TECHNICAL EDUCATION IN INDIA TODAY

L. S. CHANDRAKANT

सत्यमेव जयते

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CHAPTER 1

Introduction

Technical Education has to respond continually to both socio-economic changes and scientific and technological advance. Ideas, beliefs and values change; the faster the change, the more interesting the picture. Problems tend to become diverse as achievements become impressive.

In all industrially advanced countries technical education has received much attention because of its immediate utility in securing economic prosperity for the people, and even more so, because of its long-range relationship to social order. As the application of science and technology to industry, agriculture, transport and communications, public health and other activities becomes wider and more intensive, the need for engineers, technologists and technicians of various kinds increases. The provision for technical education is at the core of all these activities. The engineer is a responsible professional man whose every professional act has human and social consequences. Whether he is aware of this or not, he is instrumental in creating a new society and a new economic order, as well as a new physical environment. As a result of his professional accomplishments he is called upon to accept an increasingly responsible role as leader of his community. To meet his growing responsibilities, he needs depth, flexibility and a capacity for growth in directions which we only dimly visualise today. The business of engineering education is no mere narrow specialisation in certain technical disciplines; it has a wider social significance in the modern world.

The output of engineers and technologists in different countries in 1954 is given in Table I.

TABLE I

Country	*Total No. of first degrees*	*No. per million of population*
U.S.S.R.	60,000	260
U.S.A.	22,500	137
West Germany	4,450	86
France	2,990	70
U.K.	2,800	57
Italy	2,200	45
Switzerland	400	82
India	3,210	9

The figures speak for themselves. In the last five to six years vigorous efforts have been made in the Soviet Union and the United States to increase the outturn of scientific and technical manpower at all levels. U.S.S.R. reached a figure of 460 engineers per million of population in 1958. U.S.A. expects to double its output of engineers within the next four to five years. The point, however, is that the modern world is realising increasingly that national prosperity depends upon national education, and more particularly on technical education. Even with immense potential natural resources no country can advance if it remains educationally backward.

Although the first technical institution in India was established well over a century ago, technical education remained almost static for a long time; and this condition is reflected in a large measure in the lack of scientific and technological progress of the country all those years. It was only when the Second World War broke out that the need for technicians for the war effort was felt and some attention was paid to the problem of technical education and training. The problem was, however, regarded only as a wartime emergency unrelated to the fundamental and economic aspects of national life and no long range measures were adopted to improve the situation. Nevertheless, an important outcome of our World War II experiences was the formulation of post-war reconstruction plans in all fields. An appreciation that scientific and technical personnel were necessary for the successful execution of these plans also grew gradually in responsible quarters.

At about that time two important decisions taken by the then Government of India exercised a far-reaching influence on the course of development of technical education in subsequent years. One was the establishment of the All-India Council for Technical Education in 1946 to advise on all aspects of improvement and co-ordinated development of technical education. Another, was the appointment of a Scientific Manpower Committee in 1947 to assess the requirements for various categories of scientific and technical personnel and to recommend measures to meet them.

The All-India Council carried out a comprehensive survey of technical institutions in the country and formulated a scheme for immediate improvement and development with financial assistance provided by the Central Government. It also set up Boards of Technical Studies in various fields to prepare courses for various levels of training which could serve as a guide for the institutions and facilitate reorganisation of technical education in the country. Four Regional Committees, one for each region of the country, were set up to survey the needs on a regional basis, to formulate and implement development programmes in a co-ordinated manner and to help in the establishment of liaison between industry and technical institutions. The

Council also initiated various other measures for the development of technical education.

The Scientific Manpower Committee carried out a quantitative and qualitative assessment of technical personnel over a ten-year period, estimated existing shortages in training facilities and recommended measures to meet the requirements. What is more important, the Committee established for the first time in the country, the concept of integrated planning in technical education with a capacity to foresee future requirements for manpower and to meet them through organised effort.

