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Nehru and the Computer Revolution: Foundations and transitions

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Nehru and the Computer Revolution: Foundations and transitions*

Dinesh C. Sharma

Abstract

Computers and digital devices have come to play a significant role in the lives of ordinary Indians in the twenty-first century. The dissemination of computing and communication technologies on a large scale in India and the emergence of India as a major provider of such services to the world since the turn of the century is often dubbed a miracle. This has been referred to as computer revolution, IT (information technology) revolution, and digital revolution, at varying points of time. The rapid rise of digital technologies in the past 15 years in India is often seen as a byproduct of economic liberalization unleashed in 1991. While it was certainly an inflection point, 1991 was not the beginning of the IT revolution. Computer revolution in India began soon after the country attained independence, as a subtext of larger development and organization of science under the leadership of Nehru. Two of his most trusted scientist-aides—Homi Jehangir Bhabha and Prasanta Chandra Mahalanobis—spearheaded the development of scientific projects and institutions; acquiring computing power and capability necessary for their respective projects was an integrated part of this effort. Both Bhabha and Mahalanobis had plugged into computer revolution unfolding in the West in the 1950s early on and used these links to develop indigenous capability, acquire contemporary computers, and build national institutions for training in this new technology. The Electronics Committee headed by Bhabha laid the blueprint for electronics and computer development in 1970s, spawning new institutional frameworks such as the Department of Electronics. Thus began India's computer revolution.

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Introduction

If there is one piece of technology that is touching the lives of most Indians directly or indirectly every day, it is undoubtedly information technology. One can call it digital technology or we can use an umbrella term called "information and communication technologies" or ICTs. Today some 944 million digital devices, also known as mobile phones, are in operation in the country.[1] The actual number of users could be lower, given the fact that many people have more than one phone while a few million connections may not be in operation. Still penetration of wireless phones is deep and widespread. The total number of digital or electronic transactions such as payment of bills, taxes, obtaining land records, passports, various certificates, etc. which have taken place from 1 January 2014 to 31 December 2014 is over 3.49 billion.[2] About one million railway tickets are booked every day using the computerized reservation system—half a million of them via the internet. Behind all these applications and services are powerful computers, sophisticated software, and elaborate networks that connect citizens with each other and with the government as well as service providers. Computers have not become a part of an average Indian's life, but the power of computing is certainly impacting the lives of millions of Indians in the twenty-first century.

Not long ago, we had waiting period of up to five years to get a landline telephone connection, and once you got the phone, the quality and reliability of service was very poor. The situation of other public utilities was similar. Computers were there—mainframes and minicomputers—but they were the domain of scientists and academics, and a handful of government agencies and large corporations. They had very little to do with people directly or indirectly. Even smaller software companies could not afford to buy a computer. They had to write software with pencil and paper and then test it out by buying time on a commercial data centre or work on computers of their clients. From this situation in the 1980s, we have reached a situation when even a low-end mobile phone comes loaded with more computing power than the most powerful computers that were used by NASA to send man on the moon. No other technology has changed so rapidly in such a short period of time and has got disseminated to so many people in an affordable fashion. It is for this reason that we refer to advances in computing as revolutionary and call the phenomenon as "computer revolution" or "information technology revolution". Arguably, computer technology has turned out to be one of the most defining and transformative technologies of the twentieth century.

The question is how did India plug into this world of technology, despite ranking low on so many other social and economic indicators? How did India develop necessary skills and technical capability to become a formidable player in the global technology business in a seemingly short period of time, even while penetration of this technology was low domestically? Most narratives on India's information technology revolution began in 1991, when economic liberalization and the process of globalization was initiated.[3] Some attribute India's success in the outsourcing business to the Year 2000 or Y2K problem when a number of Indian software firms were awarded contracts to fix the software problem.[4] It is true that both 1991 and Y2K are important inflection points in India's IT revolution—the software industry's revenue jumped from 100 million dollars to 100 billion dollars in a span of 25 years. But the journey began much earlier. In fact, the story begins even before 1947.

The development of computer technology in India has to be seen in the context of overall science and technology development, which began in the pre-independence era as a joint project of political, industrial, and scientific elites. The National Planning Committee (NPC) set up in 1938 by President of the Indian National Congress, Subhas Chandra Bose, provided a formal forum for political elite to collaborate with elite leaders from the world of science and academia. For rapid industrialization of the country, Bose felt, "far reaching cooperation between science and politics" was necessary.[5] In order to build such an alliance, Bose invited Physicist Meghnad Saha, who was a great advocate of application of science for national development and a public role for scientists, to attend the NPC meeting in Delhi. Engineer Sir M. Visvesvaraya, another advocate of national planning, was tipped to chair the NPC but Saha proposed that the panel should be headed by a nationalist leader like Nehru so that it has enough political clout. Thus NPC with its 29 sub-committees became a forum for formal collaboration between science and politics.

