DRC Working Papers

Global Software from Emerging Markets

CENTRE FOR NEW AND EMERGING MARKETS
LONDON BUSINESS SCHOOL

No 20

The Dynamics of the Indian Information Technology Industry

By

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Business Standard, New Delhi

March 2003

CNEM is a Development Research Centre supported by the UK Department for International Development

1. INTRODUCTION

The perception of an industry is generally shaped by official statistics. In the case of the Indian information (IT) industry[1], the statistics are not even official. All statistics on it are generated by National Association of Software and Service Companies (NASSCOM). This energetic industry association had 850 members at the end of 2002 (NASSCOM 2003a:17); it claimed that they accounted for over 95 per cent of the industry's revenue. There are clearly many firms in the industry that are not members of NASSCOM; a single directory, for instance, lists over 4000 firms (EFY 2002). Although there is no reason to expect a bias in NASSCOM's figures, they are projections from its members' figures. A comparison with IT export figures recently released by Reserve Bank of India shows that NASSCOM's figures are within 10 per cent of gross exports. Imports are less than 10 per cent of exports; NASSCOM does not estimate them[2]. The official and NASSCOM figures are comparable; the difference between them could be due to leads and lags.

In the rest of the paper we will use the NASSCOM figures. But we should at the outset point out the shortcomings of defining the Indian IT industry in terms of what happens within India's borders. Thus defined, the industry includes the subsidiaries of multinational companies, which are an integral part of their global operations. NASSCOM estimates their share in the sales of the Indian industry in 2001-02 at 26.6 per cent. On the other hand, Indian companies have affiliates and subsidiaries abroad. The accounts of selected IT companies show financial investments to have been 24 per cent of their gross assets in 2001-02; virtually all of those would be abroad. If we think in terms of Indian entrepreneurs, 21 of the 25 Indian entrepreneurs chosen by Naroola (2001)

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[1] This paper refers to information technology, and excludes communications, which have their own complex story in India. It covers software-related services, ranging from simple code-writing to setting up, managing, maintaining and modifying information systems. Although Indian firms have worked on telecommunication software, they have virtually no links with the Indian telecommunication industry, firms in which are mostly joint ventures between Indian business houses and overseas telecommunications operators.

[2] The comparative figures (in $ million) are as follows:

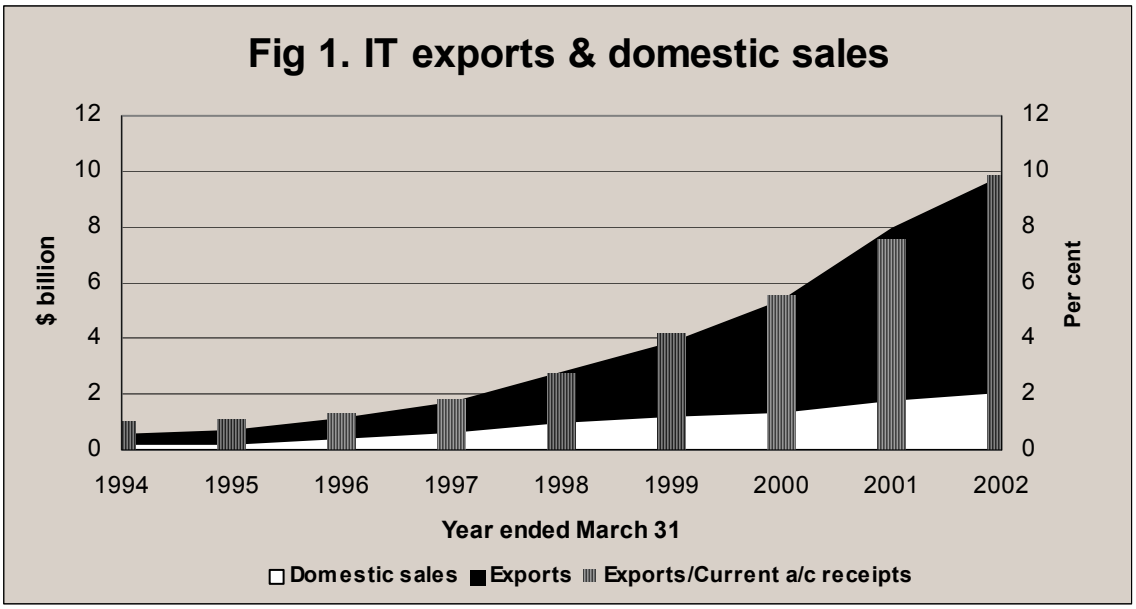
	2000-01	2001-02
NASSCOM (2002a)	6200	7780
Reserve Bank of India (2003)		
Gross exports	6341	7174
Less imports	590	672
Net exports	5751	6502

achieved their success in the US IT industry. Saxenian (1999) found 774 high-technology firms in the Silicon Valley with 1998 sales of $3.6 billion that were headed by persons with Indian names, whereas Indian firms' IT sales in 1998-99 were $3.9 billion, and exports $2.7 billion. And in 1999-2000, when NASSCOM estimated software professionals working in India at 284,000 (including those employed by IT user organisations), about 200,000 were working on H-1B visas. The two overlap to the extent that Indian companies were using H-1B visas to send professionals to the US. But a large proportion of the Indian IT work force was engaged abroad; and competition from abroad for labour was one of the crucial factors that shaped the Indian industry in the boom years. Nationality no longer defines boundaries. In this industry, enterprise, labour and capital are dispersed across the world, and each of them interacts with the industry located in India.

With that qualification, Figure 1 shows the growth of the industry's sales based on NASSCOM's figures. The industry's sales grew at an average compounded growth rate of 43.1 per cent in the eight years to 2001-02[3] – in the same period, real GDP grew at 6.2 per cent a year, merchandise exports (in US dollars) at 8.9 per cent, and current account receipts (including software exports) at 12.1 per cent. Exports propelled the growth of the IT industry; their share in revenue grew from 58.9 per cent to 75.8 per cent in those eight years. They rose from 1 per cent to 9.8 per cent of current account receipts, from 1.5 per cent to 17.3 per cent of merchandise exports, and from 0.2 to 2.2 per cent of GDP. No other industry has experienced such rapid export-led growth.

However, the growth rate of the industry declined sharply in 2001-02. Industry sales grew only 23.1 per cent, raised by a 63.9 per cent growth (from a small base) in IT-enabled services; software sales grew 21.7 per cent. Growth of domestic sales fell even more drastically to 10.7 per cent. These declines are partly due to a fall in charges for services; the real growth has been higher than these figures suggest. But there has been a slowdown even in real terms; the almost complete cessation of campus recruitment in 2002 is one indicator. The deceleration is part of the slowdown in the global IT industry, in particular of the US industry which has been the major market for Indian software. But it has raised questions about whether India's competitive advantage is declining.

[3] Fiscal year from April to March.



It has rested on low wage costs of Indian software professionals. Other low-wage countries are training their own IT labour forces, often with Indian training companies, NIIT and APTECH, participating; China and the Philippines have been seen as strong potential competitors. Countries with higher wages, such as Israel and Singapore, have acted as offshore warehouses for Indian software workers, whom they have used to do contractual work in Europe and South-East Asia. Both could undermine the growth prospects of the India-based industry.

This paper, based inter alia on over 60 interviews with Indian IT firms, reviews the growth of the industry and evaluates its prospects. It aims to go beyond the received wisdom about the Indian industry, which includes the following misconceptions amongst others.

India has succeeded in software because of low wages: Actually, wage costs are a small component of the industry's revenue – 20-25 per cent, less than its profit margin – and there are many countries where programmers' wages are not much higher than India's.

Use of English in India has made it easy for its firms to penetrate Anglophone markets: While it is true that India's software exports are heavily concentrated in Anglophone markets, so is global software consumption. Programming requires the most elementary English, with a very limited vocabulary and simple syntax. India's specialisation in finance explains the markets it has served.

India's human capital – especially its stock of engineers – enabled it to make a substantial entry into the software market: Actually, the emigration as well as the software export boom caused a serious labour shortage by the early 1990s, which was alleviated only by a rapid expansion of the educational system.

India's geographical position, exactly halfway round the world from the US west coast, made it the ideal location for firms wanting to work round the clock: A location in the US remained superior to one in India, as is evidenced by the persistence of onshore working in Indian IT firms' business.

The presence of a large number of Indians, especially engineers, in the US gave India an easy entry into the US software market: Whilst it is true that Indian engineers in the US were often instrumental in outsourcing work to India and were involved in body-shopping, Indian software firms were almost entirely the creation of indigenous entrepreneurs. Indians in the US have found it easier to operate in the US than to set up enterprises in India where red tape remains daunting and infrastructure poor.

The paper develops a more nuanced explanation of the emergence of India's IT industry. It gives due weight to historical accidents, namely that the exit of IBM in 1978 left India with a few thousand programmers familiar with mainframes, and that the presence of a few thousand Indian engineers in the US led US firms to turn to India at a time of programmer shortage. It points up the role of a new technology, namely wireless satellite links, which made it unnecessary for programmers to be located on site of work and enabled Indian firms to work at home for clients abroad; it thereby enabled them to move up the value chain from being suppliers of labour to contract producers of software. It highlights the industry's main success, namely conversion of fresh engineering graduates into reliable programmers within weeks of induction. Finally, it describes the irreversible change brought about in the global industry by the US downturn beginning in 2000, and its impact on the markets and the structure of the industry.