Thus when India attained independence in 1947, a certain awareness of the importance of technical education to national development had grown in many quarters. This awareness grew steadily in the post-Independence period. The First and Second Five-Year Plans accorded high priority to technical education and a large financial provision was made both at the Centre and in the States for the establishment of new, and for the development of existing institutions. A remarkable expansion of technical education was achieved in the course of ten to twelve years.

In 1947, there were in the country 38 institutions with a total admission capacity of 2,940 students per year for first degree courses. There were also 53 polytechnics with a total admission capacity of 3,670 students per year for diploma courses. By 1961, i.e. end of the Second Plan period, the number of institutions for degree courses increased to 102 and polytechnics to 195. The total admission capacity of the institutions increased to 13,820 students for degree courses and to 25,800 for diploma courses. The output also increased from 1,270 in 1947 to 5,700 in 1960-61 of graduates and from 1,440 to 7,970 of diploma-holders during the same period.

These are impressive numbers, especially for a country like India that has had to build from scratch with a short time. But, numbers are not everything. What of quality?

The crux of the problem of standards in technical education is three-fold: teacher, equipment and buildings. The All-India Council for Technical Education and its Regional Committees have carried out a comprehensive survey of the state of each institution in the country and have formulated schemes for its improvement and development, which envisage *inter alia* provision of adequate instructional facilities, including teachers, that are necessary for maintaining proper standards of education. On the recommendations of the All-India Council large grants are being given by the Central Government, University Grants Commission and also by the State Governments to the institutions for buildings, equipment, staff and maintenance. The All-India Council has also drawn up model plans and estimates for an engineering college and polytechnic. New technical institutions are being established in accordance with this model.

To be effective in terms of a national plan, Engineering Education must be dynamic. It must facilitate adaptability to changing conditions in technology. It must constantly raise the level of attainment of products of technical institutions. India needs not only skilled workers and technicians but also design-engineers and engineer-scientists. Before 1947, there was hardly an institution which provided facilities for post-graduate studies and research in engineering. Today, over a dozen institutions have been developed within the country where facilities for post-graduate studies and research work are

