CHAPTER XII
MANPOWER

From the discussions so far, it is evident that manpower is the key resource behind the growth and development of software industry. Accordingly, this Chapter details the various aspects of this critical resource in the context of India's software industry. Part 1 deals with the relevance and classification of IT manpower; part 2 dwells on its requirements and availability; part 3 discusses the present pattern of IT training and education in India; the major issues/problems comprise the coverage of part 4; and part 5 provides the required suggestions for improving the manpower availability as per the emerging requirements of the industry.

12.1.1 Role of Manpower

The key element of competitiveness of software industry is the endowment of skilled workforce. Sustaining and enhancing the competitive advantage in software depends on the cost and quality of higher education and training and how these institutions are attuned with the rapid changes in technology. The National Task Force on IT and the Task Force on HRD in IT, have stated that one of the key issues in achieving India's targeted growth of IT by 2008 is the availability of quality manpower. For companies on the cusp of the Internet Age, the real resource in shortest supply is brainpower, the talent to give wings to visions of a future that become the present at the speed of light. India’s natural resource in this knowledge economy is its pool of cost-effective skilled manpower, like the crude oil in Gulf and diamonds in South Africa. Analysts are of the view that this can transform India into an I.T. software and services superpower. The high international esteem for India's IT professionals is evidenced by the increased demand for them from several countries. Globally, the country was ranked third (after Israel and France) in terms of the quality of scientists and engineers by the World Economic Forum (‘World Competitiveness Report’, 1999). India is now a preferred source for software outsourcing. So, to maintain and promote this status of significance in the global software market, the country must expand the availability of
knowledge workers\(^{1}\). (Patibandla, Kapur, and Petersen, 2000, p.1267; NASSCOM, 2000, p.89; Kumar, N., 2000a, ps. 35-36; Dataquest, July 15, 2000; Hanna, N.K., 1994, p.65).

### 12.1.2 Stages of Software Development and Classification of Manpower

There are a few distinct stages in the process of software development summarised in the waterfall model\(^{*}\): requirements, analysis, design, coding, testing, and maintenance. ITes is also characterised along with this, even though it contains no software development but only its application. Almost in tune with the waterfall model, Freeman and Aspray (1999)\(^{**}\) classified the IT manpower into the following broad categories: Conceptualisers, Developers, Modifiers/Extenders, and Supporters/Tenders. Conceptualisers architect the industry by designing software systems. They are the highest trained/qualified, and are predominantly engineers. Developers translate these conceptual plans into reality. They work out the requisite programming inputs, allocate work among the programmers and manage the project until a suitable programme emerges. Modifiers/Extenders are the foot soldiers of the industry who write codes, test programmes, and modify/adapt them as required. Supporters/Tenders are meant to run computer-related services within user firms or help such firms as consultant trouble shooters, and include ITes personnel. (Joseph, K.J., 2001, ps. 22-24).

### 12.1.3 Manpower – Global Scenario

A major enabler for the growth of US high-tech industry has been the steady flow of highly educated immigrants and foreign students. Between 1985 and 1996, foreign students accounted for two-thirds of the growth in science and engineering doctorates in US universities. Most of them planned to stay back and work in the country. Globally, the biggest constraint on the spread of New Economy is anticipated to be the requisite manpower. Almost all developed countries are facing an acute shortage of knowledge workers. In several cases, 80 percent of the available time of programmers is spent on maintenance – modifying and developing old software. In fact, the global demand for software is estimated to be growing at 12 percent against a 4 percent growth in manpower and a 5 percent growth in productivity of software.

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\(^{1}\) Heeks, R., 1996.

generation. Hence, developed countries will have to outsource manpower from
countries such as India and China. (Mandel, M.J., 2000; Cane, A., 1992, p. 1728; EXIM
Bank, 1992, p.28).

12.2 IT MANPOWER – REQUIREMENTS AND AVAILABILITY

It is estimated that the total size of IT industry in India will be over US $ 87
billion (Rs. 391500 crores) by 2008. A large part of it would comprise IT Services. As
per NASSCOM study, to achieve this would require 22 lakh IT professionals – 11 lakhs
in the hard core IT sector and another 11 lakhs for the ITes. In addition to the national
demand, there would be international demand. Notionally, the Task Force on HRD has
taken it as 20 percent of the overall manpower requirements. Also, various segments of
IT industry require different skill levels. While the manpower required for software
products is of the highest order of skill, the ITes segment could be managed even by
persons from non-IT disciplines having proficiency in handling the relevant IT tools.
Furthermore, the per worker productivity of IT professionals varies according to their
skill levels. Keeping these various dimensions in view, for achieving the targets laid
down for the year 2008, the number of professionals required under different categories,
as estimated by the Working Group on IT for the Tenth Five Year Plan, are given in the
Table below.
Table XII.1: Manpower Requirements, Categorywise