The rest of the paper is organised as follows. The next Section II maps the software product space and the position of Indian firms in it. Section III traces the exodus of programmers from India in response to shortages in the US beginning in the late 1980s. Section IV describes the resulting labour shortage faced by the Indian IT industry and the practices it developed to circumvent the shortage. Section V describes the emergence of an IT export industry from early 1990s following the advent of VSAT radio links with the major markets. Section VI describes the impact on the industry of the end of the IT boom in the US in 2000. Section VII shows the extreme profitability of the industry and its impact on its development. Section VIII covers the industry's infrastructural requirements. Section IX describes how the educational system responded to provide the rapidly rising manpower requirements of the industry. Section X discusses government policies impacting the industry. Section XI analyses the industry's share in global markets for various types of software, and from it draws some conclusions on what it needs to do to meet potential competition and secure its markets.

2. INDIA'S SOFTWARE SPECIALISATION

The most striking feature of the IT industry in the past 50 years has been the fall in the cost of information processing, as semiconductors or chips have become cheaper, smaller and more powerful. This has led to three major trends. First, computers have been designed to take up ever-larger data storage and processing tasks. Second, they have been miniaturised and commoditised. Finally, chips have been divorced from computers, and embodied in diverse equipment to make it more automatic, versatile and less demanding of human attention. There has been a parallel and related trend in telecommunications: partly as a result of the use of processors, telecommunications have become cheaper, and they can carry more information faster to more remote locations. They have thereby made integration of management possible in companies with multiple locations.

With these developments, the room-sized computers of 50 years ago have given way to three types of equipment. First, there are powerful mainframe computers – servers – that can handle information processing requirements of large and dispersed organisations; they would be connected by routers – coordinating devices – to area networks consisting of a number of workstations. Second, there are varieties of small, standalone personal computers (PCs) designed to serve individuals or small offices. Finally, there are microprocessors or chips embodied in various intelligent machines, ranging from machine tools to washing machines.

Specialised software is written for these three types of devices. Mainframe computers typically use elaborate software. The servers and routers have software written into them by their manufacturers; but the software is flexible enough for the customer to expand, modify and connect with other software. Since the number of large computers is small, the number of copies sold of their programmes is also small; so the programmes are expensive. Mainframe manufacturers improve the programmes in successive generations of computers; but it is rare for owners of old computers to replace their software. They generally modify it incrementally as their needs change and networks grow. Thus large computers create a demand for complex software built into new ones, as well as for repair and maintenance of and modifications in installed software.

Personal computers also come with software initially written into them. In their case, however, it is unusual for software to be modified after installation; suppliers embody capabilities commonly required by users in the original copy. The operating systems have a limited capacity to accept add-ons; there is a market for such specialised software for use on PCs. Thus PCs support a very large market for built-in software, plus a market for various add-ons.

Machines and consumer durables embody processors that can interpret a limited number of commands; a relatively simple console controls them. The software for them is called system-on-chips or embedded software.

Thus, each of the three types of equipment has a corresponding type of software. In addition, two other types are important. Large organisations have specialised needs; software is created to cater to them. The special activities of such organisations are called domains; and domain-specific software is created – for hotels, airlines, banks and so on. And finally, software has begun to be written for programmers to increase their productivity, reduce errors and take the tedium out of programme writing. This type of software is called tools; they often come written on shrink-rapped CDs.

These five classes of software are not mutually exclusive. Tools are also designed for PC owners. In the initial years of the internet, there was a flood of tools in the market to help PC owners set up their own web sites. Similarly, much domain software is marketed retail, off-the-shelf, instead of being written for customers.

One distinction is between product software, either written into computers or sold shrink-wrapped or on the internet, and services, which are contracted with and delivered to particular users. This is a spectrum; few products require no service at all, and services often yield reusable or resaleable components akin to products. By and large, Indian firms are into services, and not products. Another distinction is between embedded software and computer software. Indian firms are largely in the latter, and have only a small presence in embedded software. A third distinction is between information technology (IT), which encompasses all the types of software described above, and IT-enabled services (ITES), which are commercial activities using IT. India entered IT first, but has made an entry into ITES since 1998.

3. FIRST WAVE – BODY-SHOPPING

US demand for programmers began to spill over to India in the late 1980s; programmers began to leave their jobs and go off to the US. Table 1 shows the wage differentials in 1995. Figures for 1997 show even wider differentials (Arora et al 2000). The differential was the greatest for programmers; Indian relative wages were higher for more senior staff. Programmers were easier to train or replace; firms took fresh engineering or IT graduates and trained them in-house. But experienced managers or specialists were scarcer, and were paid more to retain them.

Table 1
Wages elsewhere as a multiple of Indian wages, 1995

	US	UK	Ireland	Greece
Project leader	2.3	1.7	1.9	1.0
Business analyst	1.8	1.8	1.7	1.3
Systems analyst	3.4	2.4	2.6	1.1
Quality assurance specialist	3.6	2.4	2.1	1.1
Programmer	5.1	3.6	2.6	1.6

Source: Calculated from Heeks (1996).

The early stages of the body-shopping market are now lost in obscurity. It was dominated by individuals and small firms, most of which did not admit to being body-shoppers. Laws passed in the 1970s, when Indians began to go to work in the Middle East, place stringent obligations on firms sending workers abroad. The firms have to be registered with the Custodian of Emigrants, submit periodic information, and meet the cost of repatriation in certain circumstances. The firms which had sprung up to recruit manual workers died out in the 1980s, and none were set up on that model to send programmers abroad when the demand arose in the late 1980s. Those that came up posed as consultants and software producers. A large proportion of the recruiting was not done by firms in India at all. People close to the potential employers in the United States, mostly but not necessarily Indian engineers, set up contacts in India to do the recruitment for them. Large American auditing and consulting firms often recruited for their clients. In the heyday of the boom in the late 1990s, it was not uncommon for persons or firms from the US to advertise in Indian newspapers, hold interviews in hotels and recruit directly without any infrastructure in India.

The presence of Indian engineers in the US was the primary reason why recruiters looked to India, which was otherwise remote from the US in location as well as in economic relations. But the fact that English was widely used in India was also important. Computer languages use a limited vocabulary; the fact that it is in English does not give an Anglophone programmer an edge. But communication with the customer and with other members of IT teams – being able to understand and explain what was to be done or had been done – is crucial; this is where Indian programmers' knowledge of English helped.

We have no estimates of the number of programmers who were body-shopped or their earnings. But the money they send back can figure in the Indian balance of payments as remittances. Private transfers from abroad rose sharply from $ 2.08 billion in 1990-91 to $ 12.4 billion in 1996-97, but then fluctuated between $ 10 billion and $ 12 billion till 2001-02. Gross inflows of bank deposits from non-resident Indians were another $6-7

billion through the 1990s, but then began to rise to reach $11.4 billion in 2001-02. These two figures give maximum estimates of programmers' remittances. Most of the deposits are term deposits, and are withdrawn at the end of the period; the net inflow was $2-3 billion a year. But a high proportion of the withdrawals was made in Rupees, and was thus no different from a remittance. Thus programmers' remittances in the early years, and even very recently, were comparable to and could have been higher than software export receipts.

Table 2
Visas issued to temporary and exchange workers and intracompany transferees, USA, fiscal years 1996, 1998-2001 [1]

	1996	1998	1999	2000	2001
Computer workers – total	na	na	na	74551	191397
- from India	na	na	na	50587	136646
-from China	na	na	na	5276	12009
All workers – total	227440	240947	302326	136786	331206
- from India	31417	62544	85012	60757	161561
- from China	6181	7746	11367	27331	12333

1. The US fiscal year runs from October to September; for instance, fiscal year 2001 is October 2000-September 2001.

Source: USINS (1997-2002).

We have one other indicator of the outflow of programmers – from the US Immigration and Naturalisation Service (Table 2). H-1B visas are issued to workers from abroad coming temporarily to the US. They are issued for a term of 6 years to either the workers or their employers; a worker who stays on longer can proceed to get a green card and, eventually, citizenship, while working on an H-1B visa. The USA issued 51,000 H-1B visas to Indian programmers in fiscal year 2000 and another 136,000 in 2001; the number of visas to Chinese programmers, the next largest group, was 5,000 in 2000 and 12,000 in 2001. We do not have comparable figures for previous years; but in 1996, 1998 and 1999, 179,000 H-1B visas were issued to Indians. If the proportion of programmers had been the same in those years as later, some 120,000 of the visa holders would have been programmers. That makes 307,000 in the five years for which there are some data – as against 192,000 programmers in IT firms in India at the end of March 2002 (NASSCOM 2002b). Many of the H-lB visa holders would be working for Indian IT firms; some may have commuted between India and the US. But even allowing for them, the numbers who were involved in body-shopping were comparable to programmers working in India on software exports.

4. RESPONSE OF INDIAN FIRMS

From the 1950s, IBM had a virtual monopoly of computers in India. Its 360 series, released in the 1960s, became the workhorse of large organisations; they maintained batteries of programmers to write software for the machines. In 1978, however, George Fernandes, then minister of industries (and today, defence minister), asked IBM to take local shareholders into its subsidiary. It refused, and wound up operations in India; its ex-employees set up Computer Maintenance Corporation, with the primary object of maintaining IBM computers.

From then till the opening up of the early 1990s, the only mainframes being imported into India were Russian. Western computers could not be imported because of an American embargo on export of high-technology equipment to India, which was considered an ally of the Soviet Union. When Rajiv Gandhi became prime minister and visited the US in 1985, he asked to be allowed to import Cray computers, then the most powerful computers available. After much pleading, a licence was issued for one for the Indian meteorological office. It did not arrive. But in the meanwhile, the government's Centre for Development of Advanced Computing (CDAC) connected together a string of less powerful computers to create the first powerful parallel computer in 1991; CDAC continues to sell a 1-teraflop version (CDAC 2003).