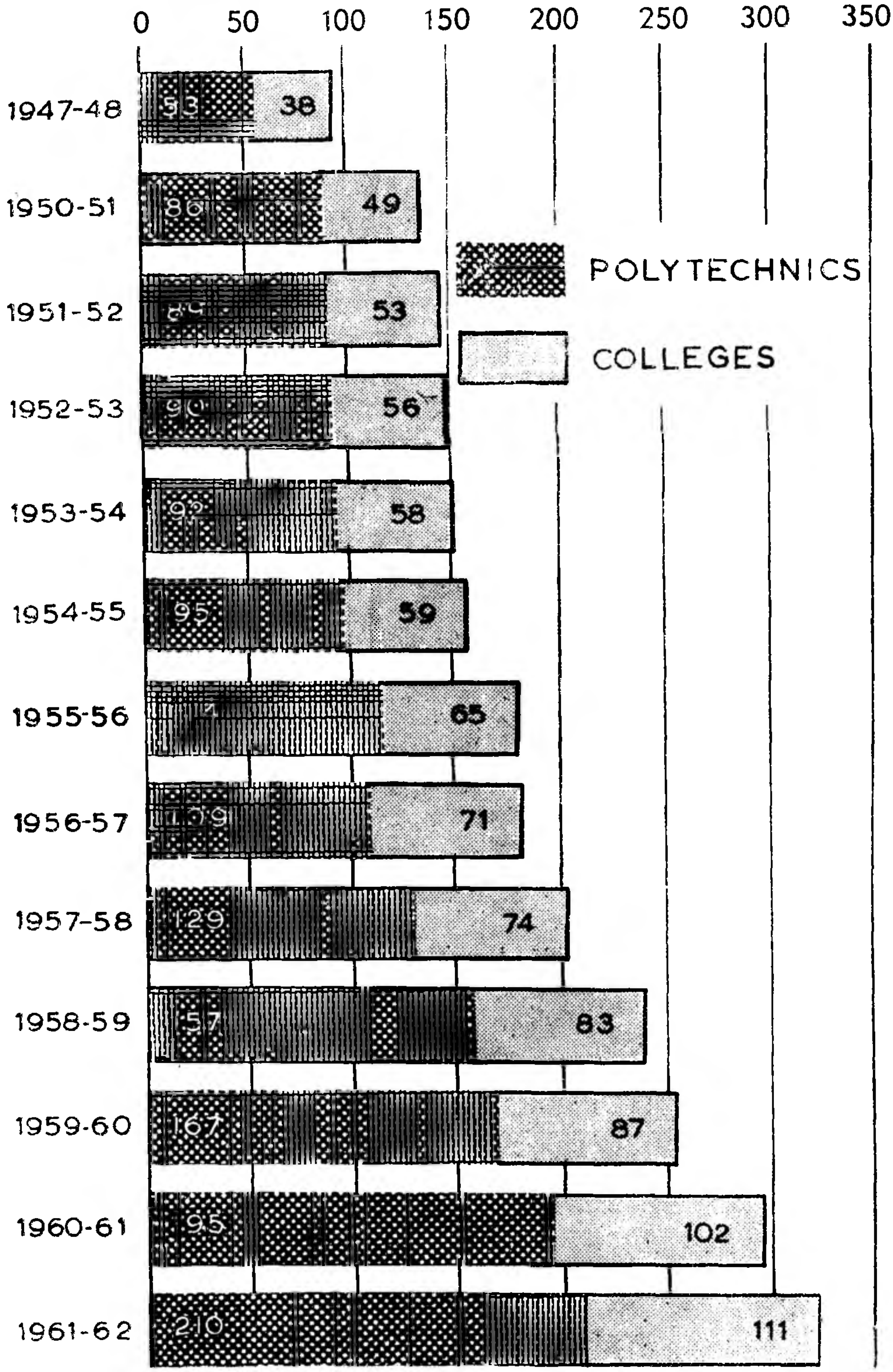
TABLE II

	Degree Courses			Diploma Courses		
Year	*Number of Institutions*	*Admission capacity*	*Output of graduates*	*Number of Institutions*	*Admission capacity*	*Output of Diploma holders*
1947-48	38	2,940	1,270	53	3,670	1,440
1950-51	49	4,120	2,200	86	5,900	2,480
1951-52	53	4,790	2,690	89	6,220	2,630
1955-56	65	5,890	4,020	114	10,480	4,500
1956-57	71	6,610	4,340	109	10,320	4,100
1960-61	102	13,820	5,700	195	25,800	7,970
1961-62	111	15,690	7,030	210	27,690	10,350

available for nearly 500 scholars. The fields of study also cover a wide range of subjects, some of which as, for instance, Power Engineering, Dam Construction and Irrigational Engineering, Production Engineering, Advanced Electronics, Aeronautical Engineering are of special importance to the development of the country. Such facilities will be expanded in the course of next five years so as to provide for at least 2,000 scholars.