<table>
<thead>
<tr>
<th>Category</th>
<th>Targeted turnover 2008 (in Rs. Crores) (X)</th>
<th>Per Capita Productivity (Annual) (in Rs.Lakhs) (Y)</th>
<th>No. of people required to achieve the targets at the beginning of the year 2008 (in Lakhs) (X/Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category-A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Products</td>
<td>90,000</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>Category-B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT Services</td>
<td>171000</td>
<td>33.75</td>
<td>5.07</td>
</tr>
<tr>
<td>E-Business</td>
<td>22500</td>
<td>33.75</td>
<td>0.7</td>
</tr>
<tr>
<td>Sub-Total</td>
<td></td>
<td></td>
<td>5.77</td>
</tr>
<tr>
<td>Category-C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT-Enabled</td>
<td>85500</td>
<td>6.75</td>
<td>12.6</td>
</tr>
<tr>
<td>Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-Business</td>
<td>22500</td>
<td>6.75</td>
<td>3.3</td>
</tr>
<tr>
<td>Sub-Total</td>
<td></td>
<td></td>
<td>15.9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>23.67</td>
</tr>
</tbody>
</table>


A total of 23.67 lakh IT professionals are required by 2007 to achieve the targeted growth by 2008. Corresponding to this, the annual manpower requirement in the next seven years arrived at by the Working Group is given below:

Table XII.2: Annual Manpower Requirement

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Requirement by 2007 (7 years) [X]</th>
<th>Average Annual Requirement [X/7]</th>
<th>Cumulative Average Annual Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.00 lakhs</td>
<td>28,500</td>
<td>(A)28500</td>
</tr>
<tr>
<td>B</td>
<td>5.77 lakhs</td>
<td>82,500</td>
<td>(A+B)111,000</td>
</tr>
<tr>
<td>C</td>
<td>15.9 lakhs</td>
<td>227,150</td>
<td>(A+B+C)338,150</td>
</tr>
</tbody>
</table>


Thus, on an average annual basis, 28500 IT professionals are required for Category A, 82500 for Category B, and 227150 for Category C, making a cumulative average annual requirement of 338150 IT professionals.

The annual manpower generation for various Courses in the Institutes in India, is given in the Table below:
Table XII.3: Annual Manpower Generation

<table>
<thead>
<tr>
<th>Discipline</th>
<th>No. of Institutes</th>
<th>Capacity intake (All Streams)</th>
<th>Capacity intake (CS&amp;E Streams)</th>
<th>Capacity intake in Streams other than CS&amp;E Streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.Tech (CS/E)</td>
<td>242</td>
<td>20000</td>
<td>3200</td>
<td>16800</td>
</tr>
<tr>
<td>B. Tech (CS/E)</td>
<td>&gt;700</td>
<td>178000</td>
<td>60000</td>
<td>118000</td>
</tr>
<tr>
<td>MCA</td>
<td>310</td>
<td>10000</td>
<td>10000</td>
<td>--</td>
</tr>
<tr>
<td>Total (Degree Holders)</td>
<td>208000</td>
<td>73200</td>
<td>134800</td>
<td>--</td>
</tr>
<tr>
<td>Diploma (CS/E)</td>
<td>1300</td>
<td>250000</td>
<td>90000</td>
<td>160000</td>
</tr>
<tr>
<td>ITI (CS/E)</td>
<td>&gt;4000</td>
<td></td>
<td>640000</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: CS&E: Computer Science/ Electronics Streams

So, based on the available level of manpower generation of degree holders, to meet the requirements of Category A&B of 111000 professionals, 73200 may be drafted from the CS&E streams and the remaining 37800 out of professionals generated through non-IT disciplines. But these 37800 will have to undergo ‘Bridge Programmes’ for their cross-migration to the IT arena. Another dimension of the manpower requirement is the required availability of the requisite skill level. Out of the aforesaid 73200, 28500 should belong to the skill level of Category A. (ref. Table XII.2). In the perspective of Working Group, assuming 50 students in each of the IT-related disciplines (CS&E) in an institute, their availability would be 150 students per institute per year. So, for sourcing the 28500 students, it would be required to upgrade 190 institutions to the Grade A level. As regards the annual requirement of 227150 professionals pertaining to Category C, the break-up of intended sources is as follows:

Table XII.4: Annual Manpower Availability

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-formal Stream from IT Training Institutes</td>
<td>200000</td>
</tr>
<tr>
<td>Graduates from Grade C Institutions</td>
<td>97000</td>
</tr>
<tr>
<td>Diploma from Polytechniques (CS/E)</td>
<td>90000</td>
</tr>
<tr>
<td>Diploma from ITIs</td>
<td>50000</td>
</tr>
<tr>
<td>Total</td>
<td>437000</td>
</tr>
</tbody>
</table>


So, on the whole, the country would be confronting veritable shortage of IT manpower unless efforts on the lines indicated above are made, especially in view of the manpower demand from abroad. For fulfilling the higher order skill requirements
(Category A&B), Bridge courses are to be imparted to a good number of personnel who are inducted to the IT stream from other degree courses. Further, even from within the IT-related disciplines, for obtaining the required number of professionals at the skill level of Category A, the existing institutions are to be upgraded. As regards Category C, meeting the requirements would be heavily dependent on non-formal training institutions. India’s shortage of software manpower would be mainly at the higher order of skills, as the present skill profile is programmer-heavy.