While addressing the 34th session of the Indian Science Congress, Nehru articulated significance of such an alliance. He said, "In India there is a growing realization of the fact that the politician and the scientist should work in close cooperation."[6] While Nehru was the key participant from the political side in the science–politics alliance, there were several leading scientists, engineers, and industrialists who represented science in this alliance. The scientific elite included Mokshagundam Visvesvaraya, Meghnad Saha, Shanti Swarup Bhatnagar, and Prasantha Chandra Mahalanobis, among others. A younger member of the scientific intelligentsia was Homi Jehangir Bhabha, who came to India on a holiday in 1939 but stayed back when the war broke out in Europe. He joined the network of scientific elite soon. Though the scientific leaders imagined a modern India with rapid industrialization, the goals and approaches of individual members of this network differed greatly. All of them had their own ambitions, areas of interest in science, and a plan to implement the same.

The role science could play in national development was further elaborated in the official policy of the Congress party which in its manifesto in 1945 noted that "science in its instrumental fields of activity, has played an ever increasing part in influencing and moulding human life and will do so in even greater measure in future.... Industrial, agricultural and cultural advance, as well as national defence depend on it. Scientific research is, therefore, a basic and essential activity of the state and should be organised and encouraged on the widest scale."[7] Future architects of scientific institutions in India knew very well about the vision of the Congress party and were ready with their plans when India gained freedom. However, not all the plans got translated into action after freedom was attained. Several new national laboratories and government departments to promote scientific research were established. Prominent scientists, mostly close to the political leadership, got to play a significant role in planning and policy making related to science and technology. While Mahalanobis, Bhatnagar, and Bhabha succeeded in garnering political support for their scientific projects and were given formal positions in the government, others like Saha, Raman, and Visvesaraya were ignored.

Having founded the Tata Institute of Fundamental Research (TIFR) in 1945 to conduct research in nuclear physics, Bhabha could convince Nehru about the utility of nuclear power for India in future, and had drawn up an elaborate plan for development of nuclear energy. He was in talks to obtain uranium from British and Canadian atomic energy commissions, much before 15 August 1947, with blessings from Nehru, as elaborated by Robert Anderson in his book.[8] In fact, the first shipment of uranium from Canada arrived a month before the Independence day. Bhatnagar, who was head of the Council of Scientific and Industrial Research (CSIR), further consolidated his position as a key scientific advisor to Nehru and earned his confidence and support which was necessary to quickly expand and modernize the chain of national laboratories under the council. The administrative body that governed CSIR was the Board of Scientific and Industrial Research (BSIR), and also covered atomic energy research. Mahalanobis, founder of the Indian Statistical Institute (ISI) in Kolkata in 1932 and a key member of the NPC, was also to play a larger role in the new government.

Mahalanobis was among the earliest Indians to have used a mechanical desk calculator for statistical work in the 1930s.[9] His services were also used by the British after the Bengal famine which had left millions of people dead and resulted in damage to the agrarian economy of the region. Mahalanobis was asked by the provincial government to conduct a survey to assess yields of paddy crops. Then he was commissioned to conduct the Bihar Crop Survey and a sample tabulation of the 1941 census data. ISI needed modern data handling machines to execute such large assignments. Import was the only option, like all instrumentation needed for scientific research in India, but it was a costly option and very difficult during the war years. Therefore, Mahalanobis thought of exploring fabrication of scientific instruments, particularly calculating machines, indigenously. In 1943, he set up the Indian Calculating Machine and Scientific Instrument Research Society. The main objective of this society was to "manufacture, assemble, repair, purchase, sell or deal in calculating, mathematical and scientific instruments and accessories".[10] This effort was in addition to the workshop ISI had for repair and maintenance of calculators. Post-1947, Mahalanobis consolidated all computing related activities under the umbrella of an Electronic Computer Laboratory.