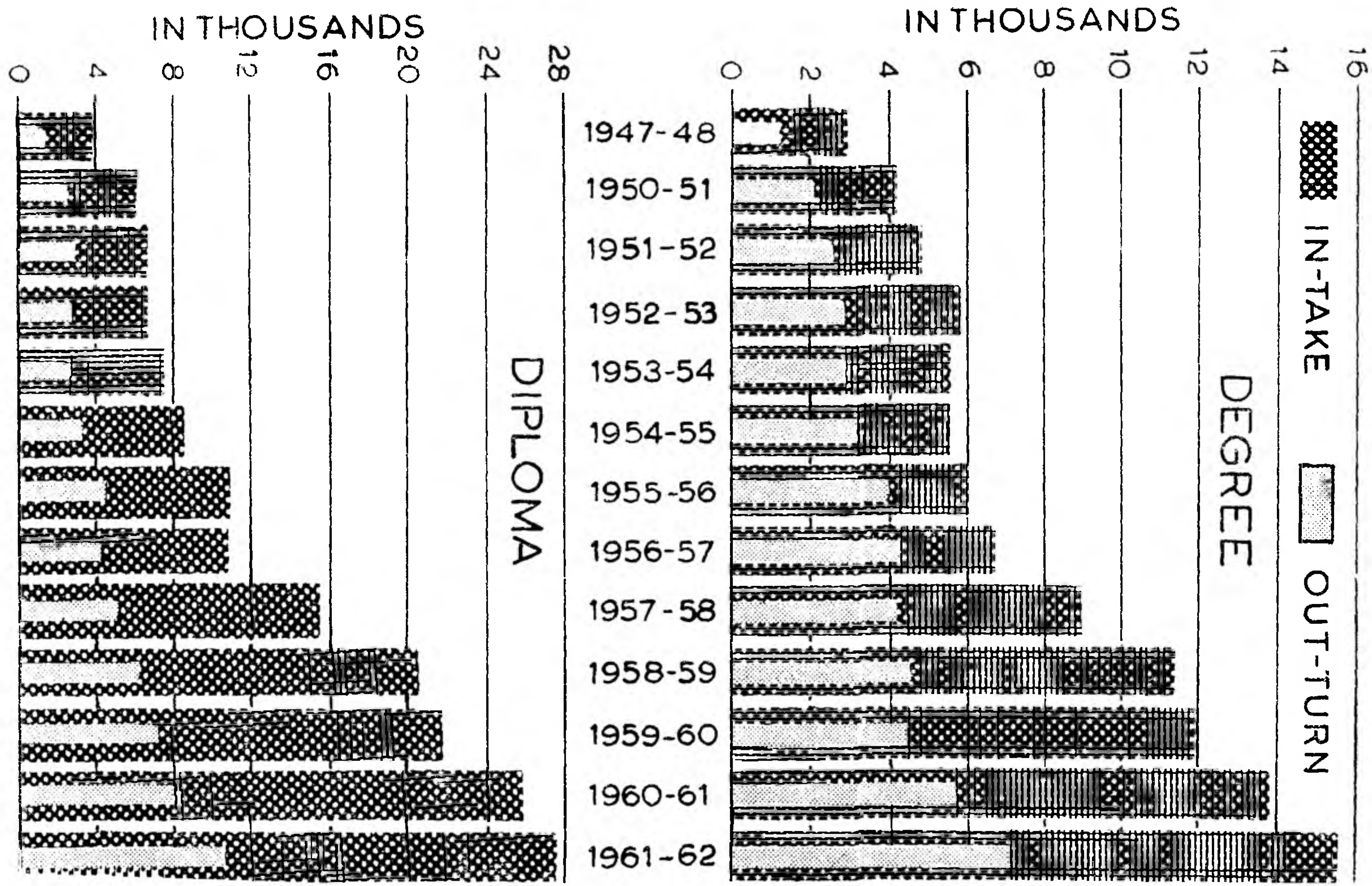
PROGRESS OF TECHNICAL EDUCATION IN INDIA
(1947–62)

NUMBER OF ENGINEERING COLLEGES AND POLYTECHNICS



PROGRESS OF TECHNICAL EDUCATION IN INDIA
(1947–62)

INTAKE AND OUTTURN OF GRADUATES AND DIPLOMA-HOLDERS



CHAPTER 2

Technical Education : Its Structure

There is no universally accepted definition of 'Technical Education'. It varies from country to country and is sometimes identified by particular types of institutions and their courses of study. In India, Technical Education represents a complex of activities that include post-graduate courses and research; under-graduate courses leading to a first degree or equivalent award: diploma courses; certificate courses; junior technical schools and technical studies at secondary school level; apprenticeship etc. The predominant characteristic of technical education is what may be called the "double finality" of educational development for the individual and the acquisition by him of techniques and skill. The emphasis on the one or the other may vary from course to course; the organisational arrangements may differ; or the types of institutions may be diverse. But both form essential components of technical education.

