software firms have emerged, they are generally small and poorly funded, and the country remains dominated by U.S. multinational firms.[18]

In Israel, the software industry was preceded by a successful hardware industry, which was the product of national defense and economic development strategies to develop Israel's R&D capability, leveraging the country's strong academic research base. U.S. multinational corporations sought to take advantage of Israel's R&D capability by opening their own R&D centers there or by buying an Israeli technology company and transforming it into an R&D center. But U.S. multinational involvement in the software sector has been limited. Israeli software firms have been able to leverage new developments in information technology to create

[14] "Changing Dynamics of Global Computer Software and Services Industry: Implications for Developing Countries," United Nations Conference on Trade and Development (UNCTAD), 2002; and "OECD Information Technology Outlook," Organization for Economic Co-operation and Development, 2004.
[15] UNCTAD, 2002.
[16] Ashish Arora and Alfonso Gambardella, "The Globalization of the Software Industry: Perspectives and Opportunities for Developed and Developing Countries," Working Paper 10538, National Bureau of Economic Research, June 2004.
[17] Erran Carmel, "Taxonomy of New Software Exporting Nations," *The Electronic Journal on Information Systems in Developing Countries*, Vol. 13, May 2003.
[18] Anita Sands, "The Irish Software Industry," in Ashish Arora and Alfonso Gambardella, *From Underdogs to Tigers* (Oxford: Oxford University Press) 2005.

cutting-edge software applications, which they have used to penetrate foreign markets. They have secured financing from venture capitalists in the U.S. and from selling shares on the NASDAQ. Most Israeli firms maintain headquarters and R&D divisions in both Israel and the U.S.[19]

The country that has received the most attention is India. From a base of almost no software exports in the early 1980s, India has built a software and services export market worth $9.2 billion annually, with a domestic software market worth $3.6 billion.[20] Employing more than 450,000 people today, the software industry has grown 30 to 40 percent annually over the past decade.[21]

Unlike Israel, the Indian software industry has focused on customized software services, rather than products. Unlike Ireland, it has been led by domestic, rather than foreign, firms, which generate two-thirds of the industry revenues. In the 1980s, the shift from mainframe to networked computing created a huge demand for technical help in migrating data across the different systems. Indian firms were able to take advantage of a highly skilled technical workforce, low wages, and experience gained on earlier data conversion projects to expand. Multinational firms soon recognized that they could achieve significant cost savings by using the 10-hour time difference and dedicated satellite links between the U.S. and India to utilize idle hardware facilities in the U.S., effectively extending the U.S. work day with labor at one-fifth of the U.S. rate.[22]

Two other countries worth mentioning are China and Brazil. Although the software industries in both countries have experienced double-digit growth rates over the past decade, the path they've taken offers a sharp contrast to Ireland, Israel, and India. Both China and Brazil have focused mainly on developing customized software products and services for their own domestic markets, rather than for export. As the economies in both countries have expanded and adopted information technologies to improve productivity, the demand for software products and services also has expanded. This has created opportunities for domestic software firms, which have grown in number, even as multinational firms continue to dominate the market for large enterprises. But a focus on the domestic market also has a downside. Since neither country has an advanced economy, and the software developed domestically is tailored to local uses, domestic firms are limited in what they have to offer to other countries. In addition, both countries are constrained by language barriers and access to capital.[23]

Offshoring. The most controversial aspect of globalization in the software industry is the movement of some jobs overseas, particularly to India. During the 1990s, the widespread

[19] Dan Breznitz, "The Israeli Software Industry," in Ashish Arora and Alfonso Gambardella, *From Underdogs to Tigers* (Oxford: Oxford University Press) 2005.
[20] National Association of Software and Service Companies (NASSCOM), "IT Software and Services Market: Industry Trends (2003-2004)," http://www.nasscom.org/artdisplay.asp?cat_id=804.
[21] Arora and Gambardella, 2004.
[22] Suma S. Athreye, "The Indian Software Industry," in Ashish Arora and Alfonso Gambardella, *From Underdogs to Tigers* (Oxford: Oxford University Press) 2005.
[23] Ted Tschang and Lan Xue, "The Chinese Software Industry," and Antonio J. Juniqueira Botelho, Giancarlo Stefanuto, and Francisco Veloso, "The Brazilian Software Industry," in Ashish Arora and Alfonso Gambardella, *From Underdogs to Tigers* (Oxford: Oxford University Press) 2005.

diffusion of the internet, the use of standard software platforms in corporate systems, improved and cheaper telecommunication capabilities, trade liberalization in developing countries, and the availability of skilled, low-cost labor—especially English-speaking science and engineering graduates—propelled U.S. companies to begin off-shoring business processes. These processes range from lower-end data entry, customer support/billing, and call centers (back-office functions) to higher-end management consulting, engineering, and R&D.[24] Indian software firms were able to position themselves as low-cost outsourcing centers for global software needs, capable of delivering a team of highly skilled software professionals to any part of the world to do any software engineering job, or performing the work in their facilities in India.