In Bombay, Bhabha was in saddle at TIFR set up in 1945 with financial help from the Tata Trust. Post-independence, he had a new structure in the government to support his dream of developing a nuclear reactor and through it demonstrate that electricity can be generated for the benefit of ordinary Indians. The new set up was in the form of the Atomic Energy Commission, established through an act of parliament in 1948. In addition, a separate Department of Atomic Energy was established with Bhabha as its secretary. Bhabha convinced Nehru that he needed an independent place of authority in the government, free of bureaucratic hurdles, to purse the goal of developing nuclear energy. As DAE secretary and AEC chairman, he reported directly to Nehru and insisted that secrecy be maintained about nuclear research.[11] Bhabha thus created a unique position for himself—he was head of a scientific institution (TIFR) and a top civil servant in the government. He could draw necessary political support and clout for his scientific goals. Like Mahalanobis, Bhabha also needed modern electronics and computing power for building nuclear reactors. The clout of Bhatnagar also grew in free India, forcing Sir C.V. Raman to make his famous comment of "Nehru-Bhatnagar effect" in reference to rapid expansion of CSIR labs after the independence.[12]

In the West, the 1940s was a decade of great advancements in computing as well as several other scientific and technological fields including nuclear physics. In computing, a major shift was taking from calculators and unit record machines to modern electronic and digital computers. The Universal Automatic Computer (UNIVAC) was the first modern computing machine of this era.[13] The first unit of this computer was installed at the U.S. Census Bureau in 1951, and ISI was counted as a potential customer while the machine was being fabricated.[14] UNIVAC used thousands of vacuum tubes, and stored data on tapes and not punched cards. Historians of computing believe that the modern term ''to program'' a computer probably originated at the University of Pennsylvania's Moore School of Electrical Engineering. Although Presper Eckert and John Mauchly, who designed UNIVAC and its predecessor ENIAC or Electronic Numerical Integrator And Computer, had realized that computers would need to store the program, a report prepared by John von Neumann, dated 30 June 1945, is cited as the founding document of modern computing. From this report as well as follow-up reports co-authored by von Neumann emerged the term ''von Neumann Architecture'' to describe design of a stored program computer. Computers developed in this period were meant for defence-related applications and other strategic areas, including nuclear research and census operations.

Leaders of Indian science were familiar with the developments in computing taking place in the Western world, given their strong links with leaders of scientific and academic world there. Both Bhabha and Mahalanobis were Fellows of the Royal Society and other science academies. Mahalanobis was highly mobile scientist, often going on long tours of important laboratories around the world and also inviting Nobel laureates and top scientists to visit ISI as well as other centres in India. -For instance, both Bhabha and Mahalanobis were in touch with von Neumann at different points of time. Bhabha consulted him while reorganizing the School of Mathematics at TIFR in 1947, and subsequently appointed K. Chandrasekharan, a postdoc fellow at Princeton, as an associate professor in 1949 as advised by von Neumann.[15] Mahalanobis, during his trip to North America in 1946, visited the laboratory of von Neumann at Princeton where an electronic computer was being developed. As per Mahalanobis's account of the meeting, the two discussed building a similar machine in India, and von Neumann assured him that he would come to India the following winter, if invited.[16]

Development of computing machines was not taken up as stand-alone activity by Indian scientific groups, but as a component critical to own scientific goals they had set to achieve— which was development of a nuclear reactor for Bhabha and national planning based on statistics for Mahalanobis. Building modern computers from scratch was a challenge. India did not have an industrial base or supporting infrastructure for such a task. Components were not available and importing was not very easy. Yet teams at ISI and TIFR put together basic analog computers, using parts from war surplus depots in Calcutta and Mumbai respectively. ISI engineers had to go to the Kashipur ordnance factory for electroplating to be done.[17] The analog computer developed by ISI scientists was ready in 1953 and was meant to solve linear equations with ten variables. Nehru was shown the machine during one of his visits to the institute. The analog computer developed by atomic energy group was called EAC-62. Some of its units were supplied to users outside the atomic energy establishment too. Eventually Bhabha put together a team of scientists and engineers led by R. Narasimhan to develop a general-purpose digital computer at TIFR. The result of this effort was fabrication of a near-contemporary machine called TIFRAC or TIFR Automatic Calculator.[18] It was designed in 1957 and commissioned in 1960, but was formally named TIFRAC by Nehru in 1962 when he came to inaugurate new headquarters of TIFR. ISI caught up soon, with a second-generation, transistor-based computer called ISIJU-1 which it developed along with Jadavpur University. For various reasons, it remained an experimental machine.

Fully aware of the fact that the computer technology in the West had moved to the next stage and that more powerful systems would be needed for their pet projects, Bhabha and Mahalanobis were constantly looking for standard, commercial machines. ISI acquired a range of systems including custom-built HEC-2M from the UK and URAL from the USSR using a variety of funding mechanism of UN agencies.[19] On his part, Bhabha was visiting computer labs as well as manufacturing companies in the US and the UK, building networks for training of TIFR scientists and technology familiarization. He lobbied hard with US funding agencies to support his project to get a powerful computer for nuclear research. This resulted in TIFR acquiring a fairly modern computer CDC 3600, from the Computer Data Corporation, in 1964. This was the system that CERN and other scientific agencies were using for nuclear research, and was dubbed as "supercomputer of the 60s".

