 CHAPTER III

HISTORICAL PERSPECTIVE: COMPUTER HARDWARE AND SOFTWARE

After giving an appreciation of the Information Technology Revolution in the preceding Chapter, the attempt of the present Chapter is to provide a historical perspective on the critical dimension of Information Technology, viz., computer industry—hardware and software. This has been looked at from both the international and indigenous angles. The Chapter comprises the following sections: section 1 covers the evolution and trends in computer hardware internationally; section 2 explains the connotation and categories of software, its evolution as well as present state of the industry in the global context; and section 3 narrates the major events and stages in the evolution of computer industry— hardware and software, in India.

3.1 COMPUTER HARDWARE INDUSTRY -- GLOBAL

Computers have come to dominate our lives. However, like many important things, computer also had very simple beginnings. The various phases in its evolution may be categorised as follows:

Numerical Age (B.C.3000-A.D.1943):

This era commenced with the invention of abacus, the first man-made numerical calculator, in B.C. 3000, and concluded with the ENIAC, the world’s first electronic computer in 1943.

Programming Plates (1943-71):

The phase may be taken as bordered by the invention of EDVAC, the first stored programme computer and the debut of microprocessor\(^{(18)}\) made by Intel in 1971. During the epoch, there was remarkable progress through a variety of vacuum tube\(^{(19)}\)-based computers.
Chip Wisdom (1971-81):

During this era, several computer companies came up and developed their own microprocessors and microcomputers. The era may be considered as concluded with the arrival of home PC from IBM in 1981.

Business Machines / Personal Companions (1981-90):

This period witnessed steady and rapid increase in the speed, power, compactness and user-friendliness as well as popularity of PCs.

The Gateway Age: Internet:

Efforts at inter-connectivity which commenced by the late sixties, fructified as the Internet and spawned the Information Revolution during this concluding era. Internet proved a turning point in the history of computers: PC is presently a Net Gateway. Indeed, the period from nineties has been taken as the age of Net revolution.

Analytically, it may be observed that technological progress in computers were led by the developments in electronic components like vacuum tubes, transistors\(^{(20)}\), ICs\(^{(21)}\), magnetic core memories, solid state semiconductors, etc. While the second generation computers came up through replacement of valves\(^{(19)}\) by transistors, the third generation computers replaced transistors by ICs. Soon ICs-VLSIs\(^{(21)}\) came mounted on multilayer boards which led to the fourth generation of mainframe \(^{(22)}\) computers. The multiprocessor\(^{(18)}\) which entered the scene in early 1970s became the processing unit for the personal computer. This low cost device revolutionised computing, and transformed computers from a ‘luxury’ to an ‘essential’. (Computerworld, 1999; Computers Today, 1999; Cane, A., 1992; BICP, 1989; Economist, Sept., 1994).

3.1.1 Computing Trends and Classification of Computers

Computing has progressed from mainframes to minis to PCs to laptops to palmtops. Interactive multimedia PCs capable of seeing and hearing is getting common. The cost of a computer has come down drastically, almost to a fraction of its initial cost. Computers are no longer stand alone processors, but are inter-connected. Progress in data storage devices and processing capacity have more or less moved up in tandem. Today a PC having 2 Gigabytes\(^{(23)}\) storage capacity is quite normal. Depending on the power, speed and storage, computers used to be classified as Supercomputers\(^{(24)}\), Mainframes, Super Minis\(^{(25)}\), Minis, Super Micros, and Microcomputers\(^{(26)}\). However,
the increasing power of minis and micros blurred these category-wise distinctions. The recent computing trends have further modified the classification as Handheld\(^{(27)}\), Notebook/Laptop\(^{(28)}\), PC Desktop\(^{(29)}\), Workstation\(^{(30)}\), Server\(^{(31)}\) and Supercomputer. (Information Technology, 1998; Anderson, B., 1986; Subramanian, 1997; BICP, 1989; Arora & Dadheech, 1996, ps.507-8).