Despite the rapid growth in the global sourcing of IT software and services in recent years, a body of evidence suggests that off-shoring has not led to net job losses in the U.S.—and, in fact, has created net additional value for the U.S. economy. First, offshore outsourcing mostly affects the IT jobs inside companies, not stand-alone software firms. Second, while services off-shoring has increased steadily, it remains at low levels, particularly vis-à-vis other phenomena that induce job shifts, such as automation/technological change, job churn, and mass layoffs due to corporate mergers.[25] A recent analysis suggests, for instance, that no more than 134,000 software sector jobs moved to India between 2000 and 2003.[26] While not insignificant, this figure is below the new annual services job increase of about 327,000 during that period, and is small compared to the 2.1 million service jobs that were created each year during the 1990s. Moreover, a study on IT outsourcing estimated that spending for global sourcing of computer software and services amounted to $10 billion in 2003, which represented a mere 2.3 percent of total IT software and services spending by U.S. corporations that year.[27]

Third, there is evidence that the number of jobs has grown, not declined, in many high-tech occupations considered susceptible to offshore outsourcing. One study finds that employment in white-collar occupations related to IT was stable or higher in 2003 than in 1999, and notes that the "computer and mathematical" occupations grew six percent over this period.[28] Finally, and perhaps most significantly, research shows that the jobs migrating offshore tend to be relatively low-skill and low-wage, and that their loss is counterbalanced by the creation of higher-skilled IT jobs. According to one recent estimate, the number of advanced and higher-paid IT jobs in the U.S. increased from 2000 to 2003, more than offsetting the loss of lower-skilled IT jobs.[29] Specifically, the number of high-value computer software engineers and computer and network systems analysts increased by 277,540 , while the number of lower-level computer programmers

[24] Kyle Eischen, "Working Through Outsourcing: Software Practice, Industry Organization and Industry Evolution in India," March 2004. *Center for Global, International and Regional Studies*. Paper CGIRS-2004-4.
[25] Mary Amiti and Shang-Jin Wei,"Demystifying Outsourcing: The Numbers Do Not Support the Hype Over Job Losses," *Finance and Development (IMF Quarterly Magazine)*, Vol. 41(4), December 2004; see also McKinsey Global Institute, "Offshoring: Is it a Win-Win Game?" August 2003.
[26] Martin Baily and Robert Lawrence. "What Happened to the Great American Job Machine? The Role of Trade and Electronic Outsourcing." *Brookings Papers on Economic Activity*. Ed. William C. Brainard and George L. Perry. Brookings Institution, 2004.
[27] Global Insight, Inc.,"The Comprehensive Impact of Offshore IT Software and Services Outsourcing on the U.S. Economy," March 2004.
[28] Catherine Mann, "Globalization of IT Services and White Collar Jobs: The Next Wave of Productivity Growth," *International Economics Policy Briefs*, December 2003.
[29] Bailey and Lawrence 2004; see also Jacob Kirkegaard, "Outsourcing—Stains on the White Collar?" Institute for International Economics Paper, February 2004.

decreased by 96,960. Moreover, the job categories projected to have the largest numerical increases over the coming decade include several advanced computer software-related occupations.[30]

Other studies advance the claim that the globalization of IT and software leads not only to outsourcing but also "in-sourcing," -- the process whereby foreign firms buy goods or services from U.S.-based firms. One analysis relies on BLS data to show that, from 1983 to 2000, the number of in-sourced jobs increased by 4 million, compared to a 3.5 million increase in number of outsourced jobs.[31] Another review claims that in-sourcing leads to higher-value jobs.[32]

A recent study conducted by Global Insight and commissioned by the Information Technology Association of America (ITAA), the U.S. IT industry's leading trade association, examined the impact of offshore IT software and services outsourcing on the U.S. economy and employment—one of the few studies specifically to have done so. Among other benefits, the study found that global sourcing of IT software and services created net new jobs, increased real GDP in the U.S., and increased U.S. workers' average wages. Specifically, it found that global sourcing created over 90,000 net new jobs in 2003, and predicted that the process would generate 317,000 net new jobs in 2008. It also estimated that the economy would create more IT jobs over the next five years in an environment with offshore outsourcing than without it (516,000 compared to 490,000). Moreover, the study found that global sourcing of IT software and services added $33.6 billion to real GDP in the U.S. in 2003, and increased the real wages of U.S. workers by 0.13 percent.