TECHNOLOGIST OR TECHNICIAN?

The terms Engineering and Technology are sometimes used synonymously and sometimes differently, to distinguish between different subjects. Technical institutions are sometimes referred to as engineering colleges; sometimes as technological colleges; and in some cases as colleges of engineering and technology. There is no doubt that a certain amount of terminological confusion exists, but this is more in usage than in basic concept. Historically engineering included only the more well-known fields such as Civil Engineering, Mechanical Engineering and Electrical Engineering. As the application of science to industry widened and the forces of Nature were harnessed increasingly for the material prosperity of man, a large body of applied scientific knowledge grew up and was called by the more comprehensive term Technology. Technology, therefore, includes all fields of engineering and applied sciences that are responsible for present-day progress.

Confusion has also arisen out of the fact that between the two words, **Technologist** and **Technician** which sound and look alike, there is a wide difference though the words are often used synonymously. A trained technician may be defined as a person who, without aspiring ever to reach one of the directing positions in industry, is nevertheless fully competent to understand, control and maintain the technical processes committed to his charge. A technologist, on the other hand, is a person capable of appreciating the latest progress in research laboratories and applying scientific knowledge and methods to industry. This distinction between a technologist and a technician is important since it determines the standard and scope of technical education at different levels. The Commonwealth Education Conference formulated the following definitions :

> **Technologist :** A person holding a degree or equivalent professional qualification in science or engineering, who is responsible for the application of scientific knowledge and method to industry.
>
> **Technician :** A person qualified by specialist technical education and practical training to work under the general direction of a Technologist.
>
> **Craftsman :** Normally, a person who has served a recognised apprenticeship in a trade and who applies his skills on the shop floor.

The definitions explain in the best way possible the nature and scope of technical education and training at three main levels.

