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DEVELOPMENT OF TECHNICAL EDUCATION IN INDIA AND STATE POLICY—A HISTORICAL PERSPECTIVE

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Note

Planning for future needs not only to make a critical study of the past, but also to analyse the general psyche of the people responsible for formulating development policies, to understand the complexities of development process and to identify the factors responsible for achievements and failures.

The objective of this article is mainly to examine the strategy followed in the past in development of technical education in India and to focus attention on the policy aspect.

It may be desirable to study the subject in depth with reference to official documents available in India and abroad, so as to understand fully the reasons for India's failure to meet the challenges of today in the field of R & D.

Author

INTRODUCTION

If one studies the development process in totality and in historical perspective, it may not be difficult to establish beyond doubt that social changes are the products of economic development, and cultural transformation is subservient to social changes. This is an axiom one should not hesitate to accept. While examining any development process, it should also be kept in mind that humanity is a part of the ecosystem. All human activities, therefore, are interrelated and inter dependent, and form an integrated system. With this perspective in view, the development of technical education in India in the past should be examined.

The eighteenth century should be considered as a major watershed in human history. Machines came into existence to help man to increase productivity in all spheres of human activities. It brought about a revolution known as 'Industrial Revolution' which introduced a new element in the concept of production and distribution, and laid the foundation of a technological civilization. Industrial revolution also became a forerunner of agricultural revolution through use of machinery and new techniques. It revolutionised the occupational pattern in the countries swayed by industrial revolution. The benefit of industrial revolution had been confined to the Western world for a long time. Consequently, a new economic order came into existence dividing countries into groups—industrial society and its

colony, which gave birth to a new political order and concept of capitalism, and as a result, imperialism and colonialism came into existence. It introduced a new system of learning process to satisfy the growing needs of an industrial society. The new learning system is known as technical education.

Technical education is thus comparatively a newcomer in the field of learning system of training to meet the occupational needs of an industrial age. The new system was born by marrying academic education with skill training especially tailor-made, to meet challenges of new situations. Since the old system of training artisans through passing knowledge and skills from generation to generation of craftsmen and artificers by words of mouths and long exposures to work could no more meet the challenges of fast changing technological environment, a new system of training institutions came into existence, which are today known as technical institutions distinct from normal academic institutions.

The first technical institution came into existence in 1790. It was founded by Dr. John Anderson, a medical surgeon in Glasgow, as a school for general education of craftsmen and artisans and for teaching apprentices the use of machinery. It was soon followed by France with the starting of her first technical institution in 1794, named as Ecole des Traveaux Publique, later renamed as Ecole Polytechnique.

The nineteenth century witnessed the birth of many branches of engineering and technology in addition to classical, civil and mechanical engineering, thus introducing a new dimension and challenge to technical education. The oldest surviving technical institute in the world, still surviving with its name, is perhaps the Rensselear Polytechnic Institute of Troy (New York State) in USA which was founded in 1823 and started giving degree in civil engineering in 1835. Since then engineering and technological profession is constantly developing and changing at a very rapid rate. Its growth is never-ending and is becoming more and more complex, because the time gap between fundamental scientific discovery and its transformation into technological applicaton is becoming shorter and shorter, almost non-existent.

The incredible advancement of science and recent sophistication of technology are making technical education more and more complex, and the thin line between study of science and technical education its merging into a complex interdisciplinary system. Therefore, there is a need to review the situation continuously and reorient the technical education system according to the changing needs. This will involve not only the diversification and upgrading of the contents and hence the quality of technical education, but also the need for structural changes which may ultimately transform the educational system as a whole.

TECHNICAL EDUCATION IN INDIA UPTO 1944

Technical education, being a tailor-made learning-training system specially designed for supply of trained manpower for industrial and economic development through judicious application of science and technology, is closely related to the

state policy for industrial development and economic growth, which, in turn, is dependent on political environment.

If one examines the development of technical education in India in historical perspective, it would be observed that the foundation of technical education was laid in India almost at the same time as in Europe but it s growth was stunted till India became independent. The Britishers came to India as a Trading Corporation for exchanging goods between England and India. The industrial revolution completely transformed Britain's socio-economic environment and consequently its relation with India. The battle of Plassey in 1757 gave the Britishers unique opportunity to change their status from commercial traders to colonizers ; thus Britain's relation with India underwent a drastic qualitative change. Britain gradually captured the political power and became the ruler of this country. To rule any country the rulers should have an intimate knowledge of its topography and resources through physical survey. For achieving this objective, the English traders established a Survey School at Madras in 1794, to train Indian personnel in modern land survey and to assist British surveyors. Since then, so long as colonial government was here, the major initiative of starting new centres for technical education came only out of the necessity of the British rulers for training middle level technical personnel required for construction and maintenance of public buildings, roads, canals, ports and harbours, railways and other services, as well as for training artisans and craftsmen in the maintenance of instruments and equipments needed for army, navy and other technical establishments.

The need for introduction of occupational education was highlighted in 1854 what has been known as Wood's Despatch. However, there are indications that technical schools existed in Calcutta and Bombay in as early as 1825 for the training of artisans and artificers. These industrial schools were attached to ordnance factories and other engineering establishments. Authentic accounts are available regarding existence of an industrial school established in 1842 at Guindy, Madras which was attached to the Gun Carriage Factory there and a school for the training of overseers at Poona in 1854.

The first engineering college was established at Roorkee more or less at the same time for the training of civil engineering licentiates by making use of the facilities created for development of upper Ganga canal for communication from Bengal to Upper India. However, on the recommendations contained in Wood's Despatch on the need for creating training facilities, three engineering colleges were established, one each in Bengal, Bombay and Madras, which developed into Bengal Engineering College, Poona Engineering College, and Guindy Engineering College respectively. These colleges were established in 1856 in pursuance of a Government policy. The pattern of training in these three colleges was more or less the same and later on these colleges were upgraded to degree level in civil engineering.

Since the submission of "Wood's Despatch", a number of Committees and Commissions were appointed from time to time by the colonial government to examine the problems of education in India. These Committees/Commissions,

while recommending measures to improve the situation, emphasised the importance and vital role of technical and vocational education and training in the country in developing its economy and industry. Of all these the most important in the 19th century was perhaps the Hunter Commission (1880-1882). The Indian Education Commission of 1882, under the chairmanship of Sir William Hunter produced a classic document which, *inter alia*, provided a comprehensive study of the prevailing situation and its improvement. However, Hunter's report was shelved in the archives as the system of technical education and training in India was designed primarily to produce trained manpower required for running a colonial system of government and to support an industrial society in the United Kingdom, and not to develop human resources for running efficiently an industrial society in India. The growth and development of technical and vocational education and training during the British Raj should, therefore, be viewed in this perspective.