3.2 SOFTWARE

3.2.1 What is Software

An important element of a computer system, and the focus of present study, is the ‘software’. It commonly refers to the programmes or the set of instructions and rules that the system follows for performing specified functions. In brief, it defines what the computer can and should do. Software can be broadly categorised into two: system software and application software. System software is an essential accompaniment of the hardware. It is a basic code or set of instructions that ‘initialize’ the machine so as to make it operational for performing functions. System software includes operating systems, communication and networking software, compilers\(^{(32)}\) and a host of system utilities. Application software refers to the specific programme performed by computers for solving user problems. Thus, categorisation of software is according to its intended purpose or task, systems software for computer problems and applications software for user problems. Software is intangible, and cannot exist independently of hardware. A few more details on system and application software are given below:

System Software:

The job of system software is to control the hardware, including peripherals, and the execution of application software. It may or may not be portable across various types of systems. However, the recent trend driven by the popularity of PCs and independent software vendors, is towards standardisation of systems software. This could enable a large number of applications programmes to be run on different types of computers as well as their ready availability as soon as a new system is developed, resulting in considerable marketing advantage to the firms. It was, in fact, the development of standardised, portable systems software that spawned the emergence of IBM-compatible clones and the PC revolution.
Application Software:

Application software is of two types -- customised as well as standardised or packaged. Customised software are programmes designed for specific and distinct jobs, like financial accounting, inventory management, invoicing, etc. Standardised or packaged software, essentially portable, are canned software packages available off-the-shelf. It will run on all compatible PCs. Now-a-days there are three most widely used software packages, viz., word processing, database management, and spreadsheets. Word processing denotes writing, editing, erasing, cutting, pasting or otherwise manipulating textual data. Database management is intended to manage vast volumes of textual or numerical data. Spreadsheets pertain to electronic ledgers that can manipulate data, enable us to do complex accounting, budgeting and ledger posting jobs.

Whereas developing systems software is complicated and time consuming, applications software is relatively simpler. Software programmes are generally stored on floppy disks, hard disks or magnetic tapes. Software is different for PCs and mainframes or minis. PC software is generally portable, but mainframe and mini software are, by and large, application-specific and machine-specific. (Bhatnagar & Jain, 1991; BICP, 1989, ps.7-8, 10 & 62; Schware, R., 1987; Business India, 1988).

3.2.2 Stages in the life cycle of software

The various stages in software development are: (a) requirements specification, (b) prototyping, (c) designing, (d) coding, (e) testing, and (f) maintenance.

(a) Requirements specification

In this stage of initiation, it is described the uses of software and how these will meet the needs of those using the software. This stage is really critical, as the initiatives and efforts here lay the foundation for the intended software edifice.

(b) Prototyping

After laying down the system requirements, the software developers can attempt a preliminary design or prototype of the final software. This would enable the end-user to compare results of the prototype with the original specifications. There could be early detection and rectification of possible errors, which would be considerable saving of time, effort and cost in the long run.
(c) Design

During the stage of design, the software specifications are transformed into a set of programmable procedures, generally into functional, independent blocks or modules which may be attended by individual programmers or small programming teams. It also makes error detection and testing easier.

(d) Coding

Coding or programming is the further transformation of the designed procedures or modules into a set of instructions for the computer. There are several tools available to help programmers in coding, like high-level languages such as FORTRAN, COBOL, and BASIC\(^{(33)}\). It is the stage of coding that undergoes maximum automation, since the process is very simple and low-skilled and free from the dimensions of creativity, organisational understanding, or consultation with end-users. Quite often, it can be cheaply conducted offshore, leading to outsourcing with firms in developing countries.

(e) Testing

It is the process of detecting errors in the product. Flaws may enter in the software development process, and it is highly essential to test and compare the software developed with the original requirement specifications, for possible corrections. This stage is significant and time-taking. Hence, there are observations that programmers spend as much time testing and correcting errors as they spend writing the initial programme. Now-a-days, a wide variety of testing tools are available.

(f) Maintenance

Software maintenance consists of either correcting errors that went undetected in the previous stages, or in changing programmes as a result of altered or additional requirement specifications. It has been estimated that 50 to 90 percent of software costs involve maintenance. Adequate maintenance and quick and reliable customer support are emerging as prominent criteria for supplier selection. (Kaul, C.L., 1999; Schware, R., 1989).