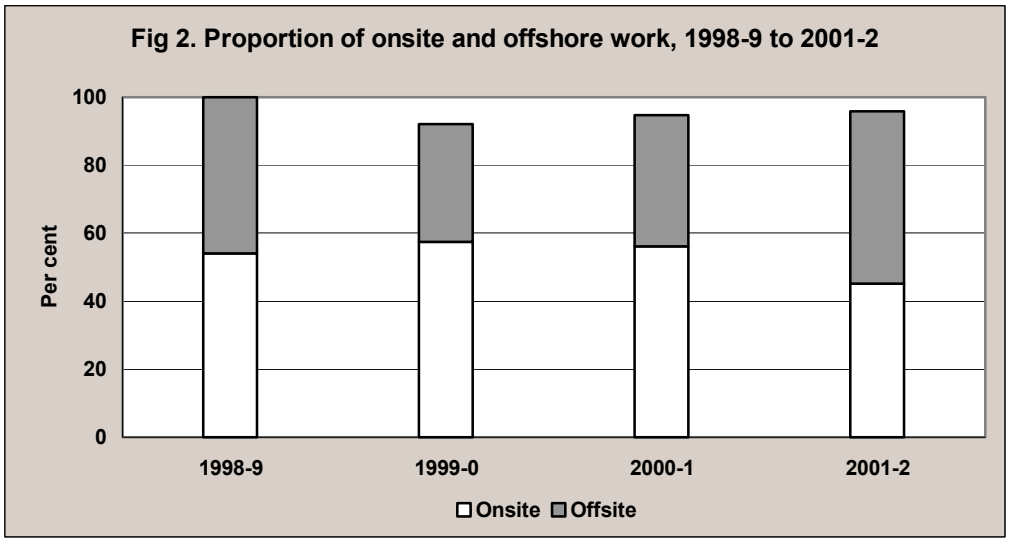
In the meanwhile, computers were finding commercial applications in India as in western countries – in materials planning, airline scheduling, CAD/CAM etc. Programmers got training in working out these applications on aging and heterogeneous computers. In this way, a stock of technological capability was built up (Evans 1992). In the 1980s, programmers were employed by three types of organisations. First, there was Computer Maintenance Corporation, which employed software engineers who worked for IBM before it closed shop in India in 1978. Then there were producers or suppliers of computers. The 1970s and 1980s saw the downsizing of computers into mini-computers and PCs, and the number of their producers grew in the US, Europe and Japan. India's import substitution policies reserved the domestic market to whoever could "produce" a product in the country. The definition of production was vague: it could consist of assembly of imported components, with a few being produced within the country or bought from another domestic supplier – who could get his own import licences. Thus a large number of licensees came up who, for instance, imported the chassis of the PC and put it into a box welded by themselves.

Finally, since mini-computers did not come loaded with user-friendly programmes such as Windows today, users also employed programmers. Amongst the users were consultants, large firms and government institutions. Thus amongst India's software producers today, TCS started as a consultancy in 1968, whilst Tata Infotech (1977), Patni Computer Systems (1978) and Wipro (1980) began as computer manufacturers. Programmers were also scattered amongst large companies and government laboratories.

These were the warehouses of programmers; they began to lose programmers as the US demand for programmers spilt over to India in the late 1980s. Loss of workers was their prime worry well into the 1990s; the survey done by Arora et al (2000) showed labour shortage and attrition to be the foremost problems. They responded to the exodus in a number of ways.

First, they turned themselves into labour suppliers. US importers of programmers, whether they were software producers or users, did not know or have a presence in India; they had to rely on someone to select Indian programmers and deal with the procedures related to their import. A new type of intermediary came up who did this for them. Some of them were Indians settled in the US; some were programmers who had been to the US and established contacts. But Indian employers of programmers also turned to this business; and to facilitate it, the larger ones set up branches in the US. They would hire out their employees on an hourly or daily basis, and would take them back when the work was over. Many employees found jobs in the US and left their Indian employers. But some stayed; and even if people left, they earned their Indian employers a margin over their wages as long as they worked for them. In 1988, 90 per cent of Indian software exports consisted of onsite work.

Then, with the coming of satellite links in 1992, it became possible to work for clients abroad without sending programmers abroad – or at least to do part of the work in India. Then the share of onsite work in exports declined (Fig 2). It fell to 66 per cent in 1995 and 56 per cent in 2000 (Kumar 2001:4280). In 2001-02 it came down to 45 per cent (NASSCOM 2003a).



Second, they structured their wages so as to discourage the most essential people from leaving. As Table 1 shows, Indian wages as a proportion of wages abroad were the lowest for the bottom-of-the-rung programmer. They were higher for programming specialists,

and still higher for domain specialists and project managers. Indian firms tried to keep the organisation intact; programmers at the bottom could come and go. The organisation of the typical Indian software firm was outwardly egalitarian; workers and managers had similar cubicles, ate together and played together. But there was a hierarchy – more pronounced at any rate than in a typical US firm. Workers kept a log of time spent and work done that went into a common server; they were assessed on the basis of productivity, quality, record maintenance and the project audit report.

Third, they developed active and anticipatory recruiting techniques. The standard method was campus recruitment. The favourite campuses were those of engineering colleges. The fact that most people at the top of IT firms were engineers may have played a part; but preference for engineers rested on the fact that selection to engineering colleges was more rigorous, and that engineers were likely to have some courses in computing and handled computers.[4]

Fourth, with the recruitment of fresh graduates they also developed short, focused training programmes designed to bring them up to speed quickly. Training mirrored actual problems from the work done by the firm.

Fifth, they made the working conditions attractive. They built comfortable dedicated offices which often embodied sports and entertainment facilities; they organised community activities like tournaments and picnics. They served good food onsite.

Finally, they recorded the progress of work, so that if a worker left leaving a job half done, someone else could immediately pick up the thread. They defined the process of work and documented it, so that it could be replicated even if people left. A client would normally look for these precautions; they are embodied in various certification procedures such as for Capability Maturity Model (CMM) of Carnegie Mellon University's Software Engineering Institute. In 2003, NASSCOM (2003a) listed 225 firms with ISO9000 certification or one of its variants, 48 with CMM5 certification, and 45 with CMM3 or 4 certification.

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[4] Arora et al (2000) show that although few CEOs of IT firms admitted to recruiting non-engineers, the growth of IT labour force far exceeded the outturn from engineering colleges. The difference is explained by the fact that the industry recruited a large number of older engineering graduates, and many non-engineers for jobs that did not require knowledge of programming – management, marketing and domain-oriented jobs. Science graduates were taken after they had done Master of Computer Applications (MCA). And only exporting firms needed to employ engineers. Firms that worked for them or for the domestic market were under no pressure to employ engineers; and the non-engineers they employed could be absorbed into exporting firms once they had acquired specialist programming skills.

These process innovations were not, of course, entirely indigenous. Indian firms worked closely with their clients abroad. The clients often paid on time-and-materials basis; to ensure that the time spent led to maximum output, clients provided the working environment and practices for programmers that were body-shopped, and set standards for them in offshore development. In particular, the flat hierarchical structures, round-the-clock working and the stress on incentive payments are borrowed from American practices.

Whereas body-shopping for large IT users imparted managerial and work-related practices to Indian firms, working for foreign IT firms familiarised them with OEM software and its architecture. Several kinds of relationships between Indian and foreign IT firms developed (Patibandla and Petersen 2002). For instance, Nortell and Cisco set up joint ventures with large Indian firms; essentially, parts of the latter's facilities and manpower were dedicated to work done for their partners. Motorola and Hewlett Packard outsourced work to a number of small satellite firms. Firms with proprietary software, such as Motorola, Oracle and Texas Instruments did not work with or give out work to local firms. Patibandla and Petersen regressed the revenue of 20 large Indian IT firms in 1990-1999 on foreign firms' share in Indian IT sales and on royalty payments by the Indian firms amongst other variables, and concluded that there was considerable spillover of technology, work practices etc from foreign to Indian firms. Our observation, based on interviews with Indian firms, suggests that the contact between local firms and Indian subsidiaries of foreign firms varied considerably. Whilst some outsourced work or partnered large local firms, others had no contact at the firm level at all; those that did high-level R&D in particular kept to themselves. Most Indian firms were exporters; spillovers to them from abroad – from clients, foreign IT firms, and through employees recruited abroad – were more important than from foreign firms within India.

The process innovations were made to cope with rapid loss of workers. But they were more generally valuable. It is they that give Indian firms a competitive advantage. They were exhibited to potential customers to assure them that quality would be maintained, work would be done on time and security of information would be assured.

5. SECOND WAVE – OFFSHORE DEVELOPMENT

There was an alternative to body-shopping, namely writing the software in India and exporting it, but it was uneconomic. The software had to be exported on tapes or disks; there were heavy import duties on them which raised costs and duty rebates did not work too well. The only profitable way to export it was through people, who were all too prone to stay on in the US.

Satellite links made the disembodied export of software possible. The first link was set up in 1985. At that time, the government did not allow private links. So Texas Instruments gifted it with the equipment, which it then proceeded to use from its Bangalore establishment. IBM, which wanted to set up a link in 1988, ran into the same problem: the government insisted on retaining its monopoly in telecommunications, the rates offered by its Department of Telecommunications were exorbitant, and it was completely inexperienced in running VSAT links.

The newly set-up Department of Electronics broke this impasse. In 1991 it created a corporation called Software Technology Parks of India (STPI), which, being owned by the government, could provide VSAT communications without breaching its monopoly (see Section VIII below). STPI set up software technology parks in different cities, each of which provided satellite links to be used by firms with wireless connections to them. In 1993 the government began to allow private, dedicated links as well. These links allowed work done in India to be transmitted abroad, and brought down the need for programmers to travel. Indian firms still had to convince their American customers that a satellite link was as reliable as a team of programmers working in the clients' office. To do so, one body-shopper moved its team to a building across the road first; then, once he had proved to the customer that the distance was no handicap, he was allowed to move the team to India.

