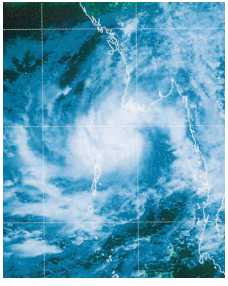


CHAPTER VI

ENGINEERING AND TECHNICAL EDUCATION

EDUCATION IN ANCIENT AND MEDIEVAL INDIA

Indian education system can be traced to *Vedic* period (prior to 1000 BC) and the Epic period (1000 BC to 800 BC) which comprised *ashrams* (hermitages) of *acharyas* and *kulagurus* (teacher sages). It is believed that teachings included technological skills and science of warfare besides Vedas, languages, logic, philosophy, ethics, politics, and economics. The education system of the Epic period evolved into three types of institutions: *gurukulas*, temple schools and the *agrahara* village institutions.

An institution of great fame, Taxila developed in the north-west India (now in Pakistan). With the political influence of Hindus, Persians, Greeks and Kusans, Taxila served as the capital of a number of dominions and through exposure of many cultural influences, acquired a cosmopolitan character. Students came from far off places to study various arts and sciences and medicine. Numerous technical skills such as carpentry, smithy, foundry and weaving were taught at Taxila. South India with a profusion of temples had a lead in the development of temple schools in medieval times.

In India, the Buddhist developed university institutions similar to *stadium generale* several centuries before their appearance in Europe. Among the famous institutions are Nalanda, Vikramshila, Jagaddala, Odantapuri and Ranchi, which gradually disintegrated with the decay of Buddhism in India.

Specifical details of technical and vocational education in medieval India are not available. However, there is ample evidence that vocational skills were highly developed. Elegance and excellence of articles such as fine fabrics of cotton and silk, embroidery, painted and enamelled wares, swords and knives and gold and silver jewellery . are well known. Such high quality could not have been achieved and sustained for centuries without a dependable system of technical education. Broadly three systems developed during that time: pupilage system, hereditary training and training schools.

EARLY DEVELOPMENTS DURING THE BRITISH RULE

The development of new technological activities growing out of scientific research in Europe led to the concept that practical skills be taught in special schools in India by the British. Schools were set up for imparting skills which needed sound knowledge of mathematics, science and use of scientific instruments. Land Surveying was given high priority to train surveyors for government works.

The first Survey School on the Indian soil was opened in May 1794 in Madras, now Chennai. Later on, technical education spread to other parts of the country. The Madras Survey School trained only English boys. The 'native Indians' were left out because of political and military implications of survey work. The East India Company feared that survey maps could fall into the hands of their French and

Dutch rivals. Civil surveying was a well-established branch of knowledge in India as it served revenue purposes. Land revenue maps were in vogue much before the British came in.

The General Committee of Public Instruction formed in 1823, comprising British Officers was the only organ to advise the Government on educational matters. This Committee was replaced by the Council of Education and the subject of education in general was brought directly under the control of the Government. The General Committee and later the Council of Education advised the branches of study useful to students for their livelihood. Apart from reading, writing and arithmetic, surveying was strongly emphasized on account of its utility to the British rule. The concept that drawing and surveying be taught at only college level and not at school level gradually emerged in Bengal. From the need to have these subjects taught in colleges to the desirability of Colleges of Civil Engineering was a big step, yet quite logical. Engineering was not yet classified into several disciplines; the term meant engineering for civil purposes as distinct from military functions. The importance of civil engineering as a discipline of education for Indians started receiving emphasis in 1840s with road and canal projects as goals.

Cautley, an army engineer, associated with the construction of Ganga Canal had envisaged the establishment of a school to supply efficient workmen for the Canal Project. James Thomason, Lt.Governor of North-Western Provinces (NWP) had a bigger idea beyond just the canal. He thought of the whole country in terms of surveys, irrigation, navigation, roads, bridges, railways, for all of which it was impossible to provide Britishers. His proposal, in the context of Ganga Canal and the infrastructure, which had already come up to service the project, to establish a Civil Engineering College at Roorkee was accepted by the Governor-General Lord Hardinge. The Roorkee College was established and it started functioning in January 1848 with an army Lieutenant as its first Principal. Within a few years, engineering colleges were established at Kolkata, Chennai and Pune. The Roorkee College was named as Thomason College of Civil Engineering in 1854 in honour of its founder who had died the year before.