Another industry report likewise estimated that, for every dollar that the U.S. spent on outsourcing to India, it gained between $1.12 and $1.14 in benefits.[33] Such studies tend to attribute the anticipated gains from offshore outsourcing to a number of factors, including cost savings and greater flexibility, which in turn are expected to lead to greater productivity, lowered interest rates and lowered inflation.[34] In addition, outsourcing has allowed American firms to gain an advantage over their Japanese and European competitors.[35] While approximately 60 percent of U.S. companies conduct some IT work in low-cost countries, only 11 percent of European firms currently are outsourcing IT work, largely because they are constrained by language, social legislation, trade unions, and regulations.[36]

Design Work. There is concern that the higher-paid design work is also moving to India. For instance, a number of multinational companies, including Oracle, Microsoft, and Texas Instruments, have established "software development centers" in India, which undertake more sophisticated product development. Moreover, in an effort to "move up the value chain" and ultimately develop the capacity to create new products and offer IT "solutions" to clients, several

[30] Mann 2003.
[31] Daniel Drezner, "The Outsourcing Bogeyman," *Foreign Affairs*, May/June 2004.
[32] Jagdish Bhagwati et al. 2004. "The Muddles Over Outsourcing." Forthcoming: *The Journal of Economic Perspectives*.
[33] McKinsey Global Institute, "Offshoring: Is it a Win-Win Game?" August 2003.
[34] Global Insight, Inc. 2004.
[35] Arora and Gambardella 2004.
[36] "Sink or Schwinn," *The Economist*, November 11, 2004.

leading Indian software firms, such as Wipro and Tata Consultancy Services, have created R&D divisions.[37]

However, Indian R&D services and software products exports have not been substantial to date, amounting to $2.3 billion in revenues (or about 1.3 percent of the global software market).[38] In addition, foreign global software development centers in India are less productive than those in their home markets, especially the U.S.[39] In general, India's software industry is far less productive than that of the U.S., with revenue per Indian employee amounting to only about a quarter of the revenue of a U.S. employee.[40]

For the most part, the work performed by Indian software firms has focused on maintaining and enhancing existing software code, not designing new software. As the Indian software industry has expanded, firms have taken on larger projects, leveraging the experience and capability they have gained from previous efforts. However, most Indian firms have not taken on higher value-added design work.[41] While some U.S. software companies are conducting their design work overseas, the evidence suggests that high-level design work remains concentrated in the U.S. Microsoft, for instance, has set up research laboratories in several cities around the world, such as Bangalore and Beijing; yet the global software leader still conducts 85 percent of its R&D in the United States.[42]

Moreover, an increasing number of foreign-owned software companies are locating their design work in the U.S. in order to be close to customers in the world's largest market and to be situated in clusters with other innovative companies. The global R&D headquarters of several leading Indian software companies, for instance, are located not in India but in Silicon Valley.[43] Indian software firms have begun setting up operations in the U.S. to be nearer to their clients.[44] For instance, a 2002 Nasscom-McKinsey study found that around 270 Indian firms had established bases in the U.S.[45] Some of these firms, like Infosys and Wipro, have begun hiring U.S. workers as consultants.[46] Also, despite the global integration of multinational activities, multinational companies continue to perform their headquarters' services activities in the U.S. In addition, foreign multinational companies with U.S. subsidiaries are more likely to integrate their service transactions in the U.S. than at their headquarters abroad.[47]

The United States' strong comparative advantage in design stems largely from the fact that it has become the largest market for software services in the world, as well as the most advanced. For instance, new applications emerge and become standardized first in the U.S. As in other design

[37] Ashish Arora et al., "The Indian Software Services Industry," *Research Policy*, Vol. 30(8), October 2001.
[38] NASSCOM, "R&D/Offshore Product Development," http://www.nasscom.org/artdisplay.asp?cat_id=779.
[39] Eischen 2004.
[40] Arora and Gambardella 2004.
[41] Arora and Gambardella, 2004.
[42] David Vise, "Gates Cites Hiring Woes, Criticizes Visa Restrictions," *The Washington Post*, April 28, 2005.
[43] Eischen 2004.
[44] Narayan Ramasubbu et al., "Empirical Analysis of Quality Management Practices in Distributed Custom Software Development," *Proceedings of the Academy of Management Annual Meeting*, New Orleans, LA, August 2004.
[45] Cited in Ramasubbu et al. 2004.
[46] Olga Kharif, "The Outsourcing Boomerang," *Business Week*, August 11, 2004.
[47] Mann 2003.

activities, innovation in software development requires proximity to end-users with specific domain knowledge. In large part, this is because the creation of new software applications requires an intimate understanding of the demand for and use of such applications[48] This understanding (or tacit knowledge) is best gained through direct client contact and interaction.[49] Hence, both U.S. companies and foreign-owned firms tend to maximize productivity and quality by locating within the vast final markets in the U.S.