Another important change was in the import regime. In the 1980s, an importer of hardware had to get an import licence from the Chief Controller of Imports and Exports, who in turn required a no-objection certificate from the Department of Electronics. That meant going to Delhi, hanging around until one got an appointment and trying to persuade an uncooperative bureaucrat. In the 1992 import policy, computers were freed from import licensing; and import duties on them were reduced in the same year. As a result, it became possible for Indian software firms to work on the same computers as their clients. Bonding facility even made it possible for clients or parent firms to lend computers to Indian firms.

These two changes – satellites and import liberalisation – made offshore development possible, and firms began to change over from body-shopping to it. This development had a number of implications. When programmers were sent abroad, they worked on fragments of programmes assigned to them by their hirers; they seldom got an idea of the entire programme and what it was meant to do. Offshore development made it possible for firms to take orders for complete programmes. Body-shoppers were generally engaged by software manufacturers abroad; except when they were sent to the clients' offices, for instance for system maintenance, they did not come in direct touch with the final users of the software. Once offshore development became possible, Indian firms could work for final clients; now the bulk of the work comes from them, and it became possible for firms to market their products. Finally, the availability of complete jobs from clients led to a change from sale of services by their results instead of labour time. Work

for final clients also led the firms to specialise in work for particular industries or verticals: it led in particular to India's specialisation in software for banking, insurance, airlines etc. It gave India a brand value and a reputation.

The next big technological change was the web. Even when satellite links became available, they could be used only by exporters that had their own disks or shared the STP ones. Internet offered the same links on telephone lines; and as the number of firms using internet expanded, the potential market for software expanded correspondingly. Since it was far easier and cheaper to obtain telephone lines than satellite links, the internet greatly increased the number of potential exporters. It also opened up a new field of work. Earlier, IT users could connect up geographically separated locations only with satellite links; once they could use the web, setting up of integrated systems became possible for dispersed locations, and new work to connect such locations became available. The web was a considerable advantage for resource-poor Indian firms. It had even greater influence on businesses that required frequent interaction with clients, such as banks, airlines and sellers of consumer durables; by offering a new channel of communication, the web made their services cheaper and more convenient.

6. END OF THE US IT BOOM

The stock market boom in the US ended in April 2000; with it, the high valuations of US IT firms and the easy availability of capital for the industry ended. Growth in US slowed down, and profits of US firms came under pressure. The slowdown was bound to affect the growth of the Indian IT industry, since North America accounted for 62.7 per cent of India's software exports in 2000-01. But a number of other things happened at the same time. For one thing, the labour shortage also eased; since the Indian IT industry paid lower wages and lost programmers to the US, the fall in demand for them brought down the rate of attrition. For another, IT costs came under pressure everywhere; that increased the demand for Indian software services as against more expensive sources, but also led clients to look for even cheaper sources. Finally, the downturn affected different IT services differently; in-house IT activities in the US, which absorbed most of body-shopped programmers, declined, and more of in-house work was sourced out in the form of ITES and business processes. But in India, as programmers became cheaper and more easily available, in-house activities increased at the expense of purchased services. The impact of these changes varied with the size of firms.

Table 3
Indian software sales, 1999-00 to 2001-02

	Revenue ($ million)			Growth (%)	
	1999-00	2000-01	2001-02	2000-01	2001-02
Exports	4000	6200	7780	55.0	25.5
Software	3440	4750	5780	38.1	21.7
ITES	560	900	1425	60.7	58.3
R&D		550	575		4.5
Domestic sales	1370	1807	2070	31.9	14.6
Software	1330	1737	1923	30.6	10.7
ITES	40	70	147	75.0	110.0
Turnover	5370	8007	9850	49.1	23.0
Share (%) of					
Exports	74.5	77.4	79.0		
ITES	11.2	12.1	16.0		

Source: NASSCOM (2002).

Export growth halved between 2000-01 and 2001-02 (Table 3). But growth of domestic sales slumped even more. There was no domestic slowdown, and hence no reason to think that demand growth for IT services slowed down. The more likely reason is that with the easing of the market for programmers, large clients could afford larger IT departments in-house. The industry oriented itself even further towards exports after the US downturn.

Amongst markets for exports, the share of the US went up from 61.2 per cent in 2000-01 to 65.6 per cent next year, and UK's share from 11.8 per cent to 14.1 per cent (NASSCOM 2002a:33-35; NASSCOM (2003a:28-29). The share of the rest of the world went down from 27 per cent to 20.3 per cent; this fall was widely distributed. US and UK were the two countries with the most liberal labour import regimes. Table 2 shows a huge increase in the number of H-1B visas issued to Indian programmers in 2001-02. Some of these visas were no doubt taken by Indian IT export companies. In markets other than the US and the UK, visa regulations discriminated more strongly against foreign programmers; so when demand growth slowed down, demand for Indian IT services fell disproportionately.

Exports of ITES saw hardly any slowdown; their share in exports rose from 12.1 per cent in 2000-01 to 16 per cent in 2001-02. ITES used relatively less educated labour; India's labour pool in such labour was much larger, and wage differential greater. Hence as cost pressures increased, ITES began to move to India.

Some of these IT-enabled services were located in India by foreign ITES providers, and some by large users of ITES. GE Capital was the biggest; it employed 12000 workers (NASSCOM 2003a:71). Banks and financial companies, which had earlier bought Indian IT services or set up IT operations, also set up large ITES centres: Standard Chartered employed 2500, JP Morgan Chase 3000, and AMEX and HSBC 2000 each. NASSCOM (2003b) put the share of foreign companies in ITES revenues at 45.1 per cent.

ITES were not the only services foreign companies relocated in India; their share in services exports also went up from 14-15 per cent in 2000-01 to 22 per cent in 2001-02 (NASSCOM 2002a:31; NASSCOM 2003a:40). Earlier, the major activity of foreign companies was reported to be R&D (Patibandla and Peterson 2002). Their Indian affiliates were not services exporters; they did only in-house work for the parents. In the past three years, however, foreign companies have set up profit centres in India that do work for outside clients. Thus there was migration of foreign IT activities to India's low-wage base.

Amongst the large companies abroad which were clients of India's software industry, there was pressure on IT budgets. They reduced the number of suppliers, made them compete for business, forced down their rates and made them give more comprehensive services. These cost-cutting moves affected the smaller suppliers more severely; they were less capable of taking on broader responsibilities, and were edged out. They were also more vulnerable. They had fewer clients – many worked for a single client – and loss of clients sent more of them into bankruptcy and closure. NASSCOM's estimates, fragile as they are, indicate the extent of the shakedown (Table 4). They show a rise in the export share of foreign firms from 14-15 per cent in 2000-01 to 22 per cent in 2001-02, and a corresponding fall in the share of Indian firms exporting less than Rs 1 billion from 14-15 per cent to 10-11 per cent. But specialist product firms, which had an export share of 3-4 per cent in 2000-01, disappeared the next year. It is unlikely that they ceased to export altogether. Insofar as they retained a share of the market, the share of small firms must have fallen even more sharply. Thus 2001-02 saw a substantial rise in foreign firms' export share, at the expense of small Indian firms. The former did not take away the market of the latter. Changes in the market were unfavourable to small firms; and the rise in the share of large firms was due to relocation of their activities to India.

Table 4
Size& ownership structure of the software export industry, 2000-01 and 2001-02

	Annual Exports Rs bn	Number of firms		Share of exports Per cent	
		2000-01	2001-02	2000-01	2001-02
Large Indian firms	>10	5	5	33-35	32
Medium Indian firms	1-10	49	47	33-35	35
Small Indian firms	<1	762[1]	2858	14-15	10-11
Subsidiaries of overseas firms				14-15	22
Product makers				3-4	
Specialist service providers				3-4	3-4

1. NASSCOM members only.

Source: NASSCOM 2002a, 2003a.

Small firms were also adversely affected by the flight to safety amongst employees; employment in the industry was suddenly proved to be precarious, and programmers developed a preference for working in big companies. The latter picked up the more experienced of them.

NASSCOM's 2000-01 figures cover only its members, whereas next year's figures cover all exporters. Hence it is likely that the earlier figures overestimate the shares of large and medium firms as well perhaps as foreign firms. If they do, the share of small firms fell even more sharply than Table 6 suggests.

Table 4 covers only exports; we have no data on the market structure in the domestic market. But IT directories list thousands of firms. Many of them have not exported at all. They do IT work for local industry, hospitals, governments etc. Some combine software consultancy with sale of hardware and packaged software. Thus below the software export industry is a large base of small firms serving the domestic market, which have moved from one speciality to another as market changes required.

7. FINANCES

Beyond the export and revenue figures that NASSCOM collects, little information on the finances of the software industry is available. Many of the firms are offshoots of conglomerates or hardware firms, and their software activities cannot be separated. A significant proportion are branches of multinational firms, whose finances are shrouded in mystery. The biggest firm, Tata Consultancy Services (TCS), is fully owned by the Tatas and gives out little beyond its revenue. The only firms about which some figures are available are those incorporated as Indian companies, which constitute a tiny fraction of the firms and account for less than half of exports. Amongst them, the financial accounts of the biggest, which have floated equity on New York Stock Exchange or NASDAQ, are models of detail and clarity; the rest are variable. However, the scanty figures available yield some illuminating conclusions. Table 5 gives the consolidated profit and loss account of such firms.