In the early stage, the superior cadre of technical personnel was mainly recruited from the United Kingdom and only limited steps were taken to train middle level personnel and skilled craftsmen. Apart from the institutions established for the purpose, the training was mainly given at such technical establishments as gun-carriage factories, railway workshops *etc.*, and through organized apprenticeship classes in electrical and mechanical engineering. This method continued for a long time. A technical institute known as the Victoria Jubilee Technical Institute was established in Bombay in 1887 to commemorate the diamond jubilee of Queen Victoria's reign. The main objective of VJTI was to train licenciates in electrical, mechanical, and textile engineering and technology. Since the industrial progress in India in the nineteenth century was painfully slow, development of technical education and training was practically marginal. This was due to the economic policies followed by the British in India in order to keep Indian economy subservient to British economy and to sustain the power structure of a colonial government.

In the beginning of the twentieth century, there had been a renewed realisation in some quarters of the importance of technical education for development of the country. Consequenctly, some leading nationalist leaders who were fighting for independence of the country, started a college of engineering at Jadavpur, Bengal under the auspices of the National Council of Education. The college started a diploma course in mechanical engineering in 1908 followed by a chemical engineering course in 1921. A devout nationalist leader and industrialist, Sir Jamshedji Tata, also established the Indian Institute of Science at Bangalore in 1909, against the wishes of the British Raj.

Indian Institute of Science started a certificate and an associateship course at the degree level in electrical engineering against the opposition of the British Government.

Although civil engineering degree course was started in the nineteenth century, as late as in 1917, the Calcutta University Commission debated the pros and cons for the introduction of degree courses in mechanical and electrical engineering. In this context, the Commission took shelter under the recommendation of the Indian

Industrial Commission (1915-17) headed by Sir Thomas Holland. The Commission was against the introduction of electrical courses, as there was hardly any scope for employment of such persons except in the field of repair and maintenance of electrical mechinery, for which facilities were already available. But in spite of the objection of the Commission, Pandit Madan Mohan Malviya, the founder of the Banaras Hindu University started a comprehensive degree course in electrical and mechanical engineering in 1917, after having been convinced of its potentialities for the development of Indian economy.

After World War I (1914-18), in 1920s and 1930s, under the pressure of national movement and with rise of the Indian capitalist class, the Government of India was forced to grant some concession to Indian industries. However, the organised industrial units were mainly engaged in cotton spinning and weaving, jute spinning and weaving, other textile goods manufacturing, chemical and allied industries, but were to a very limited extent interested in engineering and metal works. There was hardly any heavy and capital goods industry without which rapid and independent development of industries and economy cannot be envisaged. India lacked basic industries like heavy chemicals, machine tools, metallurgy, *etc.* India also lagged behind in development of electrical power which is essential for large scale economic and industrial development. The largest number of employment in technical occupations was limited to textile and allied industries and construction industries. Therefore, there was hardly any major reform in technical education and training during those periods so that its growth was painfully slow. Till the end of 1930s, there were only ten institutions offering engineering courses mainly in civil engineering with very limited facilities in electrical, mechanical, metallurgial and chemical engineering and technology. There were a few institutions offering monotechnical courses in textile, leather, and sugar technology. These were not affiliated to any university but mostly managed by the Department of Industry in selectd provinces.

As part of the overall reform of the secondary school education system so as to avoid large scale educated unemplyment, on the basis of the recommendatons of the Committees, like Hartog Committee and Sapru Committee, the secondary education system was diversified to a very limited extent through the establishment of some trade schools, and arts and crafts schools, mainly to cater for handicraft and small scale industries. In a memorandum the three members of the Sapru Committee (Report of Unemployment in UP, 1935), Dr. Tarachand, Dr. A. Siddiqui and Dr. Sam Higginbotham, emphasised that as part of the formulation of a sound economic policy of India, there was need for diversification of industry by starting ship buildings, aircraft manufacturing, heavy chemicals, military industry, *etc.*, and for training suitable manpower for these industries. However, no attention was paid to this recommendation, as it did not fall under the defined policy of the Indian Government regarding future economy and industrial development of the country. Instead, in 1936-37 two British experts, Messrs Abbot and Wood, were invited to advise the Government "on certain problems of educational reorganisation and

particularly on problems of vocational and technical education. One of the basic reasons for instituting the enquiry was the fact that a large number of university graduates were unable to secure employment of the kind for which they were trained. This situation, the Government was apprehensive, might lead to political instability. Messrs Abbot and Wood recommended a major reform in the education system by suggesting a complete hierarchy of vocational and technical institutions parallel to that of general education. On the basis of their recommendation, a model institution was started in Delhi as Delhi polytechnic which has now become the Delhi College of Engineering.

In spite of recommendations of various experts since 1882, especially those of Sir William Hunter for expanding the base of vocational and technical education and training, very little attention was paid by the colonial Government till the Second World War. With the starting of World War II in 1939, it was soon realised by the government that the indifferent attitude towards training of technical manpower in the country would not at all serve war efforts, and it would be difficult to maintain logistics without having locally trained technical personnel in large numbers and of quality, and a proper industrial base. In pursuance of this realisation, the Government of India started a massive training programme known as "War Technicians Training Scheme" on a national basis for the first time in 1940. Since the author of the scheme was Earnest Bevin, the British Minister, the trainees under the scheme were known as Bevin Boys. It was a crash programme to meet the urgent requirement of defence forces, as well as of the industries engaged in defence production and allied war efforts. This was a turning point in the history of technical education and training in India. This also laid the foundation of an organised hierarchical system of technical education which gradually took the shape of a four tier system.

THE TURNING POINT 1944-47—A PERIOD OF TRANSITION

It was soon realised by the Government of India that the survival of the government would depend, in future, on industrial development in India and building up of a proper infrastructure to support such development, especially with well trained technical manpower. For the first time, there had been a sensible policy shift in respect of economic development in India under the British Raj due to the force of circumstances.

In 1944, the Government of India created a Department of Planning and Development under the guidance of Sir Ardeshir Dalal, as a member of Viceroy's Council of Ministers. In order to reorganise Indian economy, Sir Ardeshir's approach to the question of planning was simple, direct and pragmatic. He was of the opinion that the rapid strides taken by science and technology made it possible to cure most of the economic ills of the world. He felt that traditional life in India would need to be changed, and to utilize the great opportunities created by science and technology, the services of highly qualified scientists, technologists and technicians would

urgently be required. So a large number of men would have to be given specialised training. He strongly felt that for the success of industrial development, a large scale expansion of technical education was absolutely necessary. In his plan, the greatest emphasis was, therefore, placed on creating massive educational and training opportunities for young persons in India supplemented by training some of them in institutions abroad. Sir Ardeshir Dalal also impressed upon industrialists the need for promoting research for their own and national benefit and survival. He also urged upon the science institutions the relevance of developing contact with industry for promotion of scientific research in India. Thus, 1944 became a turning point in the history of economic development in India. This year also saw for the first time in the the country, the foundation of a planned development of technical education and training and scientific research.