Pioneering Initiative: The concept of engineering education through formal instruction in a school or college was unknown at that time even in England. Consequently, the subjects of engineering were not properly classified and structured for teaching. The teachers of Roorkee College within the first 25 years of its inception did the pioneering work in systematizing the teaching of engineering and preparing education material. The printing press of the college played a great role in publishing 17 College Manuals and three volumes of *Roorkee Treatise on Civil Engineering in India*, which became standard texts in other engineering colleges.

Role of Military Engineers in Engineering Education: The Royal Engineers in the Army in India played a major role in influencing, the fortune of Roorkee College and the three other colleges in Kolkata, Mumbai and Chennai. Military engineers were the only type of engineers that came to India with the East India Company. As the Company assumed greater power for governing the country, all technical jobs in engineering and science were entrusted to military engineers. Almost all the PWD officers came from this tribe and engineering education came under their purview. The principals and teachers of these colleges were also army engineers. These men ensured that military was the feeder for admission to these colleges and the colleges, in turn, served the army by running special courses for its officers and other ranks.

The Institution of Universities: On the recommendation of the Court of Directors of the East India Company, Universities of Calcutta, Madras and Bombay were established in 1857, with a comprehensive academic scope. They established faculties of arts, science and law, as well as of

medicine and engineering. The three provincial engineering colleges were duly affiliated to the university of their region but the graduates started receiving university degrees from 1864 onwards .

Winds of Change: Exposed to and enlightened by the industrial development, political thought and education of the West in the 1880s, a growing number of educated Indians wanted India to progress in these areas. Unemployment of the educated Indian youth was on the increase and technical education was regarded not only as a basic requirement for industrialization but also to provide employment. The newspapers with nationalist leaning criticized the Government for not making enough provision for technical education. A mention of the need for technical education became a regular feature of the Presidential addresses of the Indian National Congress Sessions and their resolutions.

The Education Commission appointed in 1882 to review the progress of secondary education also drew attention to the complete neglect of practical studies and job-oriented skills. The Government accepted the recommendations of the Commission and passed a resolution in 1884 providing that every variety of studies should be encouraged to direct the attention of the youth to industrial and commercial pursuits.

As a follow up of 1884 resolution, and as directed by the Viceroy, a memorandum was prepared in 1886 by MacDonnel, the Officiating Secretary of the Government of India. He divided technical education into two classes: university education and school education. The 1886 profile of technical education in the MacDonnel memorandum is given in the following tables.

Enrolment in Four Colleges (1884-85)

NAME OF COLLEGE	University level	School level	Total
Civil Engineering College, Madras (now Chennai)	19	106	125
College of Science, Poona (now Pune)	102	77	179
Government Engineering College, Howrah	42	107	149
Thomason College of Civil Engineering, Roorkee	–	107	107
Total	318	290	608

Enrolment in Survey and Industrial Schools (1884-85)

PROVINCE	Survey Schools		Industrial Schools	
	Number	Enrollment	Number	Enrolment
Madras	—	—	6	249
Bombay	1	21	7	307
Bengal	4	171	5	172
Punjab	—	—	4	93
NW Province	—	—	2	186
Central Province	—	—	19	316
Assam	7	163	1	18
Burma	5	110	1	38
Total	17	465	45	1,379

The policy of the Government was to accept the desirability of technical education with no financial responsibility to spread it, the latter was left to the public. Low grade technical and industrial schools were opened and were run variously by education departments, district boards and privately.

Lord Curzon (Viceroy of India, 1899-1905) thought that India did not have the necessary education base to profit from higher technical education. There were only a few industries in India, mostly owned by Europeans who preferred to employ only Europeans in technical positions.

The Nationalist Opinion: The nationalist opinion to promote technical education was building up. An industrial conference sponsored jointly by Indian industrialists and the Indian National Congress became a regular feature as an adjunct to the annual congress sessions. In the first such conference in 1905, it was impressed upon the Government the desirability of establishing at least one central polytechnic institute for the whole of India and a technical college in each province. Lord Curzon rejected the suggestion as clambering of natives for things they know nothing about. His successor, Lord Minto, was advised that these were harmless platitudes not deserving serious attention.

The *Swadeshi* (of our own country) movement which started sweeping the whole country in the early 20th century led to an urge for *Swadeshi* education too. Many national educational institutions, free from Government control, were established at various places, some of which also imparted technical education. The next Viceroy, Lord Hardinge, was more inclined to give weightage to technical education. Prominent among the institutions opened with private initiatives were the Indian Institute of Science, Bangalore, which started functioning in 1911 and the Banaras Hindu University in 1916 in which a College of Engineering was started in 1919.