Table 5
Income and expenditure of selected software companies, 1997-98 to 2000-01

	1997-98	2000-01	1997-98	2000-01
Number of companies	148	255	148	255
	Rs billion		Per cent	
Income	73.4	227.3	100.0	100.0
Expenditure	55.2	155.5	75.2	68.4
Materials and stores	19.1	20.4	25.9	9.0
Wages and salaries	11.5	46.9	15.7	20.7
Gross profit	18.2	71.8	24.8	31.6
Interest and lease rent	3.2	4.2	4.4	1.8
Depreciation	3.4	11.1	4.6	4.9
Provision for income tax	1.4	4.4	1.9	1.9
Net profit	10.2	52.1	13.9	22.9
Dividends	2.1	5.6	2.9	2.5
Retained earnings	8.1	46.5	11.0	20.5

Source: CMIE Prowess Database 2003.

The accounts confirm the intensity of competition for labour in the late 1990s: the share of wages in income rose 5 percentage points between 1997-98 and 2000-01. Still, wages were only 20.7 per cent of income in 2000-01. Low Indian wages gave the firms an advantage. That, however, was not because the software industry was a labour-intensive

one, but because the difference between Indian and US wages, converted at the current exchange rate, was enormous (Table 1). The difference in the cost of living explained much of the difference in wage. The wage costs of Indian firms could have doubled without them being forced out of business: the profit margins exceeded wage costs.

Despite the rise in wages, the mean profit margins increased because of a fall in other costs. As exports came to be made increasingly through electronic communications, and the share of body-shopping, with its attendant costs of travel and accommodation, dropped, non-wage costs fell, and profit margins rose. The bulk of the profits were retained; dividends took less than 3 per cent of revenue. The high profits enabled the companies to pay off debts; as a result, their interest costs fell (Table 6). This too added to net margins.

Table 6
Consolidated balance sheet of selected IT companies, 1997-98 and 2000-01

	1997-98	2000-01	1997-98	2000-01
	Rs billion		Per cent	
Total assets	82.2	323.0	100.0	100.0
Land and buildings	4.6	16.7	5.6	5.2
Equipment	20.3	55.1	24.7	17.1
Investments in group companies	13.7	77.6	16.6	24.0
Other investments	1.9	17.7	2.4	5.5
Inventories	5.7	7.4	6.9	2.3
Receivables	13.7	58.8	16.8	18.2
Cash and bank balances	5.1	43.6	6.3	13.5
Total liabilities	82.2	323.0	100.0	100.0
Paid-up capital	4.5	12.7	5.5	3.9
Reserves	15.6	95.4	5.6	6.1
Net worth	20.1	108.1	24.5	32.5
Borrowings	28.2	14.1	34.2	4.4

Source: CMIE Prowess Database 2003.

8. INFRASTRUCTURE

The most important component of infrastructure for body-shopping was air connections. India was well connected with Europe and East Asia; but the demand for programmers came from the US, which was almost halfway round the globe from India. Besides, the connections were constrained by factors other than distance. India had only four international airports in 1990; all international traffic was funnelled through them. Of the four, international airlines preferred Bombay and Delhi which generated most of the traffic; despite the government's manipulation of landing rights, few international airlines were prepared to fly to Calcutta or Madras. There was also the question of reciprocity. Landing rights are negotiated by bilateral bargaining between governments. The government gave its own airlines, Air India and Indian Airlines, monopoly of international flights. But they could neither afford the investment required nor attract the traffic necessary to use all the landing rights abroad negotiated by the government. Their capacity limited the flights foreign airlines were allowed to fly.

Then, as seat shortages emerged from 1996 onwards, the government allowed foreign airlines to increase the number of flights. The conversion of airports into international ones took longer; new terminals with aerobridges had to be built, and customs had to set up screening facilities. Over the 1990s, international flights were allowed into Goa, Cochin, Hyderabad, Bangalore and Amritsar. But the number of flights into those airports remained small, and so did the range of their connections. Most of the flights into Cochin and Hyderabad were, for instance, from the Middle East which had a large number of migrant workers from their hinterland. Thus programmers continued to fly chiefly through Bombay and Delhi. The two cities housed a pool of programmers, who were instrumental in turning them into major centres of the IT industry. Singapore Airlines connected Madras to San Francisco via Singapore. This flight to the Silicon Valley became popular with programmers; Madras also developed into a major industry centre.

Table 7
STPI clients and their exports, 1998-99

	No of clients	Exports (Rs bn)	Exports (per cent)	Exports per client (Rs mn)
Bangalore	746	43.2	37.2	57.9
Noida (Delhi)	1103	24.5	21.1	22.2
Madras	535	18.9	16.3	35.3
Hyderabad	977	10.6	9.1	10.8
New Bombay	755	9.6	8.3	12.7
Poona	474	5.7	4.9	12.1
Calcutta	131	1.5	1.3	11.5
Bhubaneswar	152	0.9	0.8	5.9
Trivandrum	188	0.6	0.5	3.0
Gandhinagar (Ahmedabad)	295	0.3	0.2	0.9
Jaipur	95	0.2	0.1	1.6
Mohali (Chandigarh)	131	0.2	0.1	1.1
Total	5582	116.1	100.0	20.8

Source: STPI (2000).

Next to airline connections, telecommunications were the most important resource. Here, the Telegraph Act of 1861 gave the government a monopoly of telecommunications; the Department of Telecommunications strongly resisted pressures to relax the monopoly. In the 1980s, its high charges and unfamiliarity with VSAT technology deterred IT companies from setting up offshore development centres. Finally in 1991, the Department of Electronics, another arm of the government, found a way of getting around the difficulty. It conceived Software Technology Parks (STPs). The model for them was Export Promotion Zones (EPZs); these were areas of land cordoned off by the Customs which specialised in exporting and were allowed to import inputs and capital goods duty-free for export production. STPs were initially set up in defunct industrial estates; each was equipped with a dish antenna, and leased out rooms to software exporters. Soon, however, the duty-free status was granted to firms located outside the STPs as well; they were allowed to set up radio links and use the STPs' dish antennae for transmitting and receiving data. The costs of registration with the STPs were low; many firms were registered but did not export, and many more had negligible exports (Table 9). And once private firms were allowed to uplink directly in 1995, all the larger firms did so. But

STPs did provide a cheap link to small firms; from 8 per cent in 1992-93, their share of exports increased to 68 per cent in 1999-2000 – the last year for which figures are available.

In 1993, the government gave licences to private telephone companies; one fixed-line and two mobile competitors were licensed in each of the 24 circles (a licensee could hold multiple licences). Soon after the new licences were issued, the government telephone providers gave telephone connections to whomever wanted one, and deprived the private licensees of a market. Many licensees were liquidated or sold off; the agitation of the rest induced the government to migrate from licence fees to a share of revenue. There were also recurrent quarrels between the public and private providers over interconnection fees. The policy changes did not help the fixed-line providers, who still have very limited networks. But despite the acrimony, competition did increase the number of telephone lines, and bring down the charges. Thus, the cost of leased lines for software export also came down.

Every IT company needed continuous, steady, high-quality electricity supply. No state except West Bengal provided uninterrupted power supply; even West Bengal did not guarantee quality. Hence in all states, IT companies required back-up. The kind of back-up depended on the frequency and length of black-outs. In the southern states, where black-outs lasted only a few hours and were well spread out, IT companies generally set up a bank of inverters to provide for 8-12 hours of power. Elsewhere – and everywhere in businesses which could not tolerate an interruption, such as call centres – the companies set up diesel generators.

State governments owned power supply companies. Subsidies to farmers and domestic users ensured power shortages and losses. So states were incapable of giving anyone uninterrupted power supply. But spurred by competition, they devised an answer to the power problem, as well as the one of suitable accommodation. As discussed in Section VII, getting the right kind of accommodation, which could house good communications, provide a comfortable working environment and adequate parking space, was a major concern for IT companies.

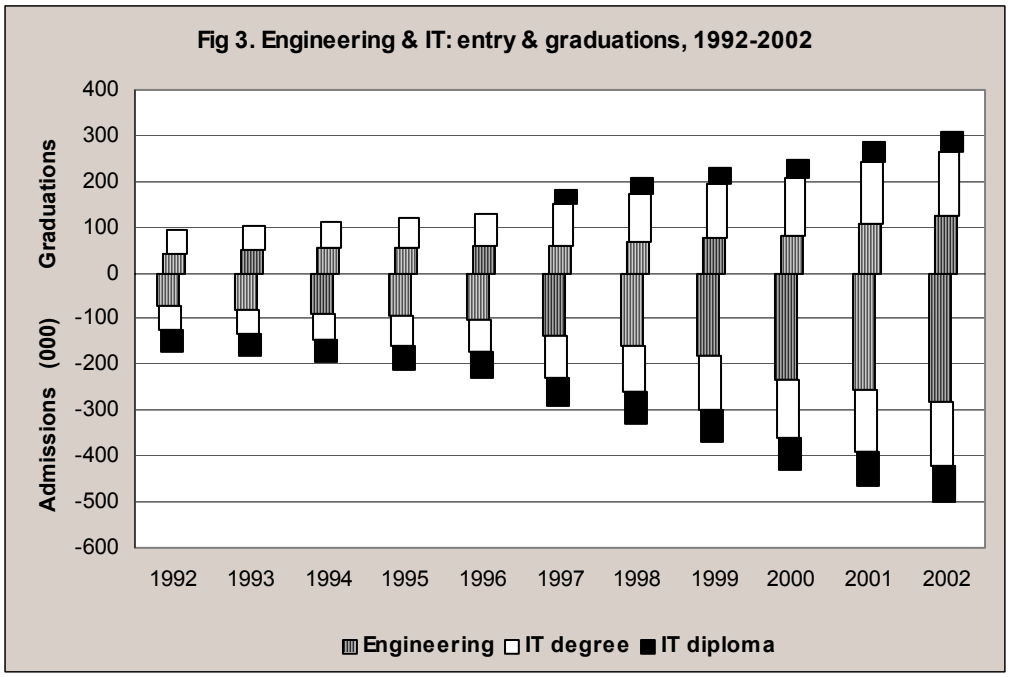
Some state governments converted old industrial estates into IT estates. Others set up new specially designed industrial estates with communications, central air conditioning, restaurants, shops and entertainment. In those states that were attractive to IT industry – especially Karanataka and Tamil Nadu – the new IT estates attracted big companies. Elsewhere they acted chiefly as nurseries for small companies.