A significant change in policy for economic development took place according to Sir Ardeshir's plan. The plan envisaged the following steps to promote development of scientific research and technical education :

(i) establishment of a Department of Scientific and Industrial Research which ultimately assumed the name of Council of Scientific and Industrial Research(CSIR).

(ii) appointment in 1945 of a committee under the chairmanship of Mr. N R Sarkar to suggest steps for development of higher technical education with the following terms of reference :

"With a view to ensuring an adequate technical personnel who will be required for post-war industrial development in this country, it is necessary to consider whether it is desirable to have a Central Institution, on the lines of the Massachussets Institution of Technology, USA with a number of subordinate institutions affiliated to it or to have higher institutions on regional basis".

(iii) establishment of an overseas fellowship scheme for training of scientists and technologists abroad.

For coordinated development of technical education and training on a national basis, two national advisory organizations were established :

(i) The All India Council of Technical Education AICTE to advise the Government of India in all aspects of development of technical education at diploma and above levels, including post-graduate teaching and research in the technical institutions.

(ii) An Advisory Committee on Technical Training ACTT to review the War Technicians' Training Scheme and recommend measures in order to adopt the above scheme to peace-time requirements of the country for rapid development of economy and industry.

The AICTE was appointed by a government resolution in 1945 under the chairmanship of Mr N R Sarkar, with Dr S R Sengupta as secretary. The first meeting of the Council was held on 30th April, 1946.

The ACTT took the shape of the National Council for Training in Vocational Trades NCTVT as a statutory body in 1956.

The AICTE recommended the establishment of four regional higher technical

institutes, in the pattern of the Massachussets Institute of Technology, USA, to meet India's post-war needs for high grade engineers, technologists, *etc.* This recommendation was accepted by the Government and accordingly the first institution in the chain was established in 1950 at Kharagpur, West Bengal, as Indian Institute of Technology with Sir J C Ghosh as its first Director. This institute was declared in 1956 an institute of national importance by an Act of Parliament. The other IITs were set up in Kanpur. Bombay and Madras and that in Delhi, the fifth in the chain, was established in 1961.

The years between 1944 and 1947 should, therefore, be considered as a transitional period, as, during this period, there was a policy shift from stagnation to dynamism.

TECHNICAL EDUCATION AND TRAINING—1947 AND AFTER

In 1947, there were hardly about 38 institutions offering first degree courses in engineering and technology and 53 institutions offering education and training at the technician's level in some very selected areas. Total fresh admission in these institutions used to be of the order of about 3000 at the degree level and about 3700 at the diploma level. These numbers were insignificant with reference to the need of such qualified manpower for proper economic and industrial development of a country of India's size and requirement. At the craftsmen's level, however, the position was somewhat better. Apart from the facilities available for training in various industries, there were about 300 training centres organised by the Government in the country with a total capacity of about 60,000 trainees. At the postgraduate level, prior to 1947, there was hardly any facilities for advanced studies and research in the country in the field of engineering and technology.

India gained her independence in 1947 from Britain after a lapse of about 200 years and became the world's largest democracy, thus holding unique place in the comity of nations. It was soon realised that if India has to play her role effectively in the world, it should have a sound economic and industrial base, which can only be achieved through effective planning, hardwork, devoted motivation and its capacity to produce trained technical manpower in number and quality.

It should be clearly understood that mere availability of science and technology does not guarantee economic development. Only judicious use of science and technology and better management of men and machines can create conditions for development.

To promote economic and industrial development in a country, the essential requirement is the capacity to develop technical manpower of good quality in adequate number. A well organised system of technical education and training is the key to the development of manpower ranging from skilled workers to highly technical engineers and research scientists.

Since technical education needs heavy investment its development calls for a careful planning. Scientific Manpower Committee under the chairmanship of Dr.

Shanti Swarup Bhatnagar was appointed in 1947 to study the problem in depth and to recommend suitable measures to meet the future challenges. The Committee assessed the requirement of scientific and technical manpower for a ten year period from 1947 to 1957 in the government departments for the execution of developmental schemes in accordance with the declared policy of the government. It was estimated that the ratio between the demand and supply would be at 4 : 1. This estimate did not take into account the demand of small scale industries and other sectors of economy. Almost at the same time, the University Education Commission, popularly known as Sir S Radhakrishnan Commission, in 1948-49, while considering the problems of higher education in India, made a critical study of the engineering and technological education in the country *vis-a-vis* the global situation and made many valuable recommendations for improvement and reform of technical education system in the country. The recommendations of the two bodies, the Commission and the Committee served as the basis of planning of technical education in the country.

Keeping in view the constraints of finance and the demand of trained manpower, the government attempted to upgrade the existing institutions and also to establish new ones. Financial incentives were also given to private sector to start technical institutions.

Since 1947, by deliberate efforts, there was a steady growth of technical education upto 1967-68. Gradually over the years, more than 135 institutions offering degree courses in about 35 branches of engineering and technology with an annual admission capacity of 25,000 were established. During the same period over 280 institutions, popularly known as polytechnics with a total admission capacity of about 49,000 covering 55 subject areas were established. At the craftsmen's level, over 350 industrial training institutions, popularly known as ITI, offering training in 32 engineering and 21 nonengineering trades with a total capacity of about 1,55,000 trainees came into existence upto 1966. There being marginal shortage of technical manpower, problems of unemployment did not arise.

During the above period two major wars were forced on India, one in 1962 and the other in 1965, which changed the complexion of the economic environment in India. In fact, there was an economic recession in 1967-68, due to certain government policies, namely, freezing of civil works, plan holiday, *etc.*From 1967-68 onward, a large scale unemployment among the technical personnel was noticeable. Consequently, there was a decline in admission to technical institutions, partly because of the government's deliberate policy to cut down the admission number by about 30 to 33% and partly due to voluntary action of the people themselves. Due to the restriction of admission and other constraining factors the annual admission was reduced to about 18,000 for the degree and about 30,000 for the technicians' courses. At the craftsmen's level the position remained more or less steady.

Keeping in view the prevailing socio-economic environment in India, a special type of institutions exclusively for girls were started.

According to a study by Dr L S Chandrakant on the impact of private enterprises in engineering education there has been slow growth in government and university sectors from 1966 to about 1974-75. But since 1974-75, there has been a spurt in the growth of so called private institutions popularly known as capitation fee institutions or nongrant institutions. They have been established with the direct encouragement from the State Governments. Such private technical institutions are concentrated in the four states, Karnataka, Maharashtra, Tamil Nadu and Andhra Pradesh. There is no such institutions in the other regions.

According to Dr. Chandrakant's study it is revealed that both in number of institutions and admissions, these private institutions have overtaken the government, government sponsored and university institutions. The comparative picture as in 1985 is given below :

	Degree Level		Diploma Level	
	Government	Private	Government	Private
1. Number of institutions	117	162	331	408
2. Number of sanctioned intake (fresh Admission)	24,313	33,575	51,927	62,998

The present situation gives a very dismal and alarming picture as it will have a very adverse effect not only on technical manpower stock but will affect the standard and quality of technical educatinon and training and ultimately will affect national productivity and quality of products.

