THE INFORMATION TECHNOLOGY WORKFORCE GAP: AN ANALYSIS OF THE U.S. AND INDIA

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The authors of this report are Melissa Andrews, Anthony Devassy, and Nancy O'Hehir, candidates for the Master of Public Policy (M.P.P.) degree at the College of William and Mary. The content of this report does not reflect the views or opinions of the Center for Public Policy Research, The Thomas Jefferson Program in Public Policy, or the College of William and Mary, but rather those of its authors.

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EXECUTIVE SUMMARY

The United States is unable to meet its requirements for skilled software personnel from the available pool of domestic workers. This increasing shortfall is, in part, a consequence of decreases in the number of students choosing to study technical disciplines.

India produces large numbers of English-speaking, technically qualified personnel which U.S. software companies rely on to meet the shortfall. However India does not produce sufficient numbers of professionals to satisfy the requirements of both the U.S. and India.

Britain, Germany, and Japan also have booming software sectors and a resulting increased demand for skilled IT workers which has to be met, in large part, from the same pool of Indian professionals.

The increased reliance on foreign skilled workers is not in the national interest of the United States. For the U.S., significant policy changes will have to be made in domestic education to increase the long-term availability of highly skilled computer professionals.

These U.S. policy decisions will also have to be based on considerations of policy changes in India and the continuing global demand.

MISSION STATEMENT

To examine and analyze the gap between U.S. IT workforce requirements and availability, focusing in particular on India as a source of qualified IT personnel.

THE INFORMATION TECHNOLOGY WORKFORCE GAP: AN ANALYSIS OF THE U.S. AND INDIA

"Since information technology is an enabling technology that affects the entire economy, our failure to meet the growing demand for IT professionals could have severe consequences for America's competitiveness, economic growth, and job creation."

- U.S. Dept. of Commerce, Office of Technology Policy, 1998

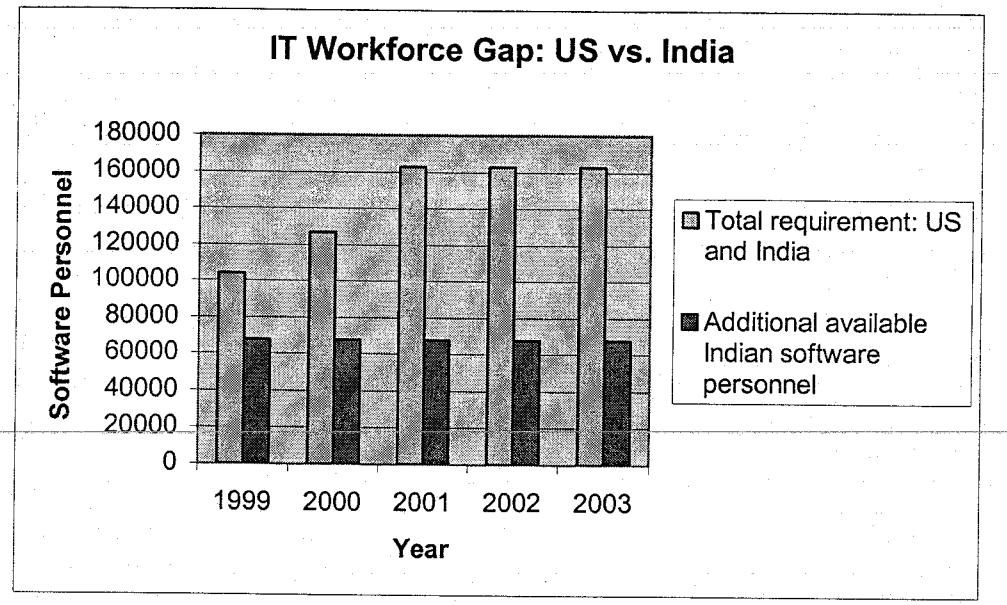
SCOPE OF THE PROBLEM

As the United States' information technology industry has grown beyond the supply of American workers, the reliance on foreign IT workers to meet the personnel demand has increased. Indian workers, in particular, are appealing to the U.S. information technology industry due to their command of the English language and the training they receive from India's prestigious information technology educational system.[1] This report will center on the increasing gap between U.S. workforce needs and availability, focusing on India as a source of qualified IT personnel.

Due to pressure from U.S. high-tech firms, Congress has raised the annual limit on H1-B visas—a temporary work visa that allows highly skilled foreign workers into the U.S.—by over 200% in the last two years, issuing 200,000 visas this year alone. Historically, about half of the H1-B visas issued each year have gone to Indian workers.[2] Despite the increasing numbers of foreign workers entering the United States to fill open IT positions, there continues to be an unmet demand for skilled Indian IT workers. Table 1 depicts the *annual* shortfall of Indian software personnel for both the U.S. and India.*

* U.S. numbers represent 45% of the H1-B visas allocated each year (65,000 in FY 1999, 115,000 in FY 2000, and 195,000 annually in FY2001-FY2003. Indian numbers are based on the need of 30,000 new workers each year. Additional available Indian software personnel is approximately 65,000 each year.

Table 1.