The large tracts of land on which the new estates were set up were generally not available in cities, and the estates were located on the outskirts and even further away. Those companies that moved to such remote sites found it more difficult to attract workers. Many of them transported workers in their own buses. Land costs outside cities were low;

so companies built large establishments there with restaurants, sports facilities, gardens and swimming pools. The 120-acre Satyam campus for instance, 38 kilometres out of Hyderabad, has a small zoo, an aviary, and a botanical garden besides the usual gym and restaurant.

9. EDUCATION

As shown in Section III, the US issued about 307,000 H-1B visas to Indian programmers in 1996 and 1998-2001; adding figures for 1997, the figure would rise to 350,000 for 1996-2001. Then there were IT workers who migrated on visas other than H-1B visas, estimated by NASSCOM at 20 per cent of the total or 25 per cent of those who obtained H-1B visas – approximately 90,000. In addition, there were those who got visas before 1996, whose number we may conservatively put at 50,000. Thus programmers who obtained US visas alone were at least half a million. NASSCOM estimated 298,250 IT workers in India in 2001-02 – 170,000 in exports, 22,000 in domestic software production, and 224,250 in IT user organisations (NASSCOM 2003a:63). Thus we get a total of migrant and India-based programmers of 800,000. Insofar as some of the H-1B visas were issued to employees of Indian IT companies and to programmers who commuted from India, and insofar as some of the H-1B visas would have expired without being replaced by a green card or citizenship, the total number of programmers would be less; still, it would be in the range of 600-700,000. NASSCOM placed the number of IT workers in 1985-86 at 6,800 (NASSCOM 2002a:63). Hence although the available stock of programmers may have induced recruiters from abroad to come to India in the first place, the growth of the Indian – and the US – industry was sustained for over a decade by the supply of freshly trained programmers. A 2002 survey showed that the median age of software engineers was 26.5 years, and that 58 per cent of them had less than three years' experience (NASSCOM 2003a:138-39). Whilst more experienced people were to be found at more senior levels, the typical programmer was likely to be in his or her 20s and just a few years out of college. Interviews suggest that emigration was also strongest amongst young software engineers; visa requirements would have ensured that they were graduates at least. How was the required supply of programmers created?



Entrepreneurs in the industry are predominantly engineers. Although many firms are owned by businessmen or business houses, the chief executives are almost always engineers. Few entrepreneurs have migrated back from the US; but many hold US engineering degrees. They recruited engineers by preference; when engineers were not available, they recruited science graduates with a master's degree in computer applications (a degree that was developed to meet the shortage of programmers). According to a NASSCOM-Hewitt survey of recruitment practices, 88 per cent of the firms visited engineering campuses, and 47 per cent recruited only there. The other important method of recruitment was through employee referrals; 68 per cent of the firms recruited this way, and 94 per cent of those paid employees for every recruit they brought.

By the early 1990s, the demand for programmers was running ahead of the supply of engineers. The IT industry had to compete with other industries for engineers; and once recruited, they had to be trained. It was necessary to expand supply beyond engineers, and to impart training in computer applications in the universities. In response to the demand, a number of universities started master's and diploma courses in computer applications (MCA and DCA). According to NASSCOM (2002a:69-70), engineering colleges offered 73,000 seats in 1992, only some of which were in computer science. But there were 98,000 seats in MCA and diploma courses. By 1996, the number of seats in engineering courses had risen to 104,000, and in MCA and diploma courses to 122,000. But there were no graduates from the newly started MCA and diploma courses; the number of engineering graduates increased from 44,000 to 61,000. In 1997, however, the first students of MCA and diploma courses graduated, and added 76,000 to the 59,000

graduating engineers; the total number of potential programmers more than doubled within a year to 135,000. It nearly doubled again to 250,000 by 2002; and the number of seats had increased to 498,000. The system was thus capable of supplying some 400,000 graduate programmers a year, allowing for wastage and for engineers not entering IT (Figure 3). NASSCOM's figures are not entirely accurate; since the duration of diploma courses was shorter than of degree courses, their entrants would have completed the courses at different times. But the general point, illustrated by Figure 3, is correct: that the supply of potential programmers showed a marked increase in the second half of the 1990s.

This expansion of supply initially benefited Indian firms which were losing programmers to US firms; programmers were likely to be hired by US firms only if they had some proven skills, which they could acquire only by working for firms in India. Once they had worked for 2-3 years in India, they would have developed the contacts necessary to get a job in the US, and the experience to improve their marketability. This is why there was a huge increase in H-lB visas in 2000-01 (Table 2); that is when the supply of programmers employable in the US increased.

The supply situation in 2001-02 is shown in Table 8. In that year, 133,000 new workers entered the industry; 64,400 left the country, leaving a net increase of 65,600 or 18.2 per cent. By then, university training courses in IT and related subjects was well established, and they provided 55.9 per cent of the new entrants – 32.1 per cent were graduates and 23.8 per cent diplomats. Almost a quarter were engineers without university training in IT – they may have gone to private training institutes – and a fifth were neither engineers nor trained in IT. The last set of recruits would have gone into management, marketing and accounting; many of them would be from management institutes, where 47% of the firms recruited. It would not be advisable to read more into the figures, which are based on somewhat sweeping assumptions regarding the proportion of disciplines and the proportion entering the industry.

TABLE 8
Balance sheet of Indian IT labour force, 2001-02 (thousands)

	Total	Entering the industry	Total	Per cent
Number at the beginning of the year			360.0	
Graduates in IT [1]	53.4	42.7		32.1
Computer science and IT	32.0			
Electronics and telecommunications	21.3			
Diplomats in IT [2]	41.1	31.7		23.8
Computer science and IT	22.2			
Electronics and telecommunications	18.9			
Non-IT engineering graduates [3]	106.7	32.0		24.1
Non-IT, non-engineering entrants		26.6		20.0
			133.0	100.0
			493.0	
Less workers leaving India			64.4	
			428.6	

1. It is assumed that (a) 60% of the graduates are in computer science and IT, and 40% in electronics and telecommunications, and (b) 80% of the graduates enter the IT industry
2. It is assumed that (a) 54% of the diplomats are in computer science and IT, and 46% in electronics and telecommunications, and (b) 77% of the diplomats enter the industry.
3. It is assumed that 30% of the non-IT engineering graduates enter the industry.

Source: NASSCOM (2002a):67-68.

However, there were considerable regional variations. To cope with the shortage, both Karnataka and Andhra Pradesh allowed private colleges to be freely set up. Karnataka also set uniform standards and thus ensured minimum quality. This was one of the major factors behind the rise of Bangalore as the IT capital. The other was the presence of the Indian Institute of Science and many companies and laboratories which employed engineers. Bangalore was also very open to outsiders – as were Bombay, Poona and Delhi. By comparison, relatively parochial cities such as Calcutta suffered.

The expansion of graduate numbers was accompanied by a fall in quality. Engineering teachers found more lucrative employment in the IT industry. Colleges taught with insufficient teaching strength; those who taught skipped the curricula. The number of computers per student was modest; although the students were supposed to learn CAD/CAM and other computer-based engineering applications, most of the teaching was on the blackboard.

This is where private training institutes, which came up in the 1990s in their hundreds, filled the gap. The dominant model was to set up corner shops on franchise which provided a number of computers and one or more instructors. Students used the shops for practicing. The cybershops were open at all hours. The two biggest training providers, NIIT and APTECH, the two companies that offered courses in software training on franchise across India, are the best known. They gave their own degrees, which were not officially recognised but still extremely popular. Their role is somewhat ambiguous; although their trainees ran into hundreds of thousands, most IT firms deny having recruited programmers trained by them. The role has obviously changed over the years.

They have fulfilled four functions through the past two decades. First, they gave potential programmers the facilities to learn and practise close to their homes. Even when engineering and science colleges gave courses in programming, the number of computers they had was generally too small to give the students much practice; they made up for the shortage by going to the local training shop. Second, the training institutions served as bases for training and certification of foreign software companies with their own specialist software, such as Microsoft, IBM, Cisco and Oracle. Third, they trained young people for jobs involving the use of PCs and computers, such as word processing, calculation, and accounting. Finally, they took on software-related contracts such as consulting and setting up of IT systems for clients, using both teachers and students for the purpose.

The training institutes filled a gap in the late 1980s and early 1990s when the supply of graduates and diplomats fell short of requirements. That was when they upgraded their training schedules from operation of PCs to programming. The qualifications they imparted would not on their own be sufficient for getting work visas and hence could not be used in body-shopping; but as VSAT links brought work offshore to India, it could be done by people trained in informal institutes.

This demand declined in the second half of the 1990s when the supply of university-trained graduates and diplomats picked up; but by that time, the training firms were picking up a considerable volume of IT-related work, on which they could use their students as cheap labour. By this time, there was also considerable demand for certification in proprietary programming systems such as those of IBM and Microsoft.

The slowdown of 2000 hit the training companies hard. Most of the small ones closed down. The corner training shops they had franchised became cybershops offering web surfing and e-mail facilities. Both NIIT and APTECH went through painful restructuring, and expanded their software business to compensate for the contraction of training.

10. GOVERNMENT POLICIES

As discussed in the previous section, both the central and the state governments noted the growth of the IT industry in the 1990s as an exchange earner and a creator of incomes and employment, and responded with policies to help it. The new BJP government that came to power in 1998, however, went further. It decided to give priority to the industry, set up a ministry of information technology, and appointed a Task Force to find out what the industry needed and to translate it into policy. Although the industry used the process to ask for many special favours, the reports of the IT Task Force (Ministry of Information Technology 1999a-c) provide a good picture of the obstructions faced by the industry (Table 9).