The picture is no different in the field of craftsmen's training. Today, there are about 1720 centres in the country, out of which only 825 are in the government sector and the rest are in the private sector. Total number of trainees in both the sectors are about 3.1 lakhs offering training facilities in 38 engineering trades and 27 nonengineering areas.

The position at the postgraduate level may be summarised as follows. ·

Prior to 1947, the government's policy for economic and industrial development was very clear—not to develop India as a self-sustaining economic or industrial power but to develop it as an appendix to United Kingdom in the matter of economic development. In view of this, no attention was ever paid to develop facilities for advance studies or research in the field of engineering and technology either at the institution or industry level. Therefore, hardly there was any facility available in this area.

The scientific research at the university level was developed in isolation without any interaction with industry or technical institutions in spite of Sir Ardeshir Dalal's best efforts. It is well recognised that science and technology are two sides of the same coin and are catalysts for economic growth and industrial development.

Realisation of this basic fact by the Government of India came rather late, and Sir Ardeshir's dream of future was partially fulfilled when a chain of five Indian Institutes of Technology were established in accordance with the Sarkar Committee's recommendation. The action on part of the Government had two objectives in view:

> (i) to upgrade the knowledge and competence of the teachers of technical institutions and to augment the pool of such teachers to meet the demands of future, and (ii) to develop adequate facilities for training manpower for research and development and to provide leadership in this area.

In addition, steps were taken to expand the facilities for postgraduate studies and research at the Indian Institute of Science, Bangalore, and a few other centres like the Department of Chemical Technology, Bombay, Departments of Applied Physics and Applied Chemistry at Calcutta University.

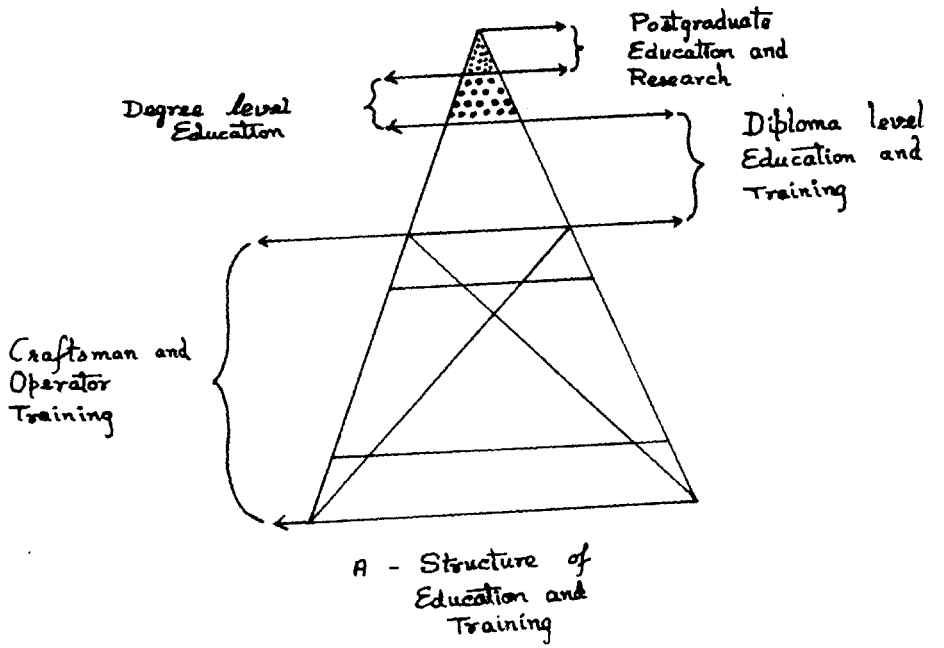
The tempo of development of postgraduate studies and research facilities was actually accelerated in 1953, after which within a period of ten years, as many as 39 institutions grew into postgraduate centres. Total enrolment to these centres was of the order of 1100. Today, one may say that the country has been able to lay a solid foundation to promote self-reliance in the field of postgraduate studies and research at the institution level. At present, there are about 90 centres offering facilities for postgraduate studies in various branches of engineering and technology, from classical civil engineering to sophisticated biotechnology, electronics, renewable energy sources, *etc.* What is needed today is a review of the position and a reorientation of the courses to meet new challenges of fast-changing technological environment. If one closely examines the position, it may be observed that out of a total of about 6,000 intake in various courses at the post graduate level, more than 33% of the total intake is concentrated in the five Indian Instituties of Technology and the Indian Institute of Science, Bangalore. This proves that the objectives defined for these institutions are being fulfilled in quantitative terms.

As regards research at the doctoral level, on an average, about 500 to 600 candidates are registered every year and about 350 or so qualify for the degree per year.

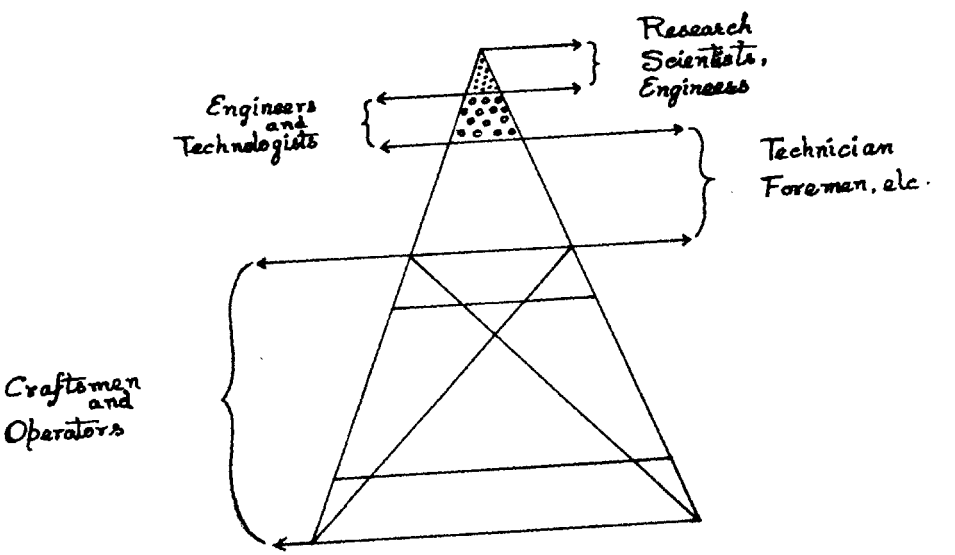
However, the facilities created fall far short of actual needs in terms of quality and subject. This situation may be rectified by taking some radical steps in regard to structure, pattern and contents of technical education.