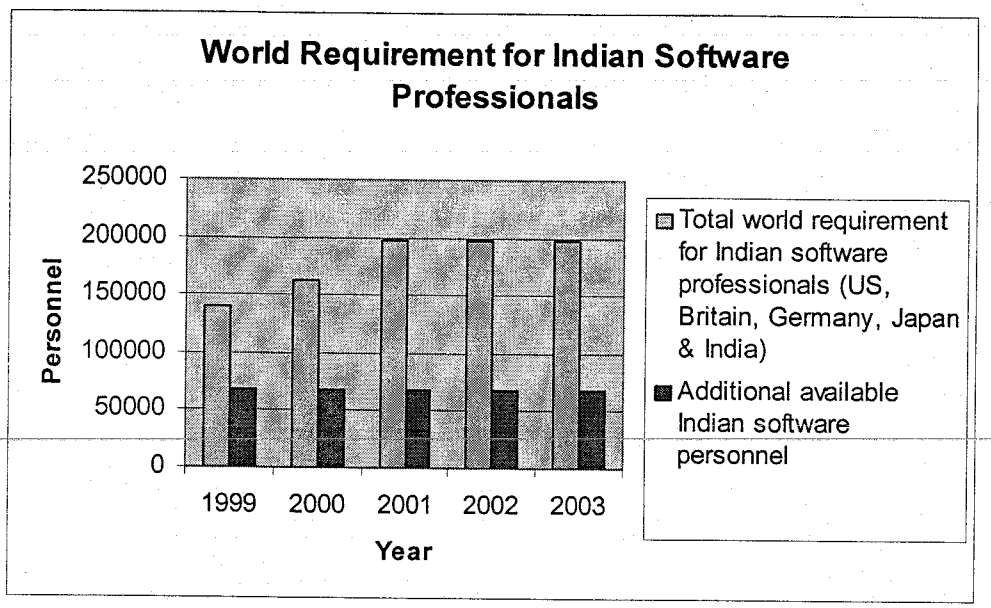
SOURCE: NASSCOM

This annual shortfall can be attributed to the fact that India is only capable of producing about 65,000 new IT workers every year. In addition, India's domestic IT industry has expanded in the last decade, leading to increased domestic demand for workers and thus, lowers levels of emigration. Because these numbers are conservative, this graph represents the minimum size of the annual gap. As the need for personnel goes unmet each year, the size of the cumulative gap grows rather quickly.

However, the U.S. and India are not alone in facing the problem of an IT worker shortage. Britain, Germany, and Japan—all three of which recently changed their visa policies in order to increase the number of Indian software professionals entering their respective countries—join the U.S. and India to comprise the global demand for Indian IT workers. Table 2 shows the *annual* global shortfall of Indian software personnel, including the U.S., India, Britain, Germany and Japan.*

* U.S. numbers represent 45% of the H1-B visas allocated each year (65,000 in FY1999, 115,000 in FY2000, and 195,000 annually in FY2001-FY2003). India's numbers are based on the need of 30,000 new workers each year. British, German, and Japanese requirements are based on the number of visas specifically set aside for Indians. Additional available Indian software personnel is approximately 65,000 each year.

Table 2.



SOURCE: NASSCOM

With the added need of these three countries, the gap already apparent from the U.S. and Indian requirements becomes even more pronounced.

U.S. IT INDUSTRY

"America's electronics and information technology industry is driving national economic growth"[3]: since 1995 30% of U.S. economic growth can be attributed to the IT industry. In FY 2000, the IT industry represented 8.3% of the economy.

The IT industry, originally centered around Silicon Valley, has also proven to be a major source of employment. From 1992 to 1998 the software industry workforce nearly doubled reaching a total of 1.6 million workers. The total U.S. IT industry, which includes software, hardware, and other sectors, represented 6.1% of the U.S. workforce in 1998. Workers in the high-tech industry make on average, 73% more than the average private sector wage in the U.S.[4]

However, the Department of Commerce states that one of the strongest indicators of a worker shortage in the United States is the upward climb of salaries.[5] So, despite being the world leader during the Information Age, the U.S is having difficulty supplying an adequate number of workers to meet the IT industry's demand. A survey performed by the Information Technology Association of America on mid- and large-size U.S. companies estimates that in 1997 there were about 190,000 unfilled IT jobs in the U.S. due to worker shortages.[6] The Bureau of Labor Statistics goes on to project that the U.S. software industry will grow at a rate of 9.3% annually, leading to an employment level of 2.5 million by 2006.[7]

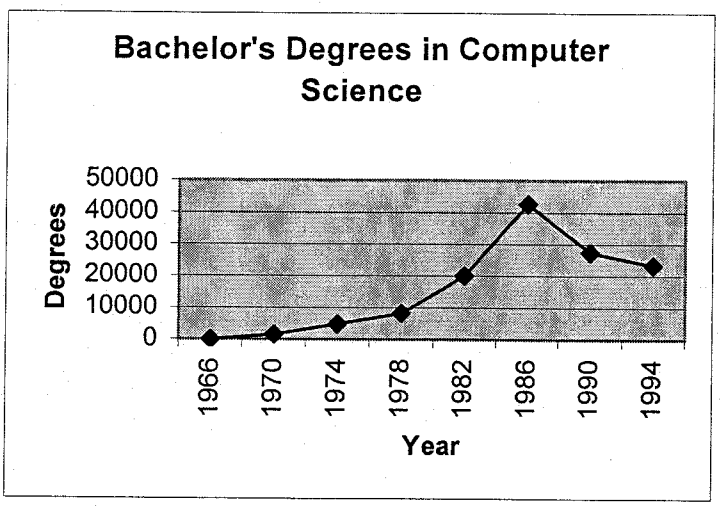
U.S. EDUCATION AND TRAINING

This workforce gap in the IT industry and the resulting need for a steady inflow of foreign personnel indicates a lack of qualified domestic workers. The American education system is simply not producing enough workers to fully staff this growing and increasingly important industry. The American Electronics Association notes:

> Although all current projections anticipate tremendous growth and job creation in most of the high-technology sectors, the current labor pool of qualified workers is at best stagnant, and in some cases, shrinking. As the demand for technology workers from key academic disciplines has grown stronger, the number of graduates in key technology disciplines has declined in many technical disciplines.[8]

After dramatic increases in the late 1970s and early 1980s, the U.S. has experienced a sharp decline in its number of computer science graduates over the last 15 years. In 1994 only 24,553 students graduated from four-year institutions with a bachelor's degree in the computer and information sciences (Table 3). This represents a 40% decline from 1986 (42,195 graduates).

Table 3.