12.3 TRAINING

Keeping in view the criticality of knowledge in a digital economy and the rapid technological changes and resultant obsolescence in the IT sector, organisations are placing greater emphasis on training and re-training their employees. As regards the genesis of training in India, the leading institutes began co-ordinating with DoE in 1984 to provide structure and stability to computer training, and to define the role of private institutions. The DoE policy came in 1985, aimed at nurturing and developing the private initiatives in computer education. Shortage of technical/skilled manpower manifested itself in the country especially after 1987, primarily caused by the rapid growth of the industry catalysed by NCP. A number of new courses such as Master of Computer Applications (MCA), Diploma in Computer Applications (DCA), B. Tech/ B.E. in computers, etc. were introduced in universities and engineering colleges. In the private sector, computer training centres were started by enterprises such as NIIT, ICE, ICS, etc. These private training centres now spread across the country offering about 1000 training courses including diplomas of various durations. As per the interim report of the Task Force on HRD in IT, non-formal sector has a substantial capacity of 5 lakh and is growing at a rate of 20 percent. Broadly, whereas universities/colleges turn out engineers, training institutes bring out software programmers. Most of these institutes require only a high school diploma for students to get enrolled. (Sylvester Lobo, 2000; Bhatia and Gupta, 1997; Pawar, R., 1991; EPW, 1995; Dataquest, 1992).

12.3.1 Initiatives under Implementation

As a follow-up of the recommendations of NTITSD, it was decided to double the intake capacity of IITs and other reputed institutions such as IISc and IIMs especially in areas like software engineering, during the IX Plan. In addition, 17 RECs
were to be upgraded to IIT standards. The student intake in RECs has also been increased since the 1998-99 session, following the recommendations of a Committee that examined the infrastructure of RECs. NCST has been upgraded by creating two campuses in Bangalore and Navi Mumbai as a Centre of Excellence for Networking and Internet Technology and for Visual and Intelligent Computing. One significant initiative was the setting up of Indian Institute of Information Technology (IIIT). The first IIIT to become functional was the one at Hyderabad, in September, 1998. The concept has since been repeated at Bangalore, Chennai, Mumbai, Pune, Gwalior, and Allahabad. An Institute for Computer Professionals of India (ICPI) is proposed to be set up on the lines of Institute of Chartered Accountants of India in collaboration with NASSCOM. In addition, IGNOU and a number of private institutes such as NIIT, APTECH, are setting up virtual institutes for continuous on-line learning in IT-related disciplines. DIT has also planned to implement IT-enabled distance education programmes in collaboration with leading academic institutions like IITs, IISc, NCST, and BITS. (Kumar, N., 2000a, ps. 37-38; NASSCOM, 2000, ps. 96-97; HRD RT, 2001).

As regards IIITs, most of them are joint initiatives by the Government and industry, while some of them as in Gwalior and Allahabad are solely Government initiatives. The National Task Force on IT has recommended that the IIITs should be given the status of a deemed university. The aim of IIITs is to give both a computer software engineering degree as well as training in short-term courses. For most of them, the industry prescribes the syllabus. This gives scope for dynamic changes in courses. Another unique feature is that private sector companies are allowed to affiliate their own schools with IIITs. IIIT, Hyderabad, for instance, has affiliated schools of IBM, Microsoft, Oracle, Satyam, and Metamor. More are expected to join the bandwagon. Many States have also come up with exclusive ‘Institutes of Information Technology’. These institutions can function as resource institutions at the regional/state level.

12.3.2 Private Training Institutes (PTIs)

As per NASSCOM estimates, there were more than 70000 PTIs in the country as on 31st December, 2000. These consist of nationally spread institutes, franchisees as well as local institutes. Over the years, the growth of PTIs has really gained momentum. Some of the leading national institutes have introduced 2 or 3 years of integrated
engineering courses. One of the new trends is that graduates and engineers from formal institutes are reorienting or retraining themselves in PTIs. In future, PTIs may play an increasingly important role, as the formal system of education could meet only a declining percentage of the increasing manpower requirements. NIIT had already become the 13th largest IT-training company in the world during the year 2000, according to an IDC survey. One of the reasons for the surge of PTIs over government institutions is said to be their alacrity in introducing courses on new technologies as well as emphasis on elementary training.

The burgeoning demand for computer professionals during the 1980s really led to the mushrooming of PTIs. Another reason attributed for the explosive growth of individual training segment has been the expanded reach of these training companies. Aptech was at the threshold of crossing the 300 mark in terms of the number of franchisees. An interesting feature of the training segment is the entrance of a number of hardware and software vendors in the field of training such as DEIL, CMC, TCS, ORG Systems, Tata Elxsi, etc. For the training sector, what is mainly required is only the initial investment, and the profitability is quite high, one of the highest in computer training. The perception still prevails that computer training is a passport to avail good job.