STRUCTURE, PATTERN AND PROGRAMMES—CHANGING TRENDS

Once again, it should be emphasised that education is a subsystem of a system involving all human activities responsible for development, and technical education and training is a subsystem of education as a whole and subsubsystem of industrial and economic development. Therefore, technical education (including training) should be considered in relation to the changing trends of industrial and economic environment. With this background, one should analyse the pattern, structure, and basic contents of technical education.



A - Structure of Education and Training



B - Structure of employment of Technical Manpower

Diagram I

Like the United Kingdom and France India started to impart technical training as a one-tier system, mainly to educationalise the apprenticeship system available for craftsmen and artificers and to familiarise them with machines and other means of increasing productivity. Although, in historical perspective, science and technology are two sides of the same coin, there had been a considerable time-lag between scientific discoveries and their applications. Technical education remained for a long time essentially training-based with very little of academic content. However, with the march of time, the time-lag became shorter and shorter. Therefore, gradually, the structure and pattern of technical education system have undergone tremendous changes so also its contents. From the one tier system evolved the two-tier to three, and ultimately the modern four-tier system. Such changes are stimulated by policy matters enunciated by the Government in regard to the development of science and technology.

From A and B of diagram I it may be observed that each tier is self-contained and there is no bar in vertical movement in employment pattern, provided an individual acquires proper education and training required for a particular tier. However, facilities created for up-grading the knowledge for working individuals were very limited in the past as provisions for continuing education were available mainly in some professional institutions like those of Electronics and Telecommunication Engineers, *etc.* through their Associateship examinations.

If the present structure of technical education and training is transferred in academic term, the pattern would look like what is shown in diagram II.

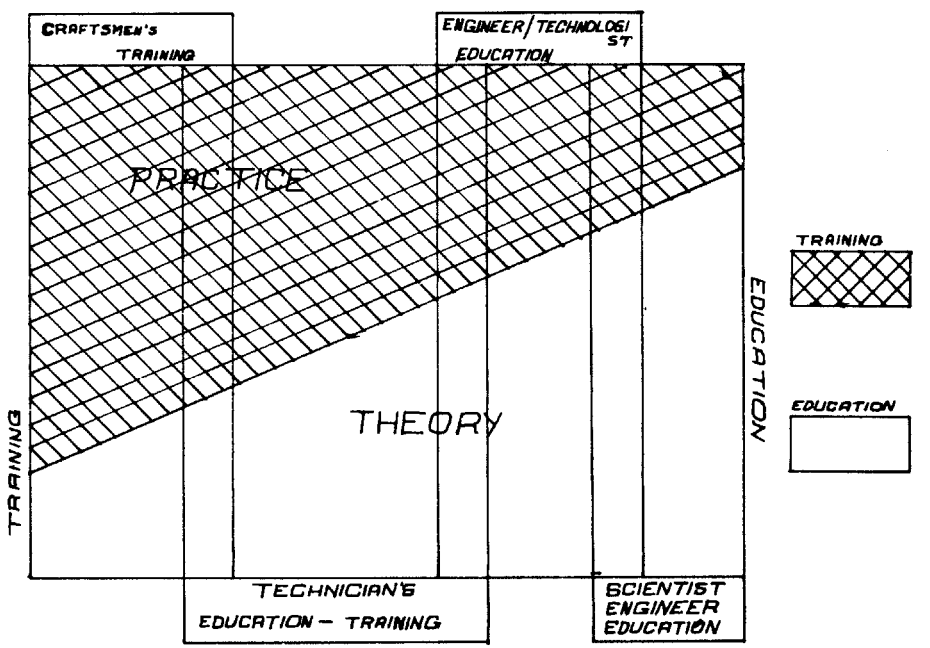


Diagram II

Education is an open ended process and continuing in character. The percentages of the two components, namely, education and training, in a learning process depend on the objective and purpose of a programme. To start with, the process was highly weighted towards training, educational component was very little as the time gap between scientific discovery and its technological application was very wide. As this gap is becoming narrower, the training component is becoming shorter. Even in the present system of technical education and training, the proportion varies according to the objectives. Thus in craftsmen's training, the training component is much more than in engineer scientists as indicated in diagram II.

(a) *Craftsmen's Training Programmes :*

At present the craftsmen are trained either in industrial training institutions (ITI) or apprenticeship training institutions (ATI) in a large number of engineering as well as non-engineering trades. These training programmes are flexible and subject to change as and when required. There is an attempt, at present, to educationalise craftsmen's training programmes to meet the challenges of technological changes undergoing in the industrial and economic environments. However, due to complex procedures, the changes are normally delayed beyond time; as a result, development activities in India are going slow and the nation is suffering.

The duration of institutional programmes as followed by the ITIs varies between one and two years according to objective of a particular trade. The admission qualification used to vary from 8th class passed to 10 years of school education. With the changing trends of technology in various spheres of economy, there is an attempt to reorient the programmes for training craftsmen specially at the ITIs. The admission qualifications for all trades are being standardised to 10 years of schooling, and the duration of training is also being standardised to two years with some variation. The training programmes are being made broad-based with emphasis on the educational component.

The Education Commission (1964-66) has recommended an educational structure as 10 years + 2 years + 3 years, *i.e.* ten years of basic schooling followed by two years of higher secondary schooling and three years of general university degree course. These durations are flexible. The training given by ITIs should be considered as part of the plus two years of higher secondary education. However, this period may vary between two and three years according to subject area.

Another channel of training is apprenticeship scheme. Under the Apprenticeship Act 1961, it is obligatory on all employers covered under the Factory Act in specified industries to make provision for training of apprentices in a specified ratio with workers. The apprenticeable trades are being notified from time to time. The period of apprenticeship varies between six months and four years, the entry qualification ranging between 5 and 11 years of prior general schooling. However, this is being standardised to ten years of schooling according to the new pattern of education envisaged in the Education Commission's report.

In 1973, the Apprenticeship Act was amended to cover graduates, engineers and technicians for conditioning them on jobs.

The training of highly skilled workers in varieties of advanced and sophisticated skills, such as process control, instrumentation, tool-making, *etc* which are not available under normal craftsmen's training or apprenticeship programmes, are imparted in selected ITIs and CTIs. In spite of the fact that admission to ITIs is open to girls, there is provision for special institutions exclusively for girls in selected trades.

(b) *Technicians' Programmes and Allied Areas :*

For industrial development, technicians constitute the most vital manpower. They are in fact the kingpin of modern industry and occupy the most important position in the scheme of trained technical manpower. Even today, there are hardly any appreciation of technicians as a class by itself. In the technical manpower scheme professional engineers and craftsmen are easily identifiable but the technicians are considerd to be the residues after subtracting the professionals and craftsmen. It may be observed from the diagram II that sometimes technicians' functions overlap those of both professionals and craftsmen, even their education and training are akin to each other. Duties, responsibilities and functions of technicians, on critical analysis, are easily recognisable. In fact, UNESCO, ILO as well as Commonwealth Educational Organization, *etc.* have clearly defined each category of technical manpower in relation to their specific functions, duties, and responsibilities, and their educational and training requirements. But till today the confusion has not yet been cleared in the minds of many.