Customs and import control were the subject of many complaints. Import duties on computer hardware were substantial; although an exporter could avoid them, he thereby subjected himself to vexatious policing. He had to set up a bonded warehouse; the movement of goods into and out of the warehouse was subject to detailed rules and could lead to harassment. The industry sought an end to the policing and arbitrariness, and proposed that the customs and import licensing authorities should rely on ex-post audits.

Exporting companies were allowed to hold dollar accounts, but there were many restrictions on how money in the accounts could be spent; here too, investigations by Reserve Bank of India or the Enforcement Directorate could lead to much worry and loss of management time. The companies wanted greater freedom investing and divesting abroad, in incurring expenses and using credit cards abroad.

The industry had a problem in raising finance: banks required a material asset as collateral, and a large proportion of the IT companies' assets were immaterial, such as programming work in progress and credit to customers. The government's financial institutions were prepared to fund on the basis of fixed assets; but computers and equipment were often leased, and when they were not, they were subject to rapid obsolescence. Hence the industry wanted the lending rules to be changed, and to be given credit on the basis of their turnover.

TABLE 9
IT Task Force's recommendations

	Total	Per cent
Laws	14	4.3
Simplification of rules	56	17.3
Central government	26	8.0
Customs	24	7.4
Other	6	1.9
Relaxation of rules	45	13.9
Exchange control	21	6.5
Banks and financial institutions	10	3.1
Other	7	4.3
Favours	50	15.5
Central government subsidies	5	1.5
Increase in financing	12	3.7
Reduction in taxes	20	6.2
Other	13	4.0
Government purchases	29	9.0
Training	28	8.7
Remove government monopolies	7	2.2
Other government support	61	18.9
Other	36	11.1
	323	100.0

Source: Ministry of Information Technology (1999a-c).

Soon after the IT Task Force reported, the Prime Minister's Council on Trade and Industry appointed a Subject Group on Knowledge-based Industries (SGKI 2000). Its report revealed widespread harassment based on labour laws. For instance, the Shops and Commercial Establishments Act 1961 and the rules framed under it limit working hours to no more than 9 a day and 48 a week, require a break to be given at least once every 5 hours, limit the total length of a working day to no more than 12 hours in a day, and require that hours worked beyond 9 a day or 48 a week must be paid for at twice the normal wage. (How a worker not allowed to work overtime can earn overtime may be a mystery to a lay reader, but poses no difficulty to lawyers). The hours of work and wage rates have to be displayed, as also the applicable minimum wage and dearness allowance (cost-of-living adjustment). Every worker who has worked more than 240 days must be given one day's leave for every 20 days he works. Before he goes on leave, he has to be

paid wages in advance for the leave period. Advances may not exceed two months' wages without the Labour Inspector's permission. Every establishment must whitewash all inside walls, passages and staircases with lime and paint all internal structural iron and steelwork at least once a year, and maintain a record of the dates of such whitewash and painting. Wages can be paid only in coins or currency. Registers have to be maintained to record attendance, the hours worked, overtime, leave taken with wages, dates of whitewash and painting, fines or deductions for damage or loss imposed on workers, and advances.

The Task Force asked that the permitted length of the shift without the need to pay overtime should be increased to 12 hours, and that women should be allowed to work night shifts. The Subject Group on Knowledge-based Industries asked for exemption for those industries from the above restrictions. The Cabinet approved night work by women in February 2003; the rest of the demands were ignored.

Employers sought to evade the rigours of the labour laws by employing temporary labour. Temporary labour is legally defined as employment lasting not more than 240 days out of a year. Thus employers either employ a worker and dismiss him within 240 days, often temporarily; or they engage a contractor to provide labour on contract. To prevent this, the government passed a Contract Labour Abolition Act in 1976, which made contract labour illegal in a wide range of circumstances. It also amended the Employees' State Insurance Act 1948 and the Employees' Provident Fund Act 1952 to ensure that an employer of contract labour, and not the contractor, became liable for paying their health insurance and provident fund contributions. The government is still debating whether to relax the law on casual labour for firms employing fewer than 200 workers.

The Task Force recommended that the Contract Labour Abolition Act should not apply to the IT industry, and that temporary status should be defined as 720 days in three years instead of 240 days in a year. It also asked that IT firms should be allowed to dismiss 10 per cent of the employees in a year without permission. The Subject Group asked that knowledge-based establishments should be exempted from the liability for the health insurance and provident fund contributions of contract employees. None of these demands was met. However, retrenchment, overtime and night work were common throughout the industry; no doubt labour inspectors were on a retainer while these went on.

Thus India's administrative style, consisting of complicated laws and rules and numerous bureaucrats, affects the IT industry as much as any. That it has grown within this environment suggests that it has found the same ways of dealing with red tape as every industry that preceded it.

11. MARKETS AND MARKET SHARE

The industry consists of three sections: body-shopping, offshore development, and specialised products and services. Body-shopping straddles frontiers, and its dimensions are indeterminate. All that is known about specialised firms is that hundreds exist; what exactly they do and what they earn from it is uncertain. We have relatively reliable information only about the business of Indian IT firms, which have a foot each in body-shopping and offshore development. An estimate of their share in the world software market is given in Table 10.

Table 10
Global IT services market and India's share 2001

	Global market		India's exports		India's share
	$ bn	%	$ bn	%	%
Professional services	128.6	36.8	2.9	37.5	2.2
IS consulting	20.2	5.8	0.1	0.7	0.2
System integration	71.0	20.3	0.2	2.0	0.2
Custom applications	18.2	5.2	2.7	34.8	14.6
Network consulting & integration	19.2	5.5			
Product services	111.1	31.8	1.5	19.9	1.4
IT training and education	22.7	6.5			
Hardware support & installation	44.8	12.8	1.2	15.9	2.7
Packaged software support & installation	43.6	12.5	0.3	3.9	0.7
Outsourcing services	109.3	31.3	3.2	42.7	3.0
Application services	1.8				
System infrastructure services	11.1	3.2			
IS outsourcing	63.6	18.2			
Application management	11.2	3.2	1.8	23.0	15.6
Network & desktop outsourcing	21.6	6.2	1.5	19.7	6.9
Total	349	100.0	7.6	100.0	2.2

Source: calculated from NASSCOM (2003a:35-6).

Starting from virtually zero ten years earlier, India took a 2.2 per cent share in the world software market – three times India's share in world merchandise trade. In custom applications, towards which much of offshore work is directed, India had a 14.6 per cent share. In application outsourcing it had an even higher share – 15.6 per cent. This may be surprising since India entered the outsourcing market only in the last four years. But it is

in fact an outgrowth of Indian firms' work on custom applications; the same clients, having developed confidence in their Indian developers, have begun to outsource more comprehensive services. These are amongst the biggest corporations and financial institutions of the US; the industry prides itself on the number of the largest clients it works for. It has also taken a 6.9 per cent share in relatively simpler outsourcing of services like call centres, transcription services and document processing. It has a modest share of 2.7 per cent in product design, embedded software etc.

These figures are uncertain and approximate; still, they show where India has a foothold and where it has not. When big clients install new computers and want new software systems, they call IBM, Cisco, Oracle or such large, established firms; so also when they want to connect up offices across the globe. But when those systems need to be repaired, maintained or expanded, they are more likely to call an Indian firm; it requires painstaking examination of existing software and stick-and-paste reconstruction, but does not call for overall architecture. Indian firms are just beginning to enter embedded software and product design, but that market is largely unpenetrated. Amongst outsourced processes, Indian firms are entirely out of system management, but have picked up some jobs to manage applications, and some outsourcing of calls and office processes.

Amongst applications, Indian firms have specialised in work for banks, insurance and financial institutions; these accounted for 35 per cent of their revenues in 2001-02 (NASSCOM 2003a:30). In product software, they were particularly strong in telecommunication software; it accounted for 12 per cent of their sales. Manufacturing accounted for another 12 per cent; but here their share was not much more than 1 per cent. Half of their work was distribute d across a wide range of other verticals.

Less information is available about the work that they did in the domestic market; but it is clear that their areas of specialisation were the same at home and abroad (Table 11). Thus, finance and insurance were the most computer-intensive industries. Services followed. The automobile industry was a relatively heavy user. Manufacturing industry in general lagged behind. The scope for software applications increases with the size of operations, the number of transactions and the complexity of products and inputs. All these combine to put banking and insurance at the top of software-intensity. The number of components and the complexity of assembly also put automobiles in this class. One of the firms that have put IT to good use is Hindustan Ink, which produces 5000 different products and sells them to 60,000 customers.

Table 11
Expenditure on information technology in Indian industry, 2000-01

	Workers/PC	IT expenditure/worker (Rs)	IT expenditure/revenue (%)
Information technology	1	95000	1.60
Insurance	3	29000	2.49
Services	6	16000	0.24
Finance	6	17000	0.09
Automobiles	9	10000	0.50
Other manufacturing	15	7000	0.15

Source: Varma (2001).

Thus, Indian firms had specialised in custom applications, but in that field they were versatile; they did whatever jobs came to them. They had not specialised. The reason was that the software boom rushed them off their feet. Once India was established as a low-cost source, clients of all sorts rushed to Indian firms and used them for a great variety of jobs. Indian firms had become jacks-of-all-trades. They were too busy to accumulate and exploit knowledge in particular areas except finance.