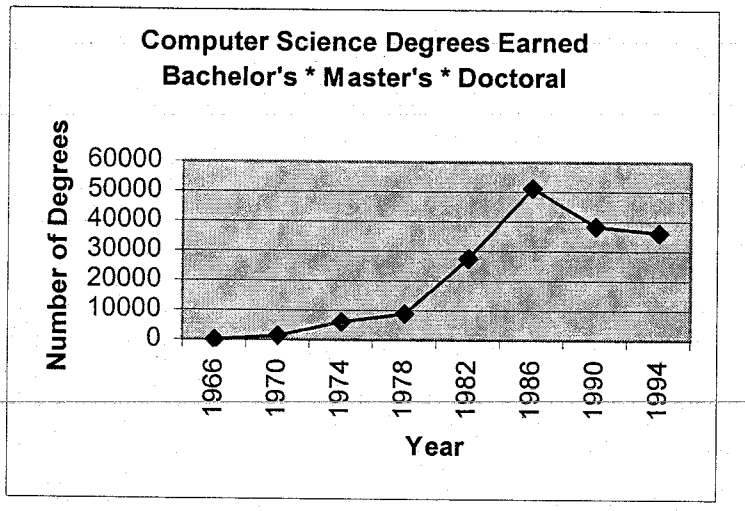


SOURCE: National Science Foundation; U.S. Department of Education, National Center for Education Statistics.

The computer science courses at the four-year undergraduate institutions focus on computer theory: operating systems, languages, distributed systems, and computer architecture.[9] Although these graduates are generally very knowledgeable about their chosen field, they are not being trained in the specific skills demanded by the current market. This may be one reason why there has been a decline in the number of students deciding on this course of study.

Although bachelors degrees awarded in these fields have steadily dropped, there have been some small increases in degrees conferred at the master and doctoral levels. However, the combined number of degrees at all levels has slipped from a high of about 50,000 in 1986 to 36,000 in 1994 (Table 4).

Table 4.



SOURCE: National Science Foundation; U.S. Department of Education, National Center for Education Statistics.

These figures only represent the formal four-year college and university sectors of American education and as such are not a complete indicator of the declining domestic IT labor supply. Many workers acquire their skills through either informal training (on-the-job) or through alternative education and training options including:[10]

- Two-year associate degree-granting community colleges which emphasize computer applications as well as basic theory, and vocational technical educational programs
- Special university and community college one-year programs intended to upgrade or enhance the skills of IT workers, or those with technical backgrounds in other fields trying to break into the IT sector
- In-house company training to supplement current employee skills or transition them from one skill set to another

In addition to those who earned a bachelor's, master's, or doctoral degree in computer science in 1994, 15,187 degrees and awards in the computer and information sciences were conferred below the bachelor level.[11] Students from these programs are also in high demand and these institutions represent an important avenue of worker supply for the IT industry.

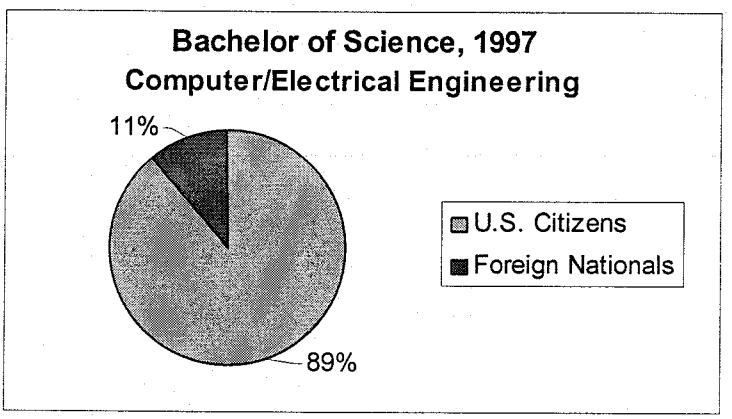
Several reasons have been suggested for the decline in students earning computer science degrees in the United States:[12]

- Only about half of all U.S. high school graduates complete courses in algebra II or chemistry—both of which are prerequisites for college math and science
- Many students believe that colleges and universities do not provide training that matches marketplace demand, particularly with respect to understanding the software development process in an industrial setting
- On-the-job training is increasingly substituting four-year university degree programs in computer science

While workers with computer science degrees from two- and four-year college and university programs are attractive to potential employers, many employers have found that the skill sets of some of these applicants are incompatible with their needs. For example, these graduates may have been heavily trained in computer theory while employers are looking for IT workers who are skilled in networking/distributed computer environments or large software projects, who have real world experience, and who are capable in business and industrial settings.[13]

Increasingly, high-tech companies are discovering that many of the students available to them from the U.S. university system, especially at the graduate levels, are not even from the United States.[14] In 1997, of the 19,660 Bachelor of Science degrees in computer engineering and electrical and electronic engineering, 2,132 (11%) were awarded to foreign nationals (Table 7).

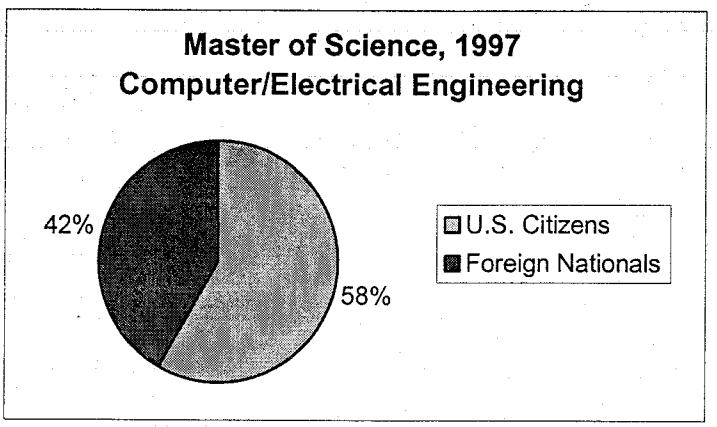
Table 7.



SOURCE: Engineering Workforce Commission of the American Association of Engineering Societies

As the academic level rises, the percentage of Americans earning these technical degrees gets smaller. In these same courses at the graduate level, 42% (4,702 of 11,121 total) of all Master of Science degrees were awarded to non-U.S. citizens (Table 8);

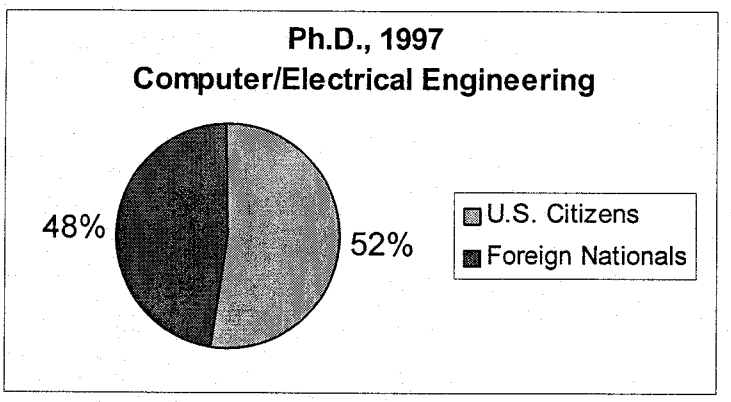
Table 8.