In academic terms, technician's job requires a level of scientific and technical knowledge and information higher than those of a craftsman or an operator but lower than those of a professional engineer or technologist.

During pre-independence era, due to definite state policy, there was hardly any place for a technician in the employment structure. Reguirements of middle level technical personnel were restricted to foremen and chargemen or overseers. The dictionary meaning of the word 'overseer' is slave driver. This concept would automatically difine the education and training needs for midile level technical personnel.

During the World War II (1939-45) there was felt need of technicians due to the growing requirement in the war effort. However, only after the independence, when the policy for economic and industrial development took a sharp turn for rapid growth, steps were taken to produce technicians for employment market.

With the increase in demands for technicians in various areas of speciality, facilities for technicians' education and training had to be expanded at an accelarated pace to match the demand. This rapid expansion of facilities without any proper preparation introduced certain distortion in the system. The technicians' education and training in the past became either an extension of overseers' education or equivalent to a mini-degree in contents and structure.

Because of shortage of technicians upto 1966, hardly any attention was given to the quality of their education and training as there was no dearth of employment opportunity. The trouble started after the Indo-Pakistan war of 1965. There was a

slump in the employment of technical personnel. This had an adverse effect on the employment of technicians as the employment opportunities decreased more than their legitimate share due to two reasons : (i) pressure of trade unions for filling up a substantial percentage of technicians' post through promotion of skilled workers, and (ii) surplus engineers displaced the technicians in many positons normally to be occupied by the latter according to their functions.

In view of the position created by various factors leading to large scale unemployment of technicians, like inefficiency of the system, displacement of technicians due to indifferent recruitment policies, *etc.*, the Government of India appointed a high power committee under the chairmanship of Prof. G. R. Damodaran in early 1970 to examine the problem in depth and to suggest solutions. The Committee consisted not only of experts from India but also from abroad—UK, USA, West Germany and Japan. The terms of reference of the Committee were very comprehensive—to examine the entire system of polytechnic education *vis-a-vis* the needs of the industry and other spheres of employment and to prepare a blue print for future development. The Committee examined the matter in detail and in depth. It was revealed that a large number of technicians' positions were occupied by engineering graduates and 'practicals', *i.e.*, skilled workers who did not have any formal technical education. Out of the total technicians' jobs, only 36% were held by trained technicians. There had been wide variations in the pattern of utilization of diploma holders as technicians in various industries, the proportion ranging from about 24% in the processing industry to about 60% in the automobile industry, ship-buildings, machine tools. It was also observed that from functional distribution angle, the main concentration of them, nearly 69%, were engaged in design and production, about 20% in laboratory testing and analysis and almost 11% in sales, store keeping, *etc.* It was also revealed that the demand for technicians was increasing in the service sectors like sales and maintenance.

Considering various aspects of technician education and training *vis-a-vis* trends of demands from different sectors of economy, Demodaran Committee came to the conclusion that in a developing economic and changing technological environment, narrow specialisation was undesirable at the first diploma level ; at the same time, diploma courses should be diversified within the major branches of study. It was also observed that education and training of technicians should be a continuous process, therefore there should be adequate provision for refresher courses as continuing education keeping in view the changing requirements of various jobs.

Damodaran Committee after examining various suggestions and actual situation in the industry and other sectors of employment recommended that duration of the basic technicians' courses should be three years, with provision for part-time courses and for specialisation at the post-diploma level. It was also strongly felt that there should be adequate provision for one year post-diploma courses for advance studies and the curricula should be well balanced between studies of humanities, basic sciences, technical studies and practice in proper sequences. The Committee also recommended that all diploma courses should culminate with a project work based

on problems involving industrial/commercial practices in the field. According to information available practically no action was taken on the report for a long time. Only recently, the government has appointed a Technicians Board for implementation of the Damodaran Committee's recommendations.

In the past, foremen, chargemen and shop supervisors, were used to be selected from the shopfloor on the basis of their experiences. However, after independence efforts were made to give them some education to increase their efficiency and productivity. For this purpose the first foreman training institute was established in 1971 at Bangalore with the assistance of the Federal Republic of Germany. Tailor-made programmes are prepared at this institute to suit specific requirements of a particular industrial establishment, after assessing their educational and training requirements. The institute also provides short-term course for practicising supervisors for better productivity.

The institute has trained about 3000 foremen, supervisors through its training programmes. Apart from these programmes, the productivity council also undertakes various short-term training programmes for technical persons at various levels for improvement of national productivity.

(c) *Educational Programmes at the Degree Level*

Before independence education and training at the first degree level were given mainly in the engineering colleges, affiliated to a university or some special institutions, or in the Department of Science and technology of a university. There were also provisions for conducting examinations at this level by professional institutions like the Institution of Engineers (India), Institution of Electrical Engineers (UK), Institution of Electronics and Telecommunication Engineers, *etc.*

In the past, the duration of degree courses conducted by the universities or special institutions used to vary between 3 and 4 years following the Intermediate in Science course in a junior college affiliated to a university. Since there was hardly any provision for research or development activities in the employment market, training and education of an engineer was oriented towards maintenance need. This training, in reality, was nothing but that of an advanced technicians' level in the modern concept. The situation continued for a long time even after independence. To some extent it is still continuing, but the number of institutions has multiplied many times.

The first major modificaton in structure was introduced after the government accepted the recommendations of the Secondary Education Commission (1953) appointed under the chairmanship of Sir A. L. Mudaliar. Most of the states accepted these recommendations and introduced 11 years' schooling pattern, which was in vogue till recently. Consequently, the duration of engineering technology degree courses was changed to 5 years and designated as *5 years integrated course*. The word "integrated" was specially used to indicate that one year *i.e.* the last year of junior college was integrated into the engineering/technology degree courses to strengthen the science inputs to such courses, as make-up courses for strengthening the

foundation and for increasing usefulness of the engineering education. This structure was accepted by most of the states.

There was also provision in some institutions like the Indian Institute of Science, Bangalore for 3 years' degree course at the first degree level with Bachelor of Science as the admission requirement. These courses were specially tailor-made to cater to the R and D sector.

However, the structure and pattern of technical education and training at the first degree level was changed after the government accepted the new pattern of general education, recommended by the Education Commission (1964-66).

As a result of acceptance of the 10 + 2 + 3 years pattern recommended by this commission the duration of technical courses at the first degree level after 12 years of schooling was reduced from 5 years to 4 years keeping the total duration for general and technical education the same. In the process, the word "integrated" became the main casuality. Its significance was forgotten. Now, technical education and training at the first degree level of four years' duration has been accepted, as a general pattern. This is perhaps the greatest tragedy in the history of technical education in India, which is reflected in the opinions of the academic world. By transferring one year of education from the technical institutions to higher secondary school, efficiency and standard of technical education at the first degree level have been badly affected.