The Period of World War I and the Period between the Two Wars: Prolonged wars ironically fuel industrial activities. Although no concrete progress was made in technical education during the World War I , a change in approach following the reports of the Indian Industrial Commission (1916) and the Calcutta University Commission (1917), led to developments in technical education in the subsequent years. With the Government becoming more responsive to public demand, the technical education profile began to slowly improve. Prior to 1919, the number of higher or university level technical or engineering institutions was only five , this rose to 21 in 1939 and the number of diploma schools increased from eight to 23. Nationalist will, private enterprise and Government assistance all played their parts in this change. To mention a few of the institutions which were established, Harcourt Butler Technological Institute, Kanpur (1920), Indian School of Mines, Dhanbad (1926), Maclagan College of Engineering, Lahore (1930), University Department of Chemical Technology, Mumbai (1934), Engineering College in Aligarh Muslim University (1935), Delhi Polytechnic (1941), Laxminarayan Institute of Technology, Nagpur (1943), Alagappa Chettiar College of Technology, Guindy (1944), Department of Engineering in Annamalai University (1945) and three other colleges in Madras Province in Coimbatore (1945), Kakinada and Anantapur (1946).

In 1936-37, the total enrolment for technical education in India was 0.126 million which rose to 0.201 million at the time of Independence.

The Post-War Transition: As the World War II drew to its end, the British Government realized that the era of colonialism was over. A transfer of power to Indian hands became inevitable. The British Government of India, therefore, considered it futile to hold on to its economic and industrial policies to suit the interest of British industry. During the dusk years of its rule, the British Raj decided to release the brakes it had applied for a century to withhold industrial progress. One of the steps was the thinking of technical

education in a big way to provide facilities all over India for higher education in science, engineering and technology comparable to anywhere in the world. The overseas scholarship scheme of 1944 was pursued more vigorously. The Central Advisory Board of Education (CABE) was asked to prepare a report on the post-war educational development in India. In the light of this report, an ad-hoc committee under the chairmanship of N.R. Sarkar was constituted in 1945 to advise on the provision of advanced technical education in India. The Sarkar Committee recommended the establishment of at least four Higher Technical Institutes one in each zone -- north, south, east and west.

A crucial recommendation of CABE was the constitution of a central agency to ensure an all-India coordinated and integrated growth and spread of technical education. The Government of India, thus, established the All India Council for Technical Education (AICTE) to supervise all technical education above the high school stage. The Council had its inaugural meeting under the Chairmanship of Sarkar in May 1946.

Early Developments in Independent India: In pursuance of the Sarkar Committee recommendations, five Indian Institutes of Technology were gradually established betwen 1950 and 1961. The Government of India appointed a Commission under the chairmanship of S. Radhakrishnan to examine the Indian University education -- including technical education -- and to suggest improvements and extensions. The Commission in its report emphasized the need of new types of engineering and technical institutions in India to produce men not only skilled in technology but who were well integrated individuals. It was emphasized that technical education must include elements of general education and engineering courses should have underlying scientific studies. The Commission also advocated closer liaison between engineering colleges and universities so that the colleges would grow vigorously in an atmosphere of higher research in science. Wherever possible, the existing engineering and technical colleges should be upgraded for postgraduate training and research. The Commission further recommended to start, without delay, higher technological institutes to produce much needed engineer-scientists and design and development engineers. The Commission clearly advocated that engineering colleges be not controlled or dominated in their administration by the Government. These and other recommendations led to several developments in the succeeding years. The first year of all undergraduate degree courses were made common in all branches of engineering. Curricula were revised to include general education and basic physical and engineering sciences.

The Structure of Higher Technological Education in India

In the Indian system, the completion of the senior secondary examination is the stage from where higher education begins (ten years of primary and secondary education plus two years of higher secondary education). The first degree, the bachelor's degree is obtained after three years of study in the case of science and liberal arts and four years in the case of engineering and technology. The master's degree programme was of two year's duration earlier but is currently of one and a half year duration. The research degree (Ph.D.) takes variable time but can be completed in three years.

In addition to degree courses in engineering and technology a number of discipline-oriented and certificate courses are also available. Their range is wide, some being undergraduate diploma courses and others postgraduate courses with a duration of one to three years.