Manpower demand could be for short-term as well as long-term needs. PTIs may cater to the short run requirements. Since the long-term needs call for not only basic theoretical training but also knowledge generation through R&D, by and large, this could be fulfilled by the formal institutions. A welcome feature of India’s software industry at present is the emergence of co-operation between industry and government at the central and state levels in setting up higher educational institutions, like IIITs. Both formal and non-formal sectors have definite and distinct roles in IT education, and the two should collaborate for best results. Another encouraging trend is that in states like Tamil Nadu, PTIs in association with government schools have launched innovative schemes to promote computer education. The schools have provided free space to PTIs in their campus. PTIs in turn have set up their own infrastructure and provide free training to school students during the school hours. After school hours, the training institutes are free to conduct commercial training. This has worked well in
creating computer literacy at school level and needs to be replicated in other states.
(Planning Commission, 2001, ps.126-7; NASSCOM, 2000, ps.96, 100-01; Pawar, R.,
1991; Economic Times, April 30, 2002; Dataquest, 1995; Patibandla, Kapur, and
Petersen, 2000, ps. 1267-8; Oberoi & Raghunathan, 1991, p.606; Rajeswari, 1995,
p.294; Kalra & Others, 1988).

12.3.3 Role of Industry to Promote IT Education

So far, requisite efforts have not forthcoming from the computer industry to
sponsor computer science graduates, give them scholarships and commit them towards
Indian companies. As observed by the Chief of Infosys, Indian software companies
which enjoy more growth incentives and tax reliefs than any other sector of industry,
should contribute a percentage of their profits to improve the standards of higher
education in the country, in their own interests. Industry-academia interaction could
have various facets like industry association in curriculum development, faculty
sabbaticals in industry, visiting faculty from industry, research collaborations, R&D
centres on campus and Industry Attachment (IA) programmes. In USA, industry-
academia interactions are given lot of encouragement driven by the philosophy that
teaching and research should be unified. Universities like MIT and Stanford pioneered
the efforts in this regard. In UK, Cambridge University initiated industry-academia
collaboration through development of the Cambridge Science Park. Encouraged by this,
quite a few Science Parks are in position in the universities across UK. In the case of
Japan, industry exposure to the student is ensured through the faculty researcher and
student working side-by-side on industry sponsored projects. Compared to these models
abroad, the industry-academia interaction in India remains at a very low key. The
industry generally does not associate the academia in its R&D activities, and prefers in-
house development or import of technology. Moreover, the engineering institutes in the
country are yet to acquire the required credibility for delivering solutions.

12.3.4 Government Initiatives

DoE attempted to deliver a direction to the training segment, by launching the
DOEACC scheme in 1990. The Scheme is implemented by the DoE Society under the
Department. It has three major functions, viz., Accreditation, Registration, and
Examination. Institutions are granted permission to conduct DOEACC accredited O (Certificate level), A (Diploma level), B (MCA level) and C (M.Tech level) courses, subject to their meeting well-defined norms and criteria. Students who qualify in these examinations are awarded Certificate/Diploma by the Society. The Society had 291600 students registered with it as on 31st March, 2001 and 152000 paper candidates appeared in the January, 2001 examination for all the four levels. Till that time, a total of 26919 had qualified in the DOEACC examinations. It seems PTIs were against it from the beginning. Several institutes failed to fulfill the Schematic stipulations, and were de-recognised. Another initiative of the Government has been the launch of 'Operation Knowledge', a national campaign to universalise computer literacy and spread the use of computers and IT in education. It was also decided to launch three schemes – the Vidyrthi Computer Scheme, the Shikshak Computer Scheme, and the School Computer Scheme—to enable every student, teacher or school desirous of buying computers to do so under attractive financial packages. (Bhatia & Gupta, 1997, ps. 452-3; Planning Commission, 2001, p. 127).

12.3.5 Present State -- Oligopolistic Control and In-house Training

The training market is now characterised by a high degree of oligopolistic control. By 2000, the top two companies, viz. NIIT and APTECH had a combined share of 52 percent. Several software training institutes in the country are, in fact, franchisees of one of these two training majors and follow the same cost structure. There are observations that such a high level of oligopolistic control over the vital supply link to the industry would require a look from an anti-trust perspective. Most other training centres are small operators. They entered the training bandwagon perceiving it as a vehicle for making quick profits.

Another trend is that large software firms impart in-house training for their employees in software related skills, laying emphasis on continuous learning. For example, TCS has been investing 6 percent and Infosys 4 percent of their total revenues on training manpower. On the whole, the software industry in India spent 5.5 mandays of average training per person per organisation. Most leading software enterprises train their new recruits to equip them with the requisite skills. However, these training programmes are quite expensive. As per some estimate, a 2-3 months induction training
programme costs around Rs.50000 per trainee. Moreover, these training programmes need to use experienced but scarce manpower who are usable in more profitable or productive activities. But, small and medium-size firms tend to do very little in-house training, mainly because of the high cost involved. Added to this is the fear that employees will leave for more lucrative jobs once their job skills are enhanced. To encourage in-house training, the government might consider extending incentives to the firms. For small and medium-size firms, a training fund may be established to partially defray the cost of training. This would be more effective than direct subsidies to training institutes. Another option is to award tax incentives on the same line as for R&D. (Kumar, N., 2000, ps. 32, 35-36, & 2000a, ps.43-44; Dataquest, July, 1991; Jalote, P.,1995; Hanna, N.K., 1994, ps. 51-52, 71-72).