(d) *Postgraduate Studies and Research Programmes :*

At the post-first degree level there are provisions for two types of courses : (1) a postgraduate master's degree leading to M. Tech, and (2) a postgraduate diploma course specially oriented to industrial needs.

However, some institutions like the Birla Institute of Technology and Science, Pilani has provision for M. Phil Course.

In the past, the duration of M. Tech used to be two years. This has been reduced to one and half years and in some cases even one year.

The health of the two years' M. Tech course was properly diagonised by the Nayudamma Committee appointed to review the working of the postgraduate courses in technical education. According to this Committee, the existing postgraduate degree programmes were outdated and stereotyped and not upto the mark. They had also proliferated out of all proportions. If this was the finding of the expert committee regarding the health of M. Tech. programmes of two years' duration, one may well imagine its standard after reduction of the duration.

As regards research degree, there is provision for Ph. D. work in various subject areas. The duration of such degree work is normally of 3 years. However, the facility is available in only a few institutions in the country.

(e) *Technical Teachers Training Programme :*

If the standard of technical education is to be improved it is essential that the

quality of teachers must be improved through organised programmes, as teachers are the soul of any educational system.

Realising the importance of training of teachers to improve the quality of technical education, the Government of India launched an organised training programme for teachers in 1958. The scheme envisaged that for augmenting the pool of teachers to meet the challenges of shortage of competent teachers at the degree level, bright technical graduates with good academic career should be recruited and trained in selected centres for a period of about three years. This was in addition to a programme of upgrading the qualification of serving teachers. Unfortunately, due to the prevailing recruitment rules, the scheme did not meet with much success. During the fourth plan, in late 1960s, a more comprehensive quality improvement programme including faculty development, was introduced. In the new programme, provision was made for the award of fellowship to serving teachers from engineering colleges for long-term studies leading to doctorate degree or master's degree at selected centres. The scheme is still continuing. Under the scheme provision has also been made for short-term and refresher courses and other programmes. The scheme is essentially meant for upgrading the quality of teachers. In 1960s, steps were taken almost at the same time to train teachers for polytechnics.

In this context, four technical teachers training institutes have been established to cater to the needs of four regions of the country. They are located at Chandigarh, Bhopal, Madras and Calcutta. These institutes offer full-time as well as short-term training courses for both graduates as well as diploma holder teachers working at various polytechnics in the country. A common feature of the long-term courses is interweaving of subject matters with pedagogy and industrial orientation. The trainees practise these aspects in real live situations. The short courses are mainly for updating and refreshing the knowledge in various disciplines as well as methodology of teaching.

The Technical Teachers Training Institutes (TTTI) are also responsible for operational researches in the entire area of polytechnic education and training.

At the craftsmen's training level, steps have been taken from the very beginning to organise programmes for the training of instructors required for Industrial Training Institutes as well as apprentice training establishments. For this purpose six central institutions have been established on regional basis. These institutions are known as Central Training Institutes CTI. The first in the chain was established as early as in 1948.

The duration of training in CTI is of one year. Training imparted in these institutions is in pedagogy and operating and upgrading skills.

The CTIs also offer a large number of refresher and retraining programmes. To each of these institutes, a model craftsmen's training centre is attached as training laboratory for practising teaching and training craft students in actual live situations.

To boost vocational training among girls, the Central Training Institute for Women Instructors in New Delhi was upgraded in 1977 to a national vocational institute.

Apart from training, these training institutions have been engaged in operational research in all aspects of industrial training to improve training methods, training *per sc etc.*

PLANNING AND DEVELOPMENT ORGANISATION

Two national organisations have been in existence since late 1940 for systematic planning and development, and advising the government in all aspects of technical education and training in India—one for craftsmen's training and the other for training of technicians and above. These are known as National Council for Training in Vocational Trades (NCTVT) and All India Council for Technical Education (AICTE).

The NCTVT is mainly responsible for the planning of training programmes for craftsmen in all their aspects, for making training purposeful, meaningful and for meeting the challenges of fast changing technological situation in the country. The Council is a statutory body to advise the Government of India on all policy matters related to programmes, standards, *etc.* with the help of various committees appointed for specific purposes.

In 1977, the Ministry of Labour, Government of India appointed a committee under the chairmanship of Mr. S. Abdul Qadir to examine in depth the quality of training imparted to apprentice in various establishments and also to trainees in the Industrial Training Institutes and to suggest remedial measures for improving the quality of training.

The Qadir Committee made a comprehensive review of the whole situation, and made valuable recommendations, keeping in view the changing trends in occupational pattern due to changing technological environment in the country. One of the major important recommendations was that the existing structure and contents of training should be reorganised and changed into self-contained modular system. It also recommended that the structure of training should be one year of broad-based basic training covering a group of trades, *e.g.* metal trades, electrical trades, heat engineering trades, *etc.* followed by one year of training in specific trade within the group. The objective of the basic training would be to equip a trainee with a sound educational and training base on which further specialised training could be built. The system would increase the employment opportunities and greater possibility of both vertical and horizontal mobility. According to the recommendation those who complete the basic training successfully could opt for only one of the following alternatives :

(a) work as an operator in a processing industry or automatic plant ;

(b) undergo further training in one or two modules of employable skills in a training institution ;

(c) join the industry as an indenture apprentice under the modular concept of training ; and

(d) take to entrepreneurship/self employment.

The most important aspect of the recommendations of the Qadir Committee is to educationalise and upgrade the inputs of the craftsmen's training programmes to meet the challanges of the fast changing technological environment. In addition, training given at the Industrial Training Institutes is integrated into the new pattern of school education, *i.e.* 10 + 2 years, as part of plus 2 stage of Higher Secondary Education. It has a built-in provision for the growth of individuals and also motivation for entrepreneurship. The recommendations of Qadir Committee are being implemented.

The other apex body is the All India Council of Technical Education which is responsible for advising the Government of India in all aspects of development of technical education and training above the level of craftsmen.

The AICTE has four regional committees to coordinate its activities. It has other special committees to assist the work as and when needed. It also appoints *ad-hoc* committees whenever some special problems are to be considered.

In 1977, the Government of India, appointed a working committee under the chairmanship of the Secretary, Ministry of Education to review the entire status of technical education *vis-a-vis* the country's present and future requirement and to recommend remedial measure for improvement. The committee made a comprehensive survey of the existing situation and made some valuable recommendations, for reform and further development of technical education. The recommendations of this committee were endorsed by the AICTE.