Parallel to his engagement with scientist-administrators (Bhabha and Mahalanobis), Nehru was nurturing two other streams of activity that would have a far-reaching impact on developments in the computer sector—commercial data processing led by IBM and founding of IITs, particularly IIT Kanpur with direct participation from the US. IBM first came to India in 1951, operating through a marketing office in Calcutta. Arthur K. Watson, chairman of IBM World Trade Corporation, visited India twice in the 1950s and during the second visit he is said to have met Nehru and committed to start manufacturing operations in India.[20] India was only the eighth country in the world where IBM had manufacturing facility. Nehru evinced personal interest in IBM's activities in its formative years and met the first batch of Indian recruits at the end of their training programme in 1961.He also visited the IBM training centre in Faridabad. In the 1960s, IBM became a formidable player in commercial data processing space, and counted all major government departments, public utilities, and business houses among its clients.

Indian Institutes of Technology (IITs), which have acquired a global brand value, were conceived as modern technical higher education centres even before India became a nation. The idea of patterning India's higher technical and engineering education on the lines of MIT was first proposed by Ardeshir Dalal, a former officer of the Indian Civil Service and an influential member of the industrial elite, after he led an industrial delegation to America in preceding years. Bright Indians were already being sent to America for higher education under a government scholarship scheme, to help tide over shortage of skilled manpower. The blueprint of higher technical education, proposed in 1946 by the panel headed by Nalini Ranjan Sarkar, was implemented by Nehru with the first IIT coming up at Kharagpur in 1951.[21] Nehru wished Indian engineering schools to be among the best in the world, so he roped in some of the leading higher education institutes of the West to develop them. External help, both technical and financial, also became necessary as national resources could not have been made available sufficiently for them due to pressure for resources from different sectors. Import of equipment, books, and technical journals all required foreign exchange which was scarce.

The first IIT at Kharagpur did not receive any direct assistance from MIT but it had international faculty drawn from several countries including the U.S. and the U.K. For IIT Bombay, United Nations Educational, Scientific and Cultural Organization (UNESCO) facilitated equipment and technical expertise from the Soviet Union and other Eastern bloc countries, while Germany provided aid for IIT Madras. Despite such varied international inputs, Nehru was keen on direct involvement of MIT in development of IITs. In 1958, the Government of India requested MIT to send a team to India and help the government prepare a blueprint for an IIT in north India, as suggested in the Sarkar panel report. The industrial town of Kanpur was chosen for locating this institute. MIT hesitated to take full responsibility for the proposed collaboration due to various factors, including likely problems associated with relocation of faculty from the U.S. to Kanpur for long durations. Instead, it suggested to the U.S. Agency for International Development, which was to sponsor the collaboration, to appoint a consortium of American universities for the Kanpur project. Subsequently MIT deputed a three-member team led by mechanical engineer Norman C. Dahl to study how MIT could help IIT Kanpur grow. A consortium of nine U.S. universities was then floated to help set up the Kanpur institute, resulting in a formal ten-year programme called the Kanpur Indo-American Project (KIAP) in August 1961.[22] Among major components of this ten-year project was IIT faculty receiving on-the-job experience in consortium institutes; and procurement of equipment, books, and journals not available in India. A major piece of equipment that came as part of the project was IBM 1620 computer, almost a year before TIFR got the CDC machine. Another IBM machine 7044 arrived soon. The two computers made up the Computer Centre at IIT Kanpur, which was used to train people from all over India as academic courses in computer science and engineering were yet to begin.

Impact

What was the impact of the three streams of computing-related activity of the Nehru era—research and development led by ISI and TIFR, commercial data processing led by IBM, and computer education and training led by IIT Kanpur?

A constant exchange of information, knowledge, and experience took place between Indian scientists and leading Western groups through education, training, lectures, and employment. Nehru depended on formal and informal advice from British scientists like A.V. Hill in matters of organizing scientific research in India. His scientist-advisors too leaned on Western scientists on several issues, specifically in the area of computing. Top names of computing in America in the 1960s—Nicholas Metropolis, Norbert Wiener, Harry Huskey, C.M Berners-Lee—directly contributed to building skills among Indians in the early phase. Many of them were invited to spend time in India under a scheme named "Short visits of scientists from abroad" devised by Mahalanobis and Bhatnagar. Under this programme, invitations were extended to eminent scientists personally signed by Nehru.[23] Mahalanobis believed that such visits were beneficial to students who could not go abroad for learning.