SOURCE: Engineering Workforce Commission of the American Association of Engineering Societies

and at the doctoral level, 48% (1,066 of 2,229) of all Ph.D.s in computer engineering and electrical and electronic engineering were awarded to foreign nationals (Table 9).

Table 9.



SOURCE: Engineering Workforce Commission of the American Association of Engineering Societies

Not only has the total number of degrees conferred in computer science decreased steadily since 1986, the percentage of these students who are American has also decreased. These facts indicate the American IT industry's near complete reliance on foreign nationals.

U.S. VISA REGIME[15]

In order to meet the needs of the growing industry, U.S. companies have begun to look outside American borders for workers. These foreign workers are brought into the U.S. on an H1-B visa which is a temporary work authorization that requires the applicant to have at least a bachelor's degree and specialized skills. In addition, the applicant must be sponsored by a U.S. company and the fee for the application is $500. Once the visa is obtained it is valid for three years with the option to renew for an additional three.

In the last couple of years, the number of H1-B visas issued by the U.S. has risen dramatically going from 65,000 to 115,000 visas in FY2000. More than half of those issued this past fiscal year went to high-tech workers and almost half of them went to Indian workers.

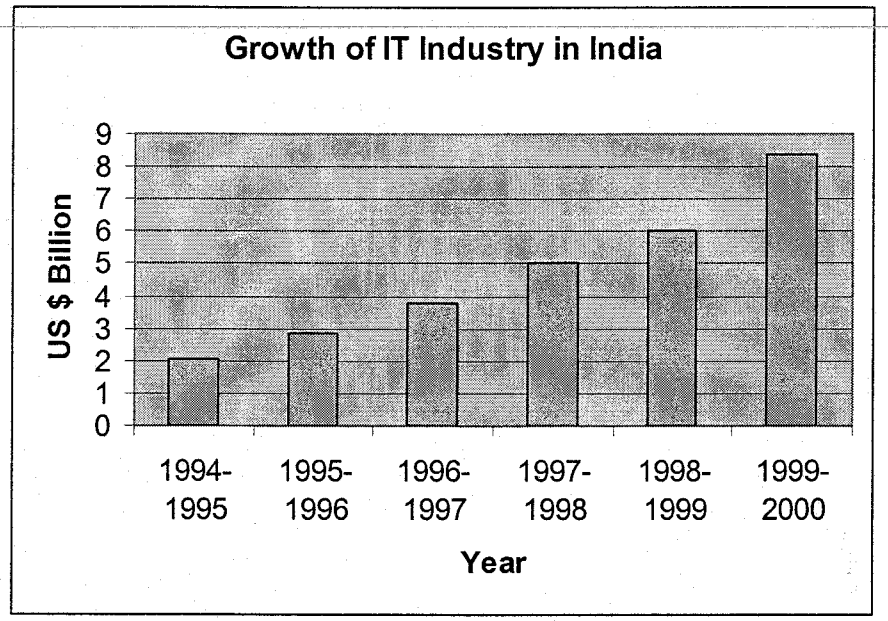
However, the cap of 115,000 visas was reached just six months into the fiscal year. As a result, legislation was passed in early October 2000 that raised the cap to 195,000 H1-B visas each year. This was done due to pressure from some of the major U.S. IT companies who claim that they cannot find enough qualified workers in the U.S. to fill their needs.

The legislation included some amendments introduced by Senator Dianne Feinstein. The amendments seek to improve the domestic IT sector and knowledge by allocating more of the $500 application fee to domestic IT education as well as attempting to reduce Immigration and Naturalization Service backlog by shrinking H1-B turnover rates to 30 days.

INDIAN IT INDUSTRY

Despite slow growth in the overall Indian economy and a less-than-healthy GDP growth rate, the Indian IT industry has experienced phenomenal growth within the last decade. In fact, between FY1998 and FY1999 India's IT industry experienced a 33% increase in earned revenues, reaching over $6 billion.[19] The value of their domestic software sector in particular, has undergone a huge increase rising from $150 million to $5.7 billion in just the last eight years.[20] Interestingly, of the $5.7 billion revenue for 1999-2000, $4 billion can be attributed to software exports which have had an annual growth rate of over 50% for the past decade. The National Association of Software and Services Companies (NASSCOM) states that total annual software exports for India could be worth $10 billion by the year 2002.[21]

Table 5.



SOURCE: NASSCOM

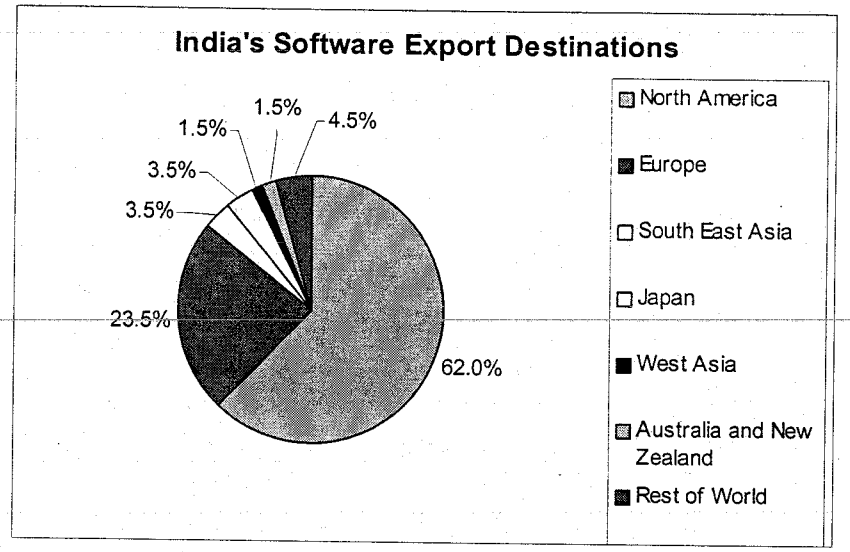
Projections made by NASSCOM estimate that between April 1, 2000 and March 31, 2001 India will export about $6.3 billion worth of software and sell an additional $2.5 billion domestically.[22] This indicates that the Indian IT industry is supported not by a domestic market but by foreign demand, particularly from the U.S. For instance, between 1999 and 2000 more than a third of the Fortune 500 companies outsourced their software requirements to India.