12.4 PROBLEMS/ISSUES

12.4.1 Poor Quality of Training

According to industry sources, quality of computer training is low in India. As per a TCS report, of about 475 institutions that are providing computer education at degree or diploma level, of which 175 are university and engineering colleges, there are only about 40-50 institutions that produce people with adequate background to be of any real use in the software industry. Even the quality of MCAs vary widely, and their graduates are generally seen as appropriate for end user organisations, not software companies. Government initiatives have produced 'trainable' rather than 'trained' labour. The major grouse of user community against PTIs is that their students need to be retrained. These mushrooming “IT training shops” can only turn out “IT literates”. The real issue is quality and not quantity. The level of computer education offered at universities and IITs, is also criticised for failing to meet international standards. Absence of R&D culture is widely prevalent (barring a few exceptions here and there). Partly, the Indian computer industry is held responsible for this, which is reluctant to take interest in IT education. The shortage of qualified and competent teachers/trainers also depresses the quality of training. (Jalote, P.,1995; Heeks, R., 1996, ps.282-4; HRD RT, ps.22-25; Planning Commission, 2001, p.130; Lakha, S., 1990 ; Joseph, K.J., 2001, p.25).
12.4.2 Shortage/ Poor Quality of Trainers

There is lack of trained manpower for serving as instructors. Not many professionals are keen to be instructors. In at least 80 percent of the institutes in the country, faculty members are inexperienced and under-qualified. This is mainly attributed to their low monetary benefits and perks. Also, training as a career does not command as much respect as a career in programming. Naturally, the first preference for brighter and qualified computer professionals is to join the organised industry where career prospects are better. Even for IITs, attracting and retaining faculty is the biggest problem. There is also lack of motivation on the part of teachers either to innovate teaching methodologies or to keep themselves updated. The oligopolistic set-up and rapidly rising demand for courses prompt the training institutes to focus on breadth rather than depth, and franchise outlets recklessly. Although no detailed survey has been done, as per a reported sample survey for the AICTE approved institutions, teacher: student ratio varies from 1:39 to 1:52 (average being 1:45) for IT courses, against the AICTE relaxed norms of 1:15. Nearly one-fourth of the IT/Computer Science faculty positions even in the premier institutions are lying vacant. Faculty having post graduate or doctoral qualifications are difficult to come across. To get the right faculty as trainers, teaching should be made an attractive profession. Academic compensation in India is linked to the compensation structure for bureaucracy and government service. This should actually reflect the opportunity costs of individuals and demand-supply relationships. (Kalra & Others, 1988; Vittal, N., 1998, p.33; Crishna, V., 1999; Krishnan, 2001).

12.4.3 High Cost of Training, Poor Facilities/ Resources

It is generally felt that the cost of IT training offered by PTIs, is too high, especially when seen alongside the highly subsidised formal education system. However, according to PTIs, their operating costs prevent them from coming down to the government subsidised university levels. Their average revenue per student in 1998-99 was Rs. 12524, i.e. about thousand rupees per month. For higher levels of training, it is even more. This results in the ‘exclusion’ of underprivileged children. Initiatives are essential to bring down the cost of operation of PTIs.
Most of the private training shops lack the basic infrastructure. There have been cases where a computer school was started without even a computer. The students are sent for their practical sessions to an EDP centre, only to see an obsolete computer system. There are no equipment, labs, library or proper maintenance facilities. Enhancing the quality of education in these institutions will require a lot of financial resources, for which the feasible source seems to be industry. Hence, organisations like NASSCOM, MAIT, or CII should really take up this matter in all earnestness. Each institution may also be required to apportion at least 20 percent of its fee revenue for replacement and upgradation of its IT infrastructure, so that it does not become obsolete. Instead of direct procurement, other alternatives may be looked into like the possibility of leasing equipment with provision for periodic upgradation and evolving a system of software consortium. (Dataquest, 1995, p.104; Kalra & Others, 1988; HRD RT, 2001, p.31).