The AICTE was very active upto the end of 1960s. Thereafter, unfortunately, it was brought to the status of an endorsing body although its chairman is the Minister of Education and it has representatives of all organizations connected with various aspects of manpower development and deployment. Efforts are being made to restore the lost glory of AICTE by giving it statutory status. Its effectiveness, in future, will depend on its revised constitution and its terms of reference. It is hoped that it will be really an autonomous body and not a machinery subservient to the Ministry of Human Resource Development.

ARTICULATION OF TECHNICAL EDUCATION WITH MANPOWER

Since technical education and training constitute a tailor-made system especially designed for meeting the trained manpower for industrial and economic development, it is necessary to strike a balance between demand and supply. Therefore, a well developed, national network of manpower information system is necessary. In the past, in the absence of such an information system, there had been imbalances ; on one side there was unemployment among the technical persons in large numbers, and on the other there had been dearth of trained persons in some branches. However, to facilitate proper working of the system, recently a reliable manpower information system for storage, updating, retrieval and analysis of manpower information to assist planning of technical education has been set up in collaboration with the

Institute of Applied Manpower Research. In the mean time, on the recommendation of AICTE steps have been taken to diversify and consolidate the existing courses and to start new courses in emerging areas to meet the demand. However, one aspect of manpower development that has been neglected is proper deployment strategy which is still missing. This lacuna is responsible for the mismatch of supply and demand of highly trained manpower.

INDIAN EXPERIENCE—A LESSON FOR DEVELOPING WORLD

After independence, India was faced with the problem of choice between quality and quantity. However, taking into consideration all aspects of development, India had to opt for quantitative expansion of trained manpower. This was a hard choice, but due to paucity of fund, it was perhaps the only choice left to the country.

In the initial stage, the policy of quantitative expansion served the country well, as the government decided to depend on imported knowhow, underlicence manufacturing of machines, limited fabrication and maintenance of machines at the first stage of development. The activities being routine in nature, there was hardly any element of research and development activities in the industry and other economic sectors.

Therefore, there was no serious trouble faced by technical education or training system. Whenever any new situation arose, the shortage of specialized trained manpower had to be met by arranging training of technical personnel by crash programmes either in India or abroad. This policy has affected research and development very badly. Apart from the method adopted being costly and time-consuming it affected industrial development. That is why even after 30 years of planning, the country has to go in for collaboration even in the field of maintenance. If, immediately after the Indo-Pak War of 1965 adequate provision was made for qualitative improvement of technical education, the story might have been different. Unfortunately, education has never been considered as a core sector in the country's planning strategy, although this sector is responsible for the development of human resources.

A critical analysis of the Indian experiences in the field of technical education may be a useful guide to many developing countries for working out an appropriate strategy for developing human resources.

CONCLUSION

From the analysis made in the present case study, it may be observed that in the preindependence days, although a number of reforms were suggested and some of them were even introduced, no substantial improvement of technical education took place. The reforms undertaken were marginal and slow due to deliberate policy adopted by the colonial government. However, in spite of several constraints, due to compulsion, the Government had to undertake some reforms to satisfy the growing needs and demands.

After 1947, the picture started changing very rapidly. In order to make the country self-reliant, the government had to undertake a massive economic and industrial development through five year plans. This necessitated rapid expansion of technical education, but very little attention could be paid at the initial stage for qualitative development. In spite of the shortcoming in the past, it has been possible for the country to supply sophisticated manpower for development of high technology like space, nuclear technology, *etc.* This is not a mean achievement. Moreover, India in the past had to depend on import of even pins ; today the country should be proud that it can produce from pin to sophisticated atomic power plant, space vehicles, *etc.*

Because of the Government's deliberate policy of a short plan holiday after the 1965 Indo-Pakistan War, which badly affected the economic development, the technical education got a jolt due to large scale unemployment among the technical personnel. This, along with the lack of definite industrial and technological policy and personnel recruitment policy, the industrial and economic sectors have stimulated large scale brain drain, as there was hardly any challenging jobs in the country.

Summarising, it may be said that one of the major failures of the system is the weakness of the research and development sector, as a result of which development of indigenous technology, to the extent required for self reliance has failed. Several factors may be responsible for such a situation and so it would not be fair to blame the planners of technical education alone. The major factors are :

1. lack of proper direction of the industrial development ;
2. lack of proper technology policy ;
3. too much emphasis on the labour intensive technology at the expense of development of modern technology and productivity ;
   [No attention has ever been paid to the time factor in formulating planning strategy, in the name of labour intensive technology, which is responsible for all the maladies of the country.]
4. lack of provision of adequate funds for proper and healthy development of technical education, particularly at the level of higher education and research ;
5. the legacy of inertia of technical education in the pre-independence period; and
6. departure of Indian Institutes of Technology from their objectives.

Consequent of these shortcomings along with lack of incentive, appreciation and opportunities, unattractive salary, *etc.*, postgraduate programmes have failed to attract the best quality students. This is a serious matter from the national point of view, as it has a far-reaching consequence on the future competence of the country in reaching a reasonable self-reliance in the high tech.areas and economic development.

According to certain studies, more than 25% of the top engineering graduates produced by some of the best institutions leave the country each year. An important dimension of the national loss through brain-drain is the reverse transfer of

technology through migration of such highly qualified manpower to developed countries. The loss of potential for innovative technology embodied in this sort of leakage of brains is to be taken as a defeat of the very purpose of high quality technical education.

Many morals can be drawn from the Indian experience. The most important of them is that no worthwhile reform is possible for development of technical education without a clear cut definition of national policy on industrial development, policy on technology adoption, R & D policy and the objectives of technical education and training. There should be no ambiguity in these policy declarations and they should have clear objectives and futuristic projections with reference to global technology and political environment and its changing trends.

To enable professional engineers, scientists and technologists to play their individual roles, the barrier between science and technology should be removed and drastic changes should be introduced in approach and contents of science and technical education in the present sterotyped system. In this respect UNESCO laid down some general guidelines in 1962 and 1976 for development of technical education programmes in relation to education as a whole, to serve the changing needs of the modern society and the requirements of a highly sophisticated technological society of 21st century, when a technical man will be forced to assume both social and moral leadership of the newly emerging global society.

In this context, the Nayudamma committee, while suggesting new courses in the emerging areas, has recommended that at the postgraduate level, wherever possible, attempts should be made to redesign the existing courses to include relevant and emerging areas. Narrow and futile definition of disciplines are dangerous. There should be interdisciplinary approach in this matter.

The curricula of professional education in general should be broad-based and flexible. It should be susceptible to continuous change with the ever-changing technological environment and need of the time. It should contain not only substantial studies in social sciences and humanities, but also heavy dosages of basic sciences including biological sciences. In future, there should be greater interaction between various branches of education to humanise the professionals on one hand, and on the other hand make others aware of the technological environment of the future for better understanding of the human mind. There will be an effective and efficient monitoring and evaluation system and a flexible and dynamic approach to planning of technical education and training, not with reference to present day stagnated socio-economic system but with an eye to the social system which is going to be adopted by the country in the 21st century.

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