In 1999, over 250,000 people were employed in the Indian software industry alone, which continues to be one of the fastest growing sectors of the Indian economy. India has a record 1,250 software exporting companies this fiscal year, with an increase to over 1,600 expected for fiscal year 2001.[23] However, with continued growth expected in the areas of IT services, software products, IT enabled services, and e-businesses the NASSCOM-McKinsey report projects that India has the potential for over two million IT jobs by 2008.[24] In addition, they estimate that the IT industry will have revenues of $87 billion by the same year.[25]

Currently India exports software to 95 countries around the world, which represents a 53% increase since 1990.[26] A majority of the exports (Table 6: countries in descending order of

their share of Indian exports) are to the U.S. and Europe, comprising about 85% of total Indian software exports.[27]

Table 6.



SOURCE: NASSCOM

The global market for India's software continues to grow. This past year, the U.S. alone imported 60% of India's software exports. Software trade with Europe has experienced great increases in the last few years. During 1999-2000 a total of $920 million worth of Indian software was exported to Europe, with the UK being the most common destination.[28] In addition, India's software exports to Japan is expected to more than triple in the next three years, rising from its FY2000 level of $140 million to $500 million in FY2003.[29]

Foreign direct investment (FDI) is also a major part of the Indian domestic IT industry. Although it was limited for some time, national regulations of foreign investment were liberalized in the 1990s and since then, several major companies have begun setting up offices in India.

Many of the companies entering India see their investment as a long-term commitment and of great importance to the growth of their organization. For instance, Gary Jackson, Vice President of Asia Operations for Cisco Systems said:

> We are seeing phenomenal growth in the Internet and telecommunications markets in India and there is tremendous potential for the country to establish itself as a leader in the Internet Economy. Our investments in the country are a symbol of our commitment to do what we can to help the country achieve that through next-generation infrastructure equipment and transfers of skills and knowledge.[30]

Currently, Cisco Systems, the worldwide leader in networking for the Internet, employs about 500 workers in its offices throughout India. The development and testing of Cisco products is done at the Cisco Global Development Center in Bangalore, its largest R&D facility outside of the United States. In August 2000, Cisco Systems announced its plan to invest $150 million over the next two years on expanding their Indian offices. Specifically, they plan to increase

employee strength by 300% and expand the R&D activities of the Cisco Global Development Center.[31]

Oracle, the world's largest supplier of information management software, started its Indian subsidiary in 1993. Today 75 of the *Economic Times* top 100 companies are Oracle customers in India. Oracle has based two of three international Research Development Centers and a Product Engineering Center in India.[32] In addition, they set up an India Development Center in Bangalore to be a "strategic part of developing products for the global marketplace." Since its founding six years ago the India Development Center has experienced great levels of growth having tripled in size in the last 18 months alone.[33]

In the past 15 years several other companies have opened up what began as small offices in India to take advantage of the large pool of engineering talent and have since expanded to employment levels in the thousands. For instance, Motorola began dealing with India in 1986 when it identified India as a strategic country partner. Today it has 1,200 employees and encompasses all of the advanced technologies, products, and services it markets globally.[34] In 1992 IBM set up shop in India, and currently employs about 2,400 professionals and is among the leading IT companies in the country.[35] And finally, Intel—the world's largest chipmaker and a leading manufacturer of computer networking and communications products—set up a development center in Bangalore in 1999 in order to meet its worldwide engineering development requirements. By the end of 1999, Intel had invested in over a dozen companies.[36]

Interestingly, a majority of U.S companies' Indian subsidiaries are managed by Indian repatriates who received advanced engineering degrees from American universities as well as several years of work experience with the parent company in the United States.[37]

INDIAN IT EDUCATION

Each year more than 45,000 Indian students choose to attend American colleges and universities and America is the first choice of more than 90% of Indian students who wish to obtain a degree abroad.[38] This, however, is not an indication of a lack of educational opportunities in India since there are currently over 1,800 education institutes and polytechnics in the country. Each year these combined institutions produce over 65,000 software professionals.

Most of these technology institutions are recognized or accredited by the government. There are, however, many private institutions that produce IT professionals as well, the number of which is growing because of the high demand for workers. The most prestigious of the government-sponsored institutions are the Indian Institutes of Technology (IITs) with six campuses in Mumbai, Delhi, Kanpur, Kharagpur, Chennai, and Guwahati. Competition for the nearly 3,000 spaces per year is quite severe with more than 100,000 annual applicants—a number that grows each year.[39] At the next level down on the academic ladder are the 17 Regional Engineering Colleges (RECs), entrance into which is also extremely competitive. For those students who lack the academic skills to gain admission to one of the IITS or RECs, they can enroll in private computer institutes. They often do so with the hope that the extra training will earn them job offers and visa sponsorships in the United States. Tuition for such schools can be as much as $10,000 for a four-year program. Because admission is based on a student's ability to pay rather than academic qualifications or potential—and because the industry is aware of this—students from the IITs and RECs are generally the ones that get the best job offers not only domestically, but from foreign companies including those in the U.S. In fact, these prestigious and competitive institutions are a likely place for foreign IT companies to "bodyshop."

To fulfill its domestic needs there are several institutions at the certificate and diploma level that train students specifically in certain skills.[40] These students don't have the option to emigrate to the U.S. since at least a bachelor's degree is required to obtain an H1-B visa, but it does exemplify the considerable domestic demand for trained IT professionals.