12.4.4 Poor Curriculum and Mismatch of Skills

There is a widespread misconception that Indian business and industry need only programmers—so much so that computer education has become synonymous with computer programming. Even reputed institutions like IITs and IIMs teach programming in the name of computer education. No wonder, India is most prolific in producing coders. According to Heeks, R., this characteristic reinforced by staff losses overseas, encourages programming-only contracts. Along with lack of technological and managerial resources, this reduces offshore productivity and quality in some companies, making onsite work more attractive. Certainly, there is a mismatch between the training imparted and skill requirements of the industry. The curricula followed by several private institutions are not tuned to the fast-changing needs of the industry. The industry increasingly needs trained labour for analysis and management. So, the problem of manpower shortage is not only lack of sufficient numbers, but also this mismatch between the skills. Students even of premier institutes such as IITs are predominantly taught about computer architecture, operating systems, etc. while the requirement is for professionals trained in the disciplines of software engineering/CASE tools, systems/utility tools, application software development tools, 4GLs, CAD/CAM/CIM, networking, etc. There appears to be no standardisation in the curriculum and they
differ widely across the country for the same degree. There are also complaints about the too theoretical or conceptual content and limited practical application of the training courses offered by private institutes, contributing only to computer literacy. This is what necessitates considerable ‘on the job training’ for new recruits. Most of the institutes and universities need to review their curricula to be in tune with the industry needs. (Heeks, R., 1992, p.245; Mehra, O.P.,1984; Dataquest, 1992; Schware, R., 1992, ps. 153-4; Gupta & Prakash, 1996; EIP, May, 1994; Pawar, R., 1991).

12.4.5 Job Switching and Migration

Job switching is endemic to the software industry, almost a norm. The employee turnover in software companies varies between 6 to 50 percent with an average turnover of 20.7 percent. (For hardware firms, this average is 11.25% and ranges between 5% to 18%). Job switching is also common among software professionals in training institutes, in the range of 5 to 50 percent. The effort of a few firms to gain competitive edge over others by luring software professionals, leads to spiralling salaries, and more importantly, a job-hopping culture. This will have adverse bearing on the external competitiveness of India’s software. The firms also suffer time and cost over-runs. Since a large software project may last several months, personnel loss may tell upon quality and productivity of the software organisation as a whole. In this manpower-intensive sector, loss of a person implies loss of knowledge, often critical, about the projects he was working on, and about the general processes of software development. In addition, with the loss of a person, all the investment in training is also lost out. All these are because of the very nature of software industry: so much of their ‘technology’ is embedded in people rather than machines. As Noyelle notes, ‘the inventory goes home every night’ and may not turn up the next day, leaving the firm with a major headache*

The best IT professionals of India often head Westward, mainly USA. As the former Indian Ambassador to USA, Abid Hussain, observed while addressing the Silicon Valley Indian Professionals Association, when you join the IITs or the IIMs, your soul immediately departs for the US – it takes four years for the body to catch up. The overseas migration has been facilitated by onsite software development and ‘bodys hopping’. Some of India’s best brains are emigrating to countries where they can earn better salaries and find professional challenges unavailable in the Indian industry.

Even though some of those emigrating may return with improved skills and capital, their numbers are too limited as compared to those settling down abroad permanently. No doubt, the government has tried to lure the NRIs back to India through various incentives, but the returnees have felt that their knowledge and experience are often not valued, but seen as a threat. Without a major change in the economic and work environment, India will not be able to retain its best IT professionals or encourage NRIs to return to the country. In an effort to create ties between research and industry, the government has established “science cities” around research institutions to serve as centres for high-tech industrial development. This is intended to attract NRI scientists and engineers living abroad to return to India as entrepreneurs.

Recently, a fresh spurt in brain drain was anticipated, caused by the rapid growth of software industry worldwide along with its increasing claims on manpower. India is being looked upon as a potential source of IT manpower to meet their international shortages. The relaxations in visa restriction for Indian software personnel by developed countries in the recent past evidence the scenario. Countries like USA, UK, Germany, Japan, France and several others had made such initiatives. Of course, the present recession in the US market has weakened their manpower demand and the quota under H1-B visa has since been brought down from 195000 to 65000, but the pick-up is expected without loss of time. Software companies have employed various strategies to retain talent, other than offering increasing salaries which have grown by an annual average of 16-21 percent. These include offering ESOPs or loyalty bonus, foreign assignments, investments in skill upgradation, improving the working conditions and facilities, and improving overall job satisfaction and motivation. More improved and innovative approaches may be required to retain the interests of India's skilled manpower indigenously.

However, it is refreshing to note that the attrition rate of software professionals has been registering declines, as indicated below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Attrition rate (%)</th>
</tr>
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<tbody>
<tr>
<td>1992</td>
<td>25</td>
</tr>
<tr>
<td>1995</td>
<td>22</td>
</tr>
<tr>
<td>1999</td>
<td>14</td>
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It is the rapid rise of software industry, along with venture capital, that has helped to reduce the extent of brain drain by creating rewarding employment opportunities within the country. IIT graduates are also assisted by the on-campus incubation centres in implementing their ideas and in getting them funded through venture capital. These developments alongwith the trend of some NRIs to return to the country to start software ventures, have prompted analysts to observe that talent is stayng back now; ‘Westward ho’ is no longer in prominence and Indian companies are testing the waters with their own products. However, any veritable reversal in migrating trends in keeping with India's software requirements, is still not visible. A major reversal of brain drain could do for India what the reverse brain drain from USA did for Taiwan's electronics manufacturing boom. (Economic Times, May 21,1999; Rajeswari, 1995, ps. 291-2; Heeks, R., 1996, p.95; Lakha, S., 1990, p.56; Derick & Kraemer, 1993, ps. 471-3; ESC, 2000; Kumar, N., 2000, ps.22-23, & 2000a, ps. 43-44; Joseph & Harilal, 2001; NASSCOM, 2000, p. 95; Kripalani & Clifford, 2000).