Though locally fabricated systems like TIFRAC and ISIJU were not technological breakthroughs, they served the purpose of helping Indian groups gain capability in various fields of computer design, fabrication, testing, operation, maintenance, and programming. A group of specialists had grown to maturity who could tackle with confidence the logical, circuit, system, and engineering design of a variety of digital equipment. TIFRAC helped spread computer consciousness among research scientists beyond TIFR.[24] Scientists from government laboratories, educational institutes, and private organizations from all over India used it for their computational needs. It helped develop initial software programming capabilities among Indians. Several staff members were recruited and trained in programming. A programming manual was developed and an extensive library of sub-routines was set up to help users of this computer write their own programs. ISIJU-1 too was put to similar use for education and training but with moderate success.

The CDC system at IIT Kanpur gave Indian scientists and engineers tremendous experience in handling such a large system right from its fabrication, installation, and testing, to solving complex problems.[25] Specific capabilities were developed in hardware and software maintenance, software program writing, hardware troubleshooting, peripherals and components fabrication, and overall system management. Since large computers came under various grants and schemes, they had to be supported locally. Sometimes manuals had to be written and training programmes conducted by Indian scientists and academics. Lack of adequate support for updating of software from computer manufacturers forced undergraduates at IIT Kanpur to write necessary software for upgrading the system for newer applications. "Producing up-to-date software for out-ofdate hardware" spurred innovation. These very innovative skills came in handy when Indian companies took up work for American firms in the years to follow.

The computer centres at TIFR and IIT Kanpur not only helped scientific users of the atomic energy establishment and IIT respectively but also a large number of academic and business users from all over the country. The two centres helped build computer consciousness and software writing skills among several hundred engineers all over India. IIT Kanpur pioneered computer education with BTech and MTech courses in computer science. Out of all this emerged early capabilities in hardware design, software programming, maintenance, and training in the late 1950s and the 1960s.

The third stream—IBM's commercial data processing operations in the 1960s—was also critical. The company contributed to creating a computer culture in government and business in early years. This helped in developing a favorable environment for the introduction of computers on a large scale in the years to come. IBM introduced top government and public sector officials to the use of computers through training programmes. It was due to IBM's aggressive marketing that computers were introduced in large industrial sectors such as textiles, jute, and steel. All this was done at a time when computers were seen as job snatchers. In addition, it helped develop a pool of highly skilled computer professionals in systems engineering, programming, and maintenance. Engineers and marketing executives who worked in IBM at various points in time later joined Indian computer companies which emerged in the 1970s. A major disadvantage, however, was that this generation of programmers was exposed to just one platform—IBM. The company policy of leasing out refurbished systems at inflated rentals landed it in trouble towards the end of 1960s and led to it closing down its operations in 1977.

It is important to note that a policy framework for development of computers and information technology and its use in the government and other sectors was yet to emerge till the end of 1960s. Yet computer technology spread in government, academia, and business in this period. The policy framework had begun to develop with the Electronics Committee set up after the war with China to chart out a plan for electronics development in India.[26] It was called Bhabha committee. The electronics wing of the atomic energy establishment was hived off into the Electronics Corporation of India Limited, and a new Department of Electronics and the Electronics Commission established during 1970–71, as a spinoff of the work done by the atomic energy group. Bhabha and Mahalanobis also wanted to get into manufacturing directly—Bhabha with the Tatas and CDC, while Mahalanobis through an entity named Sankhya Yantra Private Limited, but both ideas failed to take off for different reasons. These aborted attempts have to be seen in the background of prevailing industrial and economic policies. American electronics manufacturers too wanted to set up production lines in India to take advantage of cheap labour, but felt frustrated due to restrictive policies such as cap on production capacities and turnovers etc. The effort to create a Silicon Valley or Route 128 around IIT Kanpur too failed to take off. The focus was on import substitution and not export-led growth. This was one of the major reasons why India missed the so-called hardware bus in the 1960s.

Overall, the Nehru period saw introduction of a new technology in the country in the form of computers in government, business, and research institutes, recognition of electronics and computing as a separate sphere of policy making and government support, development of computer science and engineering education, and most importantly, building of programming and hardware skills. It is these skills and experience as well as necessary infrastructure created in the public sector and government institutions which had a beneficial impact on private sector and entrepreneurial firms which came up in the 1970s and 1980s, in the run up to the exponential growth of the sector seen in the 1990s and beyond. So, the next time someone asks you who is the grandfather of India's IT revolution, you know the answer.

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