The growth of IT education in India has been drastic during the last decade. Generic courses in the computer science and engineering fields have grown at a rate of 20% annually while specialized courses in specific computer languages and programs (such as Java and C++) have grown at a rate of 60% annually. This rapid growth in specialized courses illustrates the domestic and international demand for workers trained in specific subjects—the less time a company has to invest in workers, the less cost they are is to the company.

EMIGRATION OF INDIAN IT GRADUATES

In addition to the high level of skill Indian IT professionals bring to the workplace, the ongoing efforts of major U.S. IT companies to recruit Indian workers can be attributed to the fact that India houses the second largest professional scientific English-speaking population—second only to the United States. Thus, the transition and adjustment time Indian immigrant workers have in the United States is kept to a minimum.

Until very recently, India had been experiencing a "brain drain" of its IT professionals. In 1993 84% of Indian IT graduates immigrated to the United States; in 2000, that number dropped to 60%.[41] This decrease is certainly not due to lowered U.S. demand for workers. There are, however, two likely explanations: 1) Increased FDI in India: More and more foreign companies are setting up plants and offices in India thus increasing the number of domestic jobs. Indians are no longer forced to go overseas to find high-tech jobs; 2) Cultural issues: Many Indians would rather not leave the country because of language barriers, family ties, and different cultural norms in the countries that are seeking their services. In short, now that there are more high-paying high-tech domestic job options and opportunities, many graduates will decide to stay.

Of those graduates who do choose to emigrate to the U.S., more and more are deciding to return home without trying to extend their contracts or obtain new visas. Many will work the time limit on their H1-B visa (six years as a maximum), save as much money as possible, and then return home. For many of these professionals, working in the U.S. is a short-term means to a long-term goal of settling in India and perhaps starting a software firm or investing in one with their American earnings. If this trend continues—and there is evidence that it will[42]—eventually, even more Indian IT graduates will be absorbed into the domestic labor force, widening the American workforce gap.

GLOBAL COMPETITION FOR INDIAN IT WORKERS

As a consequence of phenomenal growth in the British, German, and Japanese software industries the same pool of qualified Indian IT personnel has to satisfy their growing demand as well.

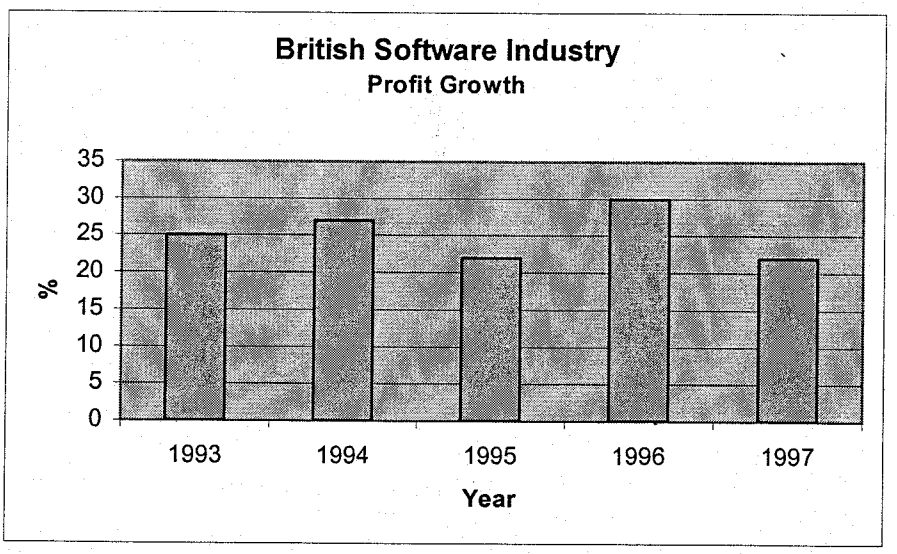
United Kingdom

Software Industry[43]

The British software industry has 30,000 companies with a combined annual turnover of £11b. Since 1993 the British software industry has achieved a growth rate of 10% per year—one of the highest in Europe. Between 1996-99, non-UK revenue was up a third to £3.6b. Profits have increased by more than 20% since 1993. The reasons for this growth are:

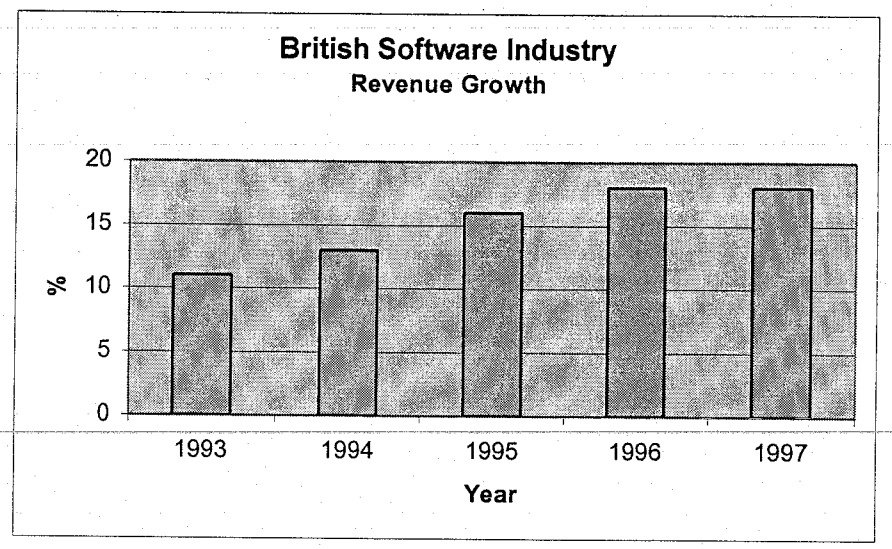
1. A sound macro economy with low inflation and sound finances
2. A skilled and flexible workforce
3. A strong regulatory framework to accredit training courses at all levels
4. A strong tradition of research and innovation in both academia and industry
5. An international view of world markets
6. One of the most open markets in Europe which allows diverse and innovative companies to flourish
7. Successful related industries including computer services and telecommunications
8. An advanced and competitively priced telecommunications infrastructure, which is vital to the success of any digital industry

Table 10.