The System of Governance of Technical Education: Education is a concurrent subject under the purview of the Central Government as well as the State Government. In addition, statutory bodies like (AICTE) and the University Grants Commission (UGC) have their empowerment by the Acts of

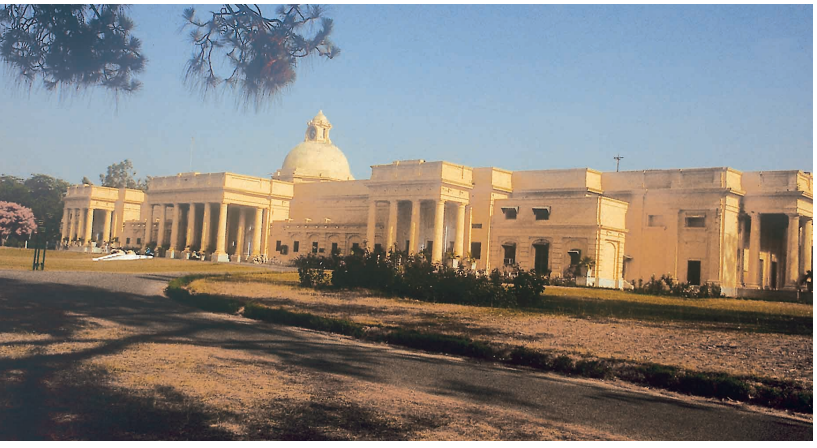
Parliament to regulate higher education. Professional Bodies such as the Council of Architecture, Pharmacy Council of India and the Institution of Engineers (India) have their roles, some of which are well defined and some others not so. The universities and deemed-to-be universities exercise various controls arising out of their statutes.

The Bureau of Technical Education (BTE) in the Ministry of Human Resource Development provides grants to centrally funded institutions such as the Indian Institutes of Technology (IITs), Indian Institutes of Management (IIMs), School of Planning and Architecture (SPA), New Delhi, Technical Teachers Training Institutes (TTTIs), Indian School of Mines (ISM), Dhanbad, and Indian Institutes of Information Technology (IIITs). BTE processes the programmes of these centrally funded institutions, monitors and evaluates them. UGC allocates and disburses funds to the central universities and has the mandate with reference to norms and standards of education in the universities.

AICTE was originally constituted as an advisory body in 1945 for all matters relating to technical education. Although AICTE had no statutory power, it played an important role in the development of technical education in India. In the late nineteen fifties, early sixties and eighties there was a large-scale expansion of technical education. Whereas the earlier growth occurred with the approval of AICTE and the Government of India, the expansion of eighties was brought about primarily in the self-financing sector without the approval of AICTE and the Government of India, and was localized in four States — Karnataka, Maharashtra, Andhra Pradesh and Tamil Nadu. It was in this period that the National Policy on Education (NEP) (1986) envisaged that AICTE be made a statutory body and be vested with the authority for planning, formulation, and maintenance of norms and standards. Even as early as 1964, the Education Commission under the chairmanship of D. S. Kothari had made similar recommendation for proper administration of technical education. AICTE was made a statutory body in 1987, by an act of Parliament, for appropriate planning and coordinated development of the technical education system throughout the country. AICTE functions through its various statutory bodies to comply with the mandate provided by the Act.

The AICTE has allowed approved institutions offering technical courses leading to diploma, degree and postgraduate degrees 15 per cent seats extra over and above the sanctioned number for foreign students. These seats will be meant exclusively for foreign students.

The University of Roorkee.



Expansion of Technical Education: When India attained Independence in 1947, there were only 38 degree-level and 52 diploma-level engineering/technical institutions with a total intake of 2,500 and 3,670 students, respectively. To carry out development plans, the country required expansion of the system of technical education, especially to provide human power for industries and technical services. The Central and State Governments provided funds to increase the technical education facilities in the 1950s and early 1960s which resulted in the establishment of a large number of Government and Government-aided private institutions in the country. The Government also adopted a policy of heavily subsidizing the technical institutions to

State	Engineering College		Polytechnics	
	Number	Intake	Number	Intak e
Maharashtra	135	35,835	169	34,635
Tamil Nadu	153	31,895	211	43,754
Karnataka	75	26,337	199	36,038
Andhra Pradesh	102	25,435	92	15,895
Himachal Pradesh	02	410	01	180
Assam	03	660	10	1,318
North-Eastern States	05	860	11	1,490
Bihar	12	2,635	28	3,983
Gujarat	20	5,885	39	9,005

attract meritorious students. The aided institutions received 50 to 70% of the capital cost and 80 to 90% of the recurring cost.