12.5 SUGGESTIONS / RECOMMENDATIONS

12.5.1 Lay Thrust on Training/ IT Education

As the software exports from India increase, so will the pressure on manpower. This will drive up costs and drive down quality, eroding both the areas of strength. Now, smaller companies are poaching on the larger organisations which serve as a training ground for manpower. Plans are to be launched with immediacy for building up a fountainhead of trained professionals particularly for export markets. India should really think in terms of manpower factories which constantly turn out well-trained personnel. There should be Masters programme in software engineering to an adequate extent to meet the industry's requirement of software engineers. The existing institutions like IITs, IISc, and RECs, and MCA courses should triple their output. This can be achieved at a marginal cost, since it would not involve hiring of new faculty, while using the existing facilities and infrastructure. Since the industry employs about 50 percent students with engineering background in disciplines other than Electronics and Computer Science, Bridge-Courses of 3-6 months duration have to be introduced. This would, inter alia, minimise the requirement of post-employment in-house training. IIT, Delhi, is already having such a programme. There should also be introduction of
new IT courses in programmes and areas having multiplier effect in ‘Select’ Institutions.

A computer course module must be made as part of the input of every graduation course in the country, to impart an IT orientation to everybody with collegiate education. This will build up a vast army of foot soldiers of technology in the emerging information age. The students will also be saved from being exploited by many of the private teaching shops which are charging very heavy fees. In addition, since computers change very fast, constant training has to be there. In fact, India’s competitive advantage may be lost unless the education and training system continues to supply IT manpower of requisite quality and ensures its periodic up-skilling. The shelf life of IT skills and emerging technologies is so short. The only constant in the IT sector are the perennial changes in technology. Accordingly, the manpower should be frequently re-oriented and equipped to meet the emerging requirements. (NASSCOM, 2000, ps. 98-99; HRD RT, 2001, ps.17, 29; Malhotra, S., 1992; Planning Commission, 2001, p.137; Chopra, R.C., 1996; Vittal, N., 1998, ps 33-34; Mehra, O.P., 1984).

12.5.2 Faculty Development

There should be periodic faculty appraisal/ certification/ upgradation both in the formal as well as non-formal sectors of education. For most of these centres, facility for faculty upgradation still remains a desideratum. Instructor enhancement programme for training of faculty has to be scaled up as a national programme. Institutes specifically dedicated for ‘Training of Teachers’ in IT may be set up in different regions of the country. “Training of Teachers” programme of the DOEACC Society may be further strengthened, and also extended to other institutions in the non-formal sector. There is a real need to train the IT faculty in the application specific thrust areas. For this, reputed institutions may conduct faculty enrichment programmes for the benefit of other institutions. Identification of application specific thrust areas should be continuously monitored by the reputed institutions with constant interaction with leading industries in India and abroad to keep pace with the technological advances. Institutions could be encouraged to apportion a part of their fee income (say 10 percent) for faculty skill upgradation. A Faculty Development Fund should be created. Teachers’ training is an area where the industry would be willing to co-operate. They could provide training
personnel, and complement expertise. The Computer Society of India\(^{(48)}\) too can play a significant role in the area of computer education in general and teachers’ training in particular. Well-known training institutes worldwide should be invited to train Indian teachers. Teachers may be encouraged to take up consultancy assignments in order that they familiarise themselves with field level issues/practical situations. This would also help associate their students in project work. (Planning Commission, 2001, ps. 136-7; Mehra, O.P., 1984, p.95; EXIM Bank, 1992, ps. 28-30; Chopra, R.C., 1996).

12.5.3 Curriculum Updation

Regular updating of curriculum in consultation with industry should be on priority. Whereas, an all India Board of IT Education could co-ordinate and monitor curriculum issues, there could be a network of institutions, which may take up the job of working closely and continuously to evolve IT curriculum, pedagogy and effective delivery methods. These institutions may also include private education and training providers. In fact, there should be an in-built mechanism to carry out revisions at least in every three years. NASSCOM has advised for a National Council of IT Education comprising experts from both the industry and academia, to constantly define courses and their content in the light of rapid developments taking place in IT. This Council could also upgrade on a regular basis the IT knowledge and skills of teachers by initiating a ‘Teach the Teachers’ (3T) programme. It is high time to initiate and popularise courses in ITes, like the ‘Planetworkz’ of NIIT and ‘ACPG’ of Aptech. (HRD RT, 2001, ps.36-37; NASSCOM, 2000, p.99; Economic Times, Oct. 16, 2002).