SOURCE: *Britain's Software Industry,* (UK: FCO, 1998)

Table 11.



SOURCE: *Britain's Software Industry,* (UK: FCO, 1998)

The total number of unfilled IT positions is expected to reach 300,000.

Migration[44]

In 1998, the net inflow of professional and managerial professionals into the United Kingdom was 37,900 with the net inflow of students during the same period being 37,500.

Visas

Recent policy changes have removed the requirement of foreign-trained professionals (including software professionals) of having two years of post-graduate experience before applying for jobs in Britain.

The British Government recently increased the number of visas that were to be made available to professionals with specialized skills by 30,000.[45] The government minister who announced the new visa regime indicated that they were to be targeted at maintaining the growth rate in high-tech sectors such as information technology.

Germany

Software Industry

The German software industry hired around 35,000 new workers during 1999. This year's expected payroll growth is 60-70,000 with only 20,000 workers being drawn from outside Europe. The total number of unfilled positions in the entire German IT industry is expected to be 75,000.[46]

Visas[47]

The new visa authorizations are only meant to cover a temporary spike in demand for skilled IT professionals and will be limited to a 5-year period beginning August 1, 2000. However, temporary authorizations are to be issued in a quick and non-bureaucratic fashion with the availability of electronic approval mechanisms. The restrictions surrounding the issue of these special authorizations are rather rigid on both the employer and employee—spouses of entering professionals are not permitted to work while in the Federal Republic and the minimum required salary of DM 100,000 ($46,000) is too high for many German companies. Furthermore,

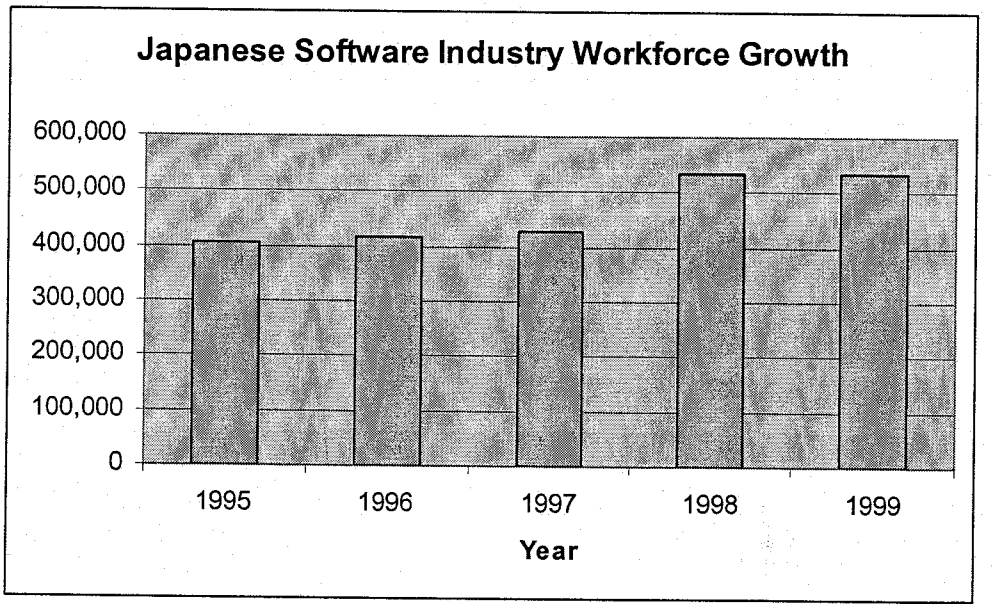
the German Embassy in India has issued guidelines which specify that only those IT professionals with information technology degrees will be eligible for fast-track green card processing. This is a significant obstacle for many Indian IT specialists as most of them have engineering degrees and diplomas and not IT degrees.

Of the 20,000 visas earmarked for IT professionals, the new visa regime is specifically designed to support 10,000 work and residency program applicants from India with the possibility of a doubling this number should demand so warrant.

Japan

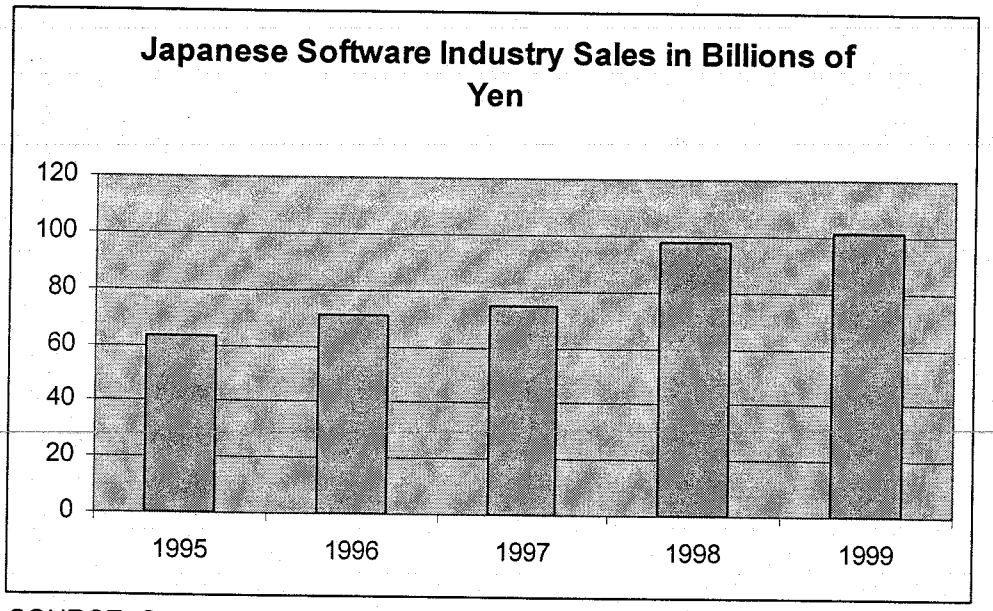
Software Industry[48]

Table 12.



SOURCE: Government of Japan, Ministry of Commerce, *Information Service Industry*

Table 13.