A number of other factors serve to maintain the presence of critical design activity within U.S.-based firms—and, conversely, to limit the potential for U.S. offshore outsourcing of high-level software jobs. First, the U.S. provides sufficient access to software talent through production of highly skilled labor and, perhaps more significantly, the attraction of skilled labor from abroad. Second, the U.S. has the world's strongest venture capital market, which firms tend to access more successfully when they have a presence in the country.[50] Third, design work tends to be a proprietary source of competitive advantage. Weak intellectual property laws overseas, especially in India, dampen enthusiasm for outsourcing such work to foreign-owned companies. Fear of security breaches likewise limits global outsourcing.

Finally, there may be limits to the offshore outsourcing of software design work based on the very nature of software development activity. As theorists have observed, the process of software development is fundamentally a process of tacit knowledge communication, approximating a craft-like activity.[51] To be effective, such communication requires agglomeration, not only near final markets, but also within the development process, for example, face-to-face communication between software developers. It appears that distance matters for purposes of higher-end software development.[52]

For these reasons, it is likely that the U.S. will remain a leader in software innovation for the foreseeable future.

Immigration. However, fears of a shortage of scientists and engineers continue to worry software industry leaders. The number of US citizens pursuing PhDs in science and engineering in US universities has not changed very much over the past decade, but the proportion of US candidates in science and engineering PhD programs has declined significantly, from 77.5 to 58.3 percent. Almost all of the growth in the number of science and engineering PhDs awarded in the past decade has come from foreign students. As a result, US reliance on foreign-born scientists and engineers has greatly increased.

Foreign-born workers now account for one-fifth of all core IT workers, up from one-tenth in the mid-1990s. Asian immigrants alone now account for 13 percent of all IT workers – with nearly one-third of them from India.[53]

[48] Arora and Gambardella 2004.
[49] Eischen 2004
[50] Arora and Gambardella 2004.
[51] Eischen 2004.
[52] Eischen 2004.
[53] The IT Workforce Data Project, 2003.

Legislation in the 1990s paved the way for this rapid rise in foreign-born worker participation in the IT workforce by expanding the number of persons allowed to enter the US with H-1B temporary worker's visas. As the high-tech industry boomed in the 1990s, the cap was raised from 65,000 to 195,000. The number of L-1 visas, which help multinational businesses transfer workers with "specialized knowledge" to the US, also tripled in the past decade. Indian workers are by far the largest users of the L-1 visas, accounting for one-quarter of the total in 2002.

High unemployment in the IT sector, following the dot.com bust, provoked a backlash against the industry's heavy reliance on foreign-born workers. The cap on the H-1B visa program was allowed to revert back to 65,000, although later raised by 20,000 in response to pressure from large high-tech firms, who complained that they couldn't find qualified workers in the US and who worried that there would be a brain drain from the US if foreign students were forced to return home after graduation.

There were also some restrictions added to the L-1 visa program in response to reports that employers were moving large numbers of non-U.S. engineers and information technology professionals to the United States as a source of lower-cost contract labor. Several foreign corporations even established U.S. subsidiaries specifically for that purpose. L-1 visas do not have an annual cap and are not subject to prevailing wage laws.

China and India have led other nations in the number of students enrolled in IT-related programs in US universities, and in the number of H-1B visas approved by the INS. But those two countries have also made great strides in educating their own IT workforces. Between 1997 and 2001, the number of IT graduates from accredited programs in India rose from 42,800 to 71,000, compared to an increase from 37,000 to 52,900 in the US over roughly the same period.[54] China is catching up, with 41,000 IT graduates in 2001. In overall science and engineering, China has increased its number of graduates by 75 percent over the past decade, compared to an 8 percent increase in the US.[55]However, there is some evidence that only about 13 percent of university graduates in other countries are suitable for employment by multinational companies – the figure is 25 percent for India and 10 percent for China.[56]

Nevertheless, with IT salaries rising in both India and China, and restrictions on finding employment in the US, there is a growing risk that foreign students in the US will take the lessons from their participation in cutting-edge research in US universities back to their home countries to support the growth of competitor firms there. There is also a risk that they would choose never to come to the US in the first place. If more foreigners decide to start their careers and their own companies back in their home countries, the US could find itself lacking a vital resource.

[54] Arora and Gambardella, 2004.
[55] Babco, 2004.
[56] Diana Farrell, Martha A. Laboissiere, and Jason Rosenfeld, "Sizing the Global Labor Market," *The McKinsey Quarterly*, 2005, Number 3.