3.2.3 Evolution of Software Industry

Initially, operating software used to be sold as part of the system. Apart from the operating system, compilers and other standard utilities, the software was unique to each installation. Hence, the incompatibility of software between different machines
was common during the early days. This constrained the progress in information processing. For solving this, IBM came out with its system 360 in 1964. The essence of system 360 was the creation of a broadline of compatible computers spanning a large range of performances, with resultant cost reduction. Software used to be in-built in the computers sold by IBM during the fifties and sixties. However, in 1968, the US anti-trust policy requisitioned IBM to stop bundling software with hardware. This led to the development of software as a separate industry. Soon independent software vendors appeared. By the 1980s, it acquired the status of a major industry, and gave indications of overtaking hardware in the total revenue generation. Initially, the industry was limited to the developed countries. But the spurt in computer applications gave rise to the explosion in demand for software services, commonly referred to as the 'Software Crisis'. The acute shortage of skilled personnel to cope with this demand, led software developers in major markets to source skilled labour from outside. This gave an opportunity for developing countries such as India and China having low-cost manpower to make a successful entry into the global software industry. In this way, the software industry started moving to developing countries. (Cane, A., 1992, ps. 1726-8; Dataquest, 1986; Patibandla, Kapur, and Petersen, 2000; Basrur & Chawla, 1999; Mitter & Etendoglu, 1999).

3.2.4 Emergence of Software Packages

Software development costs, which is basically controlled by manpower costs, have registered rising trends, because of the aforesaid increase in the demand for software professionals alongwith their shortage. These adverse trends prompted the move away from custom software to generalised software packages. In the case of software packages, the cost of production could be spread over several users. The hardware manufacturers also gave encouragement to this trend, as they could then concentrate on their own production, and software would be developed by independent software houses. The increasing predominance of package software drastically brought down the price of software. This also greatly facilitated computer sales.

Alongwith this may be observed the structural shift in the software industry. Until the 1980s, a major portion of business software was mainframe-based, with minicomputer-based software coming in second. Since building mainframe software
necessitated expensive access to mainframes, industrialised countries alone emerged as the prime software developers. However, the advent and increasing popularity of microcomputers transformed the very structure of this industry. The market dynamics, viz., PC boom, generated an imperative need for standard off-the-shelf software. The operating system for IBM-PC was developed by an outside company, viz., Microsoft who has since emerged as the world's largest software house. (Srivastava, S., 1985; Capers, J., 1994; EXIM Bank, 1992).

3.2.5 Present State

With the emergence of a separate and distinct software market, the ascendancy of software over hardware commenced. The ratio of hardware: software costs in data processing systems changed from 4:1 in 1960 to 1:4 in 1990. Software costs are now accounting for a much larger proportion of the total system cost. Here, it should be borne in mind that whereas the hardware costs have registered consistent declines over time, the software costs have looked up because of the increase in manpower costs. The remarkable increase in the use of computers with corresponding growth in the demand for software and software professionals, resulted in acute shortage of software professionals and escalation in software development costs. A developed and sizeable global software market exists today, and grows at an annual rate of 10 percent. Products and packages account for about 75 percent of the world market. Developed countries such as the U.S.A., Japan, and EEC nations, account for 80 percent of this market, and the continued American domination is its conspicuous feature. The industry is also distinguished by fast technological changes. Keeping pace with these swift changes is one of the major problems of software developers, so that it has even been commented that by the time something is got programmed, it is obsolete before it is got to the marketplace.

An emerging trend, in favour of developing countries, is the internationalisation of software services. This is the result of an interplay of several factors. The standardisation of job activities, programming languages and hardware set-up along with the severe skills shortage currently experienced in developed countries, have mainly provided the enabling environment for this. Advanced markets such as U.S.A. are increasingly specialising in higher professional services such as application
solutions, software consultancy and developing highly R&D and marketing intensive
generic products and packages. Lower end of services such as support services,
maintenance, data feeding, coding, and niche market packages are met by low wage
cost countries like India. (Heeks, R., 1992; BICP, 1989, p.62; Patibandla, Kapur, and
Petersen, 2000, p. 1268; Scientific American, 1994).

3.3 INDIA’S EXPOSURE TO COMPUTERS

3.3.1 Hardware

India’s first exposure to computers began at ISI, Kolkata where a Russian
computer URAL--1&2 was installed in 1955. Thereafter came the second generation
computers in 1962, with the installation of IBM mainframe computers under US-AID
at three select places. Third generation mainframe computers were introduced towards
the late sixties or early seventies, with the arrival of IBM 360 & 370. By 1978, there
were 800 IBM computer installations. Initially, the market was clearly the domain of
foreign companies, led by IBM and ICL (then ICT). For more than two decades (1955-
77), there was virtual dominance of IBM who controlled about 70 percent of the Indian
computer market.