SOURCE: Government of Japan, Ministry of Commerce, *Information Service Industry*

The acute shortage of qualified personnel in the Japanese software industry has assumed crisis proportions. The Japanese Government has decided that foreign skilled labor is to be used to not only keep the economy going but to also attempt to maintain the country's competitive edge in the global IT industry.

In a recent survey of software developers, more than 40% indicated that they were experiencing human resource shortages. This figure is particularly striking since the same survey revealed that 43% of the Japanese IT industry believed that software development was going to be the direction of future business growth and development. The shortfall in the number of skilled IT workers is expected to be around 200,000.

Many Japanese companies are setting up recruitment offices in India. Since the perceived (and actual) significant barrier to effective recruitment efforts in India is the language difference, there have also been efforts to set up Japanese language centers.

Migration[49]

Of the total number of foreign nationals who entered Japan in 1998, the number of engineers was 32,890 with 22,058 coming from Asia.

Table 14. Number of Indian Nationals Entering Japan

1990	1995	1997	1998
20,623	25,070	33,316	34,819

SOURCE: Government of Japan, Statistic Bureau, Management and Coordination Agency, *Japan Statistical Yearbook 2000*, 2000

Table 15. Registered Foreigners

1990	1995	1997	1998
3,107	5,508	7,478	8,658

SOURCE: Government of Japan, Statistic Bureau, Management and Coordination Agency, *Japan Statistical Yearbook 2000*, 2000

Visas

In an effort to increase the number of skilled specialists recruited from India, the Japanese Government has introduced a special work visa category. This category is characterized by relaxed visa and work permit rules including the enhancement of the number of multi-entry visas for up to three years.[50]

The Japanese Government has indicated that it will be issuing over 10,000 work visas specifically targeted at Indian software engineers.

U.S. POLICY DECISION FACTORS

The overriding strategic goal of the United States will be the maintenance of Strategic Information Dominance (SID) which is defined as "[T]he ability to use information technology on a grand scale to insure national security and deny all kinds of global adversaries the opportunity to attack national interests".[51]

Given this strategic goal, the policy decisions of an American policymaker that are related to the IT workforce gap would have to be based on a consideration of:

- U.S. education
- Indian public policy factors
- The global competition for Indian IT professionals

U.S. Education

As part of a broad-based education agenda and in order to alleviate the domestic shortage of IT professionals (and hence lessen the reliance on foreign workers), the federal government has initiated several programs to try to raise the technical skills of the domestic American workforce:[52]

- Improving math and science education: The Goals 2000 Educate America Act of 1994 was designed to raise American students' competencies in math and science. Most of the responsibility for this program rests with the school systems at the state and local levels though the federal government plays a role in encouraging improvements.

- Enhancing school-to-work opportunities: The School-to-Work Opportunities Initiative serves as the catalyst for the creation of state and local systems that better prepare students for college and careers. Funding for this initiative creates programs that integrate academic and vocational learning, expose students to a wide range of career opportunities, create internships and other work experiences, and forge links between high schools and post-secondary education institutions.

- Improving technological literacy: There are four goals that guide the federal government's technology literacy agenda:
    1. Connect every school and classroom in America to the Internet
    2. Provide access to modern computers for all teachers and students
    3. Develop effective software and online learning resources as an integral part of school curriculum
    4. Provide all teachers with the necessary training and support to help students learn through computers and the Internet

Improving the technical skills of American students and encouraging opportunities that expose them to technical careers can influence their choices throughout their academic life.

The fact that there is incomplete information about the labor market contributes to the increasing problem of a workforce shortage. The U.S. Office of Technology Policy reported that in trying to analyze the IT sector, it found that available information and data was inadequate to "completely characterize the dynamics of the IT market."[53] This information problem extends to those in the industry itself. Without sufficient information about what is available in the job market, and where the best students are coming from and what they've learned, neither

educational institutes nor businesses can gauge their goals and achieve an efficiently-functioning labor market: "Potential employees...need to know where the jobs are and what skills are needed,...employers need to identify and recruit highly trained workers."[54] As one of the several strategies of IT businesses to expand the pool of qualified workers, they are forming partnerships with schools, colleges, and universities that encourage students to explore these opportunities.

Indian Policy Decision Factors

Decisions by the Indian Government in certain specific areas would significantly impact the number of available Indian professionals. In other words, if the Indian Government were to implement significant policy changes to change the status quo in the areas listed below, there would be policy implications for the U.S. IT workforce gap.

"Brain Drain"

Although Indian universities produce over 65,000 IT professionals each year, less than half of these professionals remain to work in India. It is conceivable although unlikely that the Indian Government could introduce restrictions on skilled professionals leaving the country. The more probable policy option would be to create more incentives for these professionals to remain in India.

Unreliable Infrastructure

One of the ways in which the Indian Government could try to ensure that a higher proportion of their IT professionals remain in the country would be the enhanced creation of IT-related jobs. The primary obstacle to not only expanding the current export oriented software industry but also the indigenous market for IT related products and services is the antiquated infrastructure facilities. While the extant communications infrastructure is congested and unreliable, high-speed fiber-optic networks to support a digital economy are virtually non-existent. Furthermore there is a lack of a steady supply of electricity.

Software Markets

As noted earlier the current Indian software industry is predominately skewed towards meeting the requirements of overseas customers. The Indian Government could continue to ease restrictions on foreign direct investment to allow the establishment of more export oriented software production facilities.

The domestic market for software products is marginal in comparison to the overwhelming demand from abroad. Again the most important obstacles to expanding the domestic market are the infrastructure problems noted above. Also, the market penetration of computers and other IT related products is restricted to the privileged few and those cities which form the hub of the Indian software industry. An estimate of the total number of PCs in the country is 3.2 per 10,000 population.

Global Demand

The demand from the software industries for skilled personnel will result in the governments of developed countries changing their visa regulations and entry requirements to increase the number of Indian IT professionals available for employment. U.S. policymakers will need to track these changes to assess their impact on the availability of sufficient numbers of Indian workers to the U.S. software industry.

ENDNOTES

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[4] *Op cit*, p. 3.
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