Regional Engineering Colleges: A large number of industrial projects were contemplated in the Second Five Year Plan (1965-61). To ensure the supply of trained personnel for these projects, an assessment of demand and supply was made . It was estimated that a shortage of engineers and diploma holders would occur. Therefore, a scheme was formulated for the growth of the existing engineering colleges and polytechnics. The scheme was reviewed for capacity expansion. As a part of this initiative, eight Regional Engineering Colleges (RECs) were established in the first phase. It was decided to have one REC in each of the major states, thus adding up to a total of 17. REC's have a national character and each college is a joint and cooperative enterprise of the Central Government and the State Government concerned.

Private Initiatives: Technical education has always been and continues to be one of the more preferred areas of study with expectations for better career opportunities. During the last two decades, the growing demand for expansion of technical education and the inability of the Government (which traditionally has been establishing and running technical institutions), to meet the social aspirations, has resulted in private initiative to provide the alternatives. In recent years, private registered societies and trusts have established a phenomenally large number of technical institutions. The self-financing technical institutions now account for more than two-third of the admissions to engineering colleges and nearly half in polytechnics.

According to the AICTE the intake in degree and diploma courses in engineering at the time of Independence with the corresponding figures of 1,85,758 and 2,11,894 as on March 31, 2000 (Annual Report for the year 2000) shows an increase in intakes by factors of 74.3 and 57.74 respectively. There is a significant imbalance in the geographical spread of technical education. The above table shows the contrast between selected states which have some of the highest intake capacities with those that have the lowest (as on March 2000).

Shortage of Technical Human Resource: In absolute numbers technical personnel have increased in the country. However, international comparison shows that per thousand population, India has 3.5 S&T personnel, whereas China has 8.1, South Korea 45.9, U.S.A. 55, Germany 76, Israel 76 and Japan 110. Thus India needs several times more S&T personnel if it has to compete globally.

Research and postgraduate education in engineering and technology is confined to only a few institutions. Despite attractive scholarships, nearly 60 per cent of over 19,000 postgraduate seats approved in 191 institutions remain vacant while less than 7,000 complete the courses. Annually less than 400 research scholars complete their Ph.D. in engineering and technology. The low out-turn of postgraduates who constitute the supply source of teachers, is a major concern of technical education system which suffers from 12,000 vacant positions, a number which is growing.

A significant percentage of degree holders in engineering, particularly from better institutions, take up management and administrative jobs or go abroad. This results in a loss of 40 per cent to 50 per cent in some critical areas of technology from IITs and a few other institutions.

To offset this inevitable loss and the need of a much larger number of good institutions of engineering and technology, private initiative is the only option since this national need cannot be fulfilled by public funding. Private initiatives, therefore, have an honourable role to provide opportunities for technical education to a much larger number of students.

Need for a Technical Education Policy

The National Education Policy (NEP) of 1986 addressed to the issues of engineering and technical education in the private sector in a different context. The 1980's saw a phenomenal growth of technical institutions in four states. This sudden increase of technical education, like in adiabatic expansion of a thermodynamic process, resulted in cooling of quality. To arrest the decline in the degree of excellence, as envisaged in NEP, AICTE was made a statutory authority. This response was largely conditioned by the imperatives of damage control rather than the need of control to ensure high norms and standards. Through the years, AICTE has become more effective in fulfilling its mandate flowing from the AICTE Act of 1987. The Act was born in a milieu of distrust of the private sector in the area of technical education. The atmosphere has changed and the private sector has to be encouraged in every way to invest in technical institutions to provide high-quality education. The existing system is a mix of what was designed and what has evolved, both of which need a critical appraisal and review. A new policy initiative is needed which would take into account the inescapable role of the private sector, the emerging technologies, the new modes of knowledge delivery in an electronic environment, the role of Governments and universities, the system of regulations and controls, the market pressure of foreign agencies which are making inroads in the Indian education system, networking of education and research, distance education, the system of accreditation and its international interface and the promotion of excellence and its sustenance.

India urgently needs a coordinated blueprint for technical education, research and development encompassing Governments, private sectors, and research and academic institutions, consistent with the industrial, technological and economic future of the country.