It was the exit of IBM that resulted in the computer manufacturing industry in
India. This came in the wake of implementation of FERA, which restricted foreign
companies operating in India to hold only 40 percent equity. Whereas ICL diluted its
foreign equity to 40 percent and became ICIM, IBM refused to dilute its equity and left
India on June 1, 1978. The exit of IBM left a major vacuum in the field of system
maintenance. This job was assigned to the Computer Maintenance Corporation (CMC).
As regards hardware manufacture, the Electronics Corporation of India Ltd. (ECIL)
which started with the production of 12-bit systems, progressed to higher
configurations. Private sector also made its entry into the computer market, by making a
beginning through calculators. It was in 1978 that HCL and DCM launched
microcomputers. By 1983, several private sector enterprises entered the field and
brought in reasonable amount of competition. By this time, WIPRO and HCL also
launched minicomputers. In fact, in 1978, when IBM left, the ex-IBM officials
sustained the Indian computer industry by spawning a number of hardware and software
organisations. However, it should be noted that even though the Indian computer
manufacturing industry came of age only in the post-IBM era, Government initiatives towards self-reliance in computer technology were dated back to 1969. This was with the setting up of computer division of the aforesaid ECIL, which actually was the Government’s alternative to IBM. (BICP, 1989, ps. 7-11; Agarwal, S., 1985; Karki & Cameron, 1994; Dataquest, 1983, & 1987).

3.3.2 Setting up Department of Electronics and Electronics Commission

Alongside, the Government also brought in organisational initiatives for promotion of the electronics industry. The first major step was the constitution of an Electronics Committee, known as the Bhabha Committee, in August, 1963, for review and advice in respect of the entire gamut of electronic components and equipment. Pursuant to the Report of this Committee (‘Electronics in India--Report of the Electronics Committee’, Feb., 1966), Government set up the Department of Electronics in June, 1970, and a special high-powered Electronics Commission in February, 1971, to lay down the policies and guide the development of electronics in India, on the same lines of the Atomic Energy Commission and the Space Commission.

3.3.3 National Computer Policy (NCP), 1984

The Indian computer industry which was in the nascent stage till 1984 witnessed accelerated growth thereafter, both in terms of production as well as number of producers. This has been mainly attributed to the liberalisation aided by market trends, domestic as well as foreign. A major enabling event for the growth of this industry was the NCP of November, 1984. In the wake of this, the hardware industry went through a virtual overhaul. Thrust of the policy was on growth. The whole thing was a great push by the new Government under the then Prime Minister Rajiv Gandhi who was keen on computerisation. NCP also catalysed widespread application of computers. For this, the real boost came from organisations and institutions belonging to the Government, like the National Informatics Centre (NIC). Through their NICNET (NIC network), plans were launched for the computerisation of government establishments at the central/state/district levels. This was followed by computerisation of various offices and activities.
3.3.4 Impact of IBM PC and Other International Developments

Around this time, the international developments were also impacting the Indian computer market. IBM PC had emerged as the global standard for microcomputing. The Indian market started receiving PC-compatibles towards the end of 1984. The rise of Singapore, Hong Kong, Taiwan, and South Korea as major clone markets, also helped in the boom of our PC-compatible market. The PC wave, in turn, engendered ancillary industries like PCBs, floppy drives, power supply, and printers. (Dataquest, 1987; July 15, 2001).

3.3.5 Evolution of Software Industry in India

The entry of India into the computer software sector dates back to the early sixties when commercial computers were installed in India. Until late seventies, computer usage in India was limited to large organisations. This has been attributed to their high cost and the relatively higher skill requirements for operating those early generation machines which had only rudimentary software. However, it has been observed that, in stretching these machines to the utmost, the early pioneers of software in India created a base of extremely skilled programmers. During the seventies software in India was mainly developed in-house. These were meant for specific purposes. Since the late seventies, there was increasing spread of microcomputers in India. Conditions became favourable for the growth of computer technology, and there was a proliferation of computer hardware. In the midst of all these, computer software grew in India as part of the broader process of development of the computer (and electronics) industry. The developments subsequent to the exit of IBM in 1978 also imparted a boost to the software industry. CMC who was assigned the task of servicing IBM equipment and software, emerged as one of the most successful Indian computer firms with distinguished track record in software development for both the indigenous and overseas markets. Another development was that many of the Indian professionals previously employed and trained by IBM set up small software businesses that generated entrepreneurship within the local software industry. (Oberoi & Raghunathan, 1991; Lakha, S., 1990, & 1994).