12.5.4 Basic and Fundamental Research

As rightly pointed out by the Working Group on IT for the Tenth Plan, there is a need for setting up Schools of Advanced Studies and Special Research Groups in the emerging areas. Open-ended research including basic/fundamental research in the frontier areas of IT, with long-term benefits in view, in institutions of higher learning/R&D institutions like TIFR, IITs, IISc, etc., needs to be given thrust. Research Chairs may also be supported, jointly with the industry. These could help to produce the required number of Ph.Ds and post-doctoral researchers. For the country to move up the value chain in software industry and to become a superpower in IT, it is essential that
greater importance is given to post graduate education and research. (Planning Commission, 2001, ps.135, 138-9).

12.5.5 Role of Private Sector

The private sector should be empowered to play a more active role. According to NACT, the private institutions need income tax status comparable to that of educational trusts, subsidies in the purchase of computers and software for education through duty benefits, special tax incentives for imparting training in non-metros and to schools, deemed export status for training foreign students in India, and the issuance of guidelines to financial institutions for offering soft loans to this sector. This should be supported with a conducive environment like deduction of computer educational expenses from personal income tax and the grant of soft loans to students wanting to take computer courses. (Crishtna, V., 1999).

12.5.6 Role of Industry

The industry could train students and thus ensure for themselves captive manpower. According to NCST sources, most industries in the developed world attempt this. There, the Companies take a greater interest in education and universities. The Indian corporate sector should also work hand in hand with educational institutes to find qualified people, failing which they will have to bear the brunt of manpower shortage and uncontrolled emigration. A stream of institutions may be set up by the industry to meet their specific needs. They must have full freedom in designing their curriculum which will be up-to-date and as per the market demand. The IT industry and educational institutions can mutually benefit through their closer co-operation and collaboration. In spite of efforts made, such collaborations have not been effective in the past, as wide differences of perception persist between them. The institutions could use industry experts for development of courseware relevant to the industry needs, assist them in problem solving through joint collaborative research and use them as faculty for specific industry oriented modules. (BICP, 1989, p.66; Business India, 1988, p.137; Vittal, N., 1998, p.35; HRD RT, 2001, ps. 40-41).

12.5.7 Networking and Exchange

The institutions may be networked to synergise their strengths. There could be sharing of faculty, courseware as well as good instructional and information resources,
through exchange programmes, joint R&D, etc. Universities and technical colleges must be assisted to establish links with international electronic networks for exchange of technical information, and to gain access to public domain software. Exchange schemes may also be encouraged between universities in different countries and scholarships granted for postgraduate studies abroad in software engineering and information technology. (HRD RT, 2001, ps. 31-32; Schware, R., 1987, p.1264).

12.5.8 Accreditation

There is a proliferation of computer training institutes in the non-formal/private sector but there is no system of evaluating their credentials. A nodal agency should be set up to check credentials of the institutes and oversee their working by prescribing certain minimum norms on the lines of the DOEACC scheme. A system of certification or rating of institutions in the private sector is to be devised patterned after the AICTE gradations of private engineering colleges. This will serve the dual purpose of providing incentives for institutes to improve and also serve as a guide to students to decide the best institutes to join. There is a need for evolving standards, practices and certification mechanism for recognition/accreditation of online learning courses. At the earliest, recognition must be accorded to the DOEACC ‘C’ level qualifications. Being an M.Tech level course, the recognition will not only boost the course but at the same time will be a source of faculty for IT undergraduate level courses. DOEACC Society should attempt to get wide acceptance of their qualifications by major industrial houses for its students to enhance their employability prospects in the private sector. (Planning Commission, 2001, ps. 137-8).

12.5.9 Managerial Requirements

Small and medium software firms are typically managed by professionals with technical background. But they often lack managerial and marketing skills. Similarly, the software industry lacks project management skills. Standardised courses may be ushered in to improve skills in overseas marketing, business analysis, project management, and quality management. Some government support towards sharing costs of the course material and the training of trainers in these areas can be of great help. This would certainly lead to high economic pay-offs within no time, by generating the requisite human capital for this manpower-hungry industry. Government–industry
sponsored courses at IIMs could address the management and marketing issues of the IT industry as well as the IT management issues in the user industries. (Hanna, N.K., 1994, p.73).

12.5.10 Government/Fiscal

Industrial houses should be given appropriate fiscal benefits for instituting Chairs, funding research, offering scholarships, and upgrading facilities in educational institutions. Since job opportunities for trained personnel in this sector are not a problem, loan facilities can be provided to children from underprivileged sections for meeting their training and education costs in software activities besides providing subsidies and scholarships, and creating government–aided institutions. The government should invest in computer centres in the major cities and lease hardware resources to training institutes at reasonable rates. Setting up training centres as joint ventures of government and large multinationals may be explored, following the model of Singapore and Japan. Another option could be the provision of training grants to overcome manpower constraints, a la Singapore. A few other governmental initiatives should be to provide centres of excellence in informatics and software engineering in selected universities, and computer literacy through schools and mass media. (Planning Commission, 2001, p.137; EXIM Bank, 1992, ps. 28-30; Dharmadhikari, V.K., 1988, p. 74; Hanna, N.K., 1994, p.66).