12. BROADER ECONOMIC EFFECTS

The software industry's 2001-02 sales came to 2.2 per cent of GDP. Although thousands of small IT firms dot all cities, the export industry, accounting for 79 per cent of sales, is largely concentrated in half a dozen cities, all of which, apart from Delhi, are in the peninsula (cf Table 7). In these cities, the large exporting firms acquired a highly visible presence. They pioneered a new trend in architecture – compact, air-conditioned buildings clad in heat-reflecting glass, soothing colours inside, facilities for eating, sports and recreation and underground car parks. The incomes they locally generated led to the emergence of new shopping malls, restaurants and bars. Signs of poverty – beggars, shanties and manual labour – receded. The southern cities came to look newer and neater than northern ones.

Taxes in India are widely evaded, and the income-elasticity of tax revenue is low. Further, the most income-elastic taxes – income tax and excise – are with the centre. So the prosperity of the industry was not immediately reflected in that of the cities or states of its location. To get around this problem, the Karnataka government set up a Bangalore Agenda Task Force in 1999. It was a meeting point between the state authorities active in Bangalore – the civil administration, Bangalore Municipal Corporation, Bangalore Development Authority, Bangalore Telecom, the local police, and the Karnataka Power Transmission Corporation – and the major companies and their executives. The latter promised resources as well as technical and administrative help, and in return the public authorities promised to improve their facilities and services. In the course of this partnership, the local IT industry helped in modernising the administration of the public authorities. Their century-old single-entry accounting system was replaced by a double-entry system that recognised and kept track of assets. It turned the chronic deficits of Bangalore Development Authority into surpluses. A GIS system was set up for solid waste management. In 2003, the Karnataka government set up a Mysore Agenda Task Force for its second city on the model of Bangalore. On a more limited scale, IT firms set up a Poona Exporters' Association. Whenever a member was asked for a bribe or met bureaucratic obstruction, the Exporters' Association went on behalf to the superior of the erring government servant and represented for the member. The tactic was generally successful. At the national level, NASSCOM, the industry association, played a similar role in lobbying the government for changes in laws favourable to the industry.

The industry recruited from engineering colleges, and was faced with labour shortage throughout the 1990s. Its pressure led to considerable changes in tertiary education. They led to rapid expansion of engineering education, to dedicated degrees and diplomas in information technology, and to changes in curricula of engineering and science courses. They were also involved in the setting up of the Indian Institutes of Information Technology in Bangalore and Hyderabad. HP funded research and helped train research in universities and colleges in and around Bangalore; Motorola took in teachers from engineering colleges during sabbaticals (Patibandla and Petersen 2002). Globsyn Technologies ran its training courses in the engineering colleges of West Bengal; one of the courses it offered was in entrepreneurship for engineers. The alumni of Indian Institutes of Technology raised $12 million to improve facilities.

13. CONCLUSION

As we showed in Section XI, Indian firms had succeeded by first providing manpower to large US clients, and later by doing custom applications for them – in other words, by taking on any kind of work that they were prepared to give. They developed a loyal roster of clients amongst the largest firms, but were unspecialised in terms of work. Can this continue? According to a NASSCOM calculation, 90 per cent of America's 1352 largest corporations used outside service providers; of those, 44 per cent used overseas providers in 2001 (Table 12). Suppose the proportion were to rise to 67 per cent. Of their IT budget, 7.8 per cent went to overseas providers; suppose it were to rise to 20 per cent. And suppose some of the smaller corporations started sourcing services overseas. On these assumptions, demand for Indian IT services could easily quadruple. In other words, there is considerable scope for expansion in India's major market.

TABLE 12
NASSCOM projections, 2001-02 to 2004-05

	2001-02	2002-03	2003-04	2004-05	
				Optimistic	Minimum
No of large US companies	1352	1352	1352	1352	1352
- who will use offshore providers	535	681	815	676	669
Average software purchases ($m)	65	68	71	75	75
- of which from offshore providers	7.8	12.2	20	23.2	18.7
Total offshore purchases	4160	8339	16295	20357	12541
Smaller companies' purchases	42	250	815	1425	627
Total large+small companies	4202	8589	17110	21782	13168

Source: extracted from NASSCOM (2002a:66).

However, as mentioned in Section VI, there was a major redirection of India's IT exports between 2000-01 and 2001-02. The share of exports going to the US, UK and Singapore increased from 74.9 per cent to 81.8 per cent; it fell from 3.6 per cent to 2.5 per cent for Japan, from 3.2 per cent to 2.6 per cent for Germany and from 1.2 per cent to 0.8 per cent for Switzerland (NASSCOM 2002a:33-5; NASSCOM 2003a:28-9). What this shows is that Indian exports are heavily dependent on the sending out of programmers, and hence on the visa regime. The share of exports to the three countries that have liberal visa regimes for Indian programmers rose; the share of exports to countries with stricter regimes fell. Programming is eminently teachable, there are bound to be pressures to replace labour imports, and as labour shortages ease, countries will replace imported with domestic labour. And access to labour markets is a political variable; countries discriminate between programmers from different source countries. Thus, the US, UK

and Singapore remain open to Indians. But Germany has issued far more green cards to East Europeans than to Indian; and Japan has imported Chinese in preference to Indian programmers. Elsewhere, official prejudices against Indian programmers have been expressed in other ways. When the CEO of Polaris Software went to Jakarta to discuss a dispute about work it was doing for Bank of Indonesia, he was arrested in January 2003. In March 2003, the police in Kuala Lumpur raided a housing estate and arrested many Indian programmers who had visas, while they were ostensibly searching for illegal immigrants. In the same month, the Netherlands government expelled 13 programmers working for i-Flex Solutions, an Indian subsidiary of Citigroup which was marketing Flexcube, a product it had developed for universal banks, and had for that purpose set up an office in Amsterdam in 2000. The CEO of the company was extradited from London to Amsterdam and imprisoned.

Table 13
Comparative IT industry size & programmers' wages

	Industry revenue $m	Average wage/year $th	Relative Wage (India=100)
Romania	n	2.4	40.8
India	6.2	5.88	100.0
Czech Rep	0.7	6.4	108.8
Philippines	1	6.5	110.5
Malaysia	n	7.2	122.4
Vietnam	n	7.2	122.4
Ukraine	n	8	136.1
China	>1	8.9	151.4
Israel	2.6	25	425.2
Ireland	6.7	28	476.2
Russia	<1	6	102.0

Source: NASSCOM 2003a:85-87.

Movement of labour is subject to discretionary non-tariff barriers; it is customary for industrial countries to reject visa applications without giving reasons. Hence entry of Indian programmers can be arbitrarily restricted at any time, and the market for body-shopping will remain vulnerable to such actions.

Apart from this, India's wage advantage itself is vulnerable. There are countries like Romania where the average programmer's wage is lower than in India at current exchange rates (Table 13). In other potential competitors such as Czech Republic,

Philippines, Malaysia and Vietnam it is within a 25 per cent range of the Indian average wage; if there were another crisis like the 1998 East Asian one, India's wage advantage could disappear.

This implies, first, that India's competitive advantage would depend on its macroeconomic policies – on how well it maintains the difference in the cost of living between itself and other countries at the current exchange rate. India did not follow the extensive devaluations in East Asia in 1998; as a result, it lost competitive advantage in such industries as textiles and steel. It could similarly lose competitive advantage in IT if relative prices in India were to rise.

The second implication is that the Indian IT industry must find other sources of competitive advantage than low wages. Some Indian firms have developed such sources in the process technology they have developed. Meticulous planning shortens development lags and makes them predictable; extensive documentation reduces vulnerability to staff departures and other accidents; Chinese walls ensure security of work done for clients. Well designed buildings and campuses increase labour productivity. In these process innovations, the Indian industry has an advantage it should preserve and develop. In addition, it should adopt process innovations from elsewhere, and generate its own. The development of tools which increase productivity and control quality is of utmost importance for Indian firms. The quality and reliability of their software distinguishes the world's leading firms from Indian ones; Indian firms must bridge the gap. The days of cheap, labour-intensive programming are nearing their end; Indian firms must take a lead in process innovation and productivity increase.

Third, the industry must learn from and document the domain knowledge arising from the work it does. It has worked for a very broad range of industries, but except for some financial software, it has not codified or utilised the domain knowledge that might have come to it. It should exploit all sources to acquire domain knowledge – the work it does, buying into firms abroad that have such knowledge, and investing in firms that can yield domain knowledge. It is in such knowledge that it must seek to differentiate itself from its competitors, who are not far behind.

Finally and crucially, the world IT industry has passed through a phase of extreme fragmentation of work, which however is now passing. In the initial stages, the upper end of the industry was a craft business. The software used by big businesses had grown incrementally, and its varied provenance and resulting complexity were such that marginal additions and patches were the best that could be done. Since it belonged to an era when software was not standardised, large users employed software managers; they preferred to buy incremental packages of software services. It was this porous structure of legacy software use that enabled Indian firms to penetrate the market.

That phase is now passing, and so is the opportunity the Indian firms exploited. To survive and grow, they will need to tap the more durable sources of demand for information technology. IT is essentially used to mimic real-world processes, and to use their computer models to automate, control and improve those processes. This work is a variant of old-style consultancy, but instead of advising firms it requires close involvement with them while they reconfigure their processes. The two basic components of this type of work is intimate knowledge of real-world processes – domain knowledge – and capacity to make robust conceptual models of it. The firms that do this kind of work globally are few and large; the smaller Indian firms, coming with a different body of experience, are at a handicap in competing with them. They could reduce the handicap by getting practice at home. Hitherto they have neglected the domestic market because its paying capacity was low and because Indian client firms were less capable of making systemic changes that modelling would throw up. Though no more attractive than before, Indian industry and services are more or less a captive market for the Indian IT industry. The domain knowledge they can provide could be applied to work for clients abroad; the domestic market can provide the intellectual capital for entering the global market. For this reason, the IT industry should increase work it does at home, and if necessary cross-subsidise it.

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