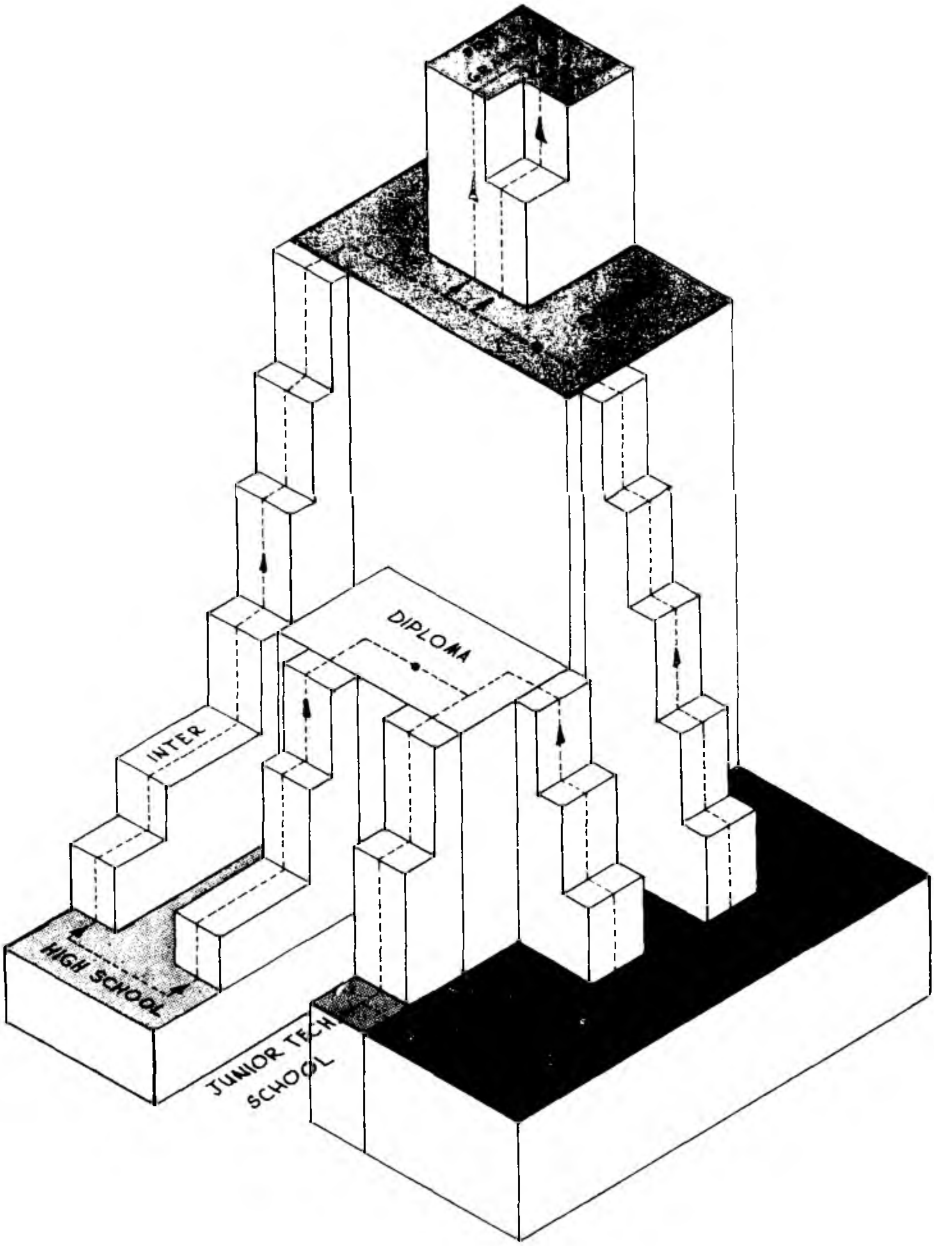
FOUR-TIERED STRUCTURE

Technical education in India is a four-tiered structure comprising post-graduate courses and research; first degree courses; diploma courses; and vocational or industrial training. Each tier is a self-contained aspect intended to serve a specific purpose and neither the diploma courses nor the industrial training courses are a preparation for the next higher tier.

For post-graduate courses and research, however, only those candidates who have a first degree in the relevant subjects are admitted. The objective of the first degree courses is to train technologists, some of whom may eventually become designers, research engineers or specialists in various fields either after further studies at post-graduate level or experience in the profession. They are not concerned with preparing persons for specific positions or jobs in industry, but with giving them a broad-based education in the scientific principles and methods underlying technology. Equally, they are not concerned to develop particular technical skills in students but to acquaint them with various production methods in accordance with constructional requirements in a system that consists of an assembly of men, materials and machines.

FIRST DEGREE COURSES

Till recently, the duration of first degree courses was generally four years



STRUCTURE OF TECHNICAL EDUCATION

with the Intermediate in Science as the minimum admission qualification. The Intermediate in Science, a preparatory stage for university courses was of two years' duration after a high school education that extended over a period generally of ten years. It therefore took six years for a student to complete the first degree after his high school education.

Secondary education in the country is in process of re-organisation and the new pattern envisages an eleven-year schooling intended to prepare candidates for life and for direct entry to university. The existing Intermediate course is being abolished. As a result of this change, the first degree courses are being re-organised into a five-year integrated course after higher secondary education. The advantages of a five-year integrated course are: first, a more fruitful integration of fundamental sciences, technological subjects and liberal arts will be possible. Second, a higher level of scientific and technical competence may be expected since the students can absorb the different subjects in more suitable stages and in the right combinations. Third, a five-year tutelage will give the teachers an opportunity to reduce class work and to develop in the students a capacity for growth and maturity. Finally, in these days of specialisation, a five-year curriculum admits of introduction to different specialised fields and prepares the student for post-gradutate studies or research.

The first degrees are awarded in the main fields of technology, *viz.* Civil Engineering; Mechanical Engineering; Electrical Engineering; Electrical Communication Engineering; Chemical Engineering; Mining; Metallurgy; Textiles Technology; Agricultural Engineering; Leather Technology; Architecture. Courses in Instrument Technology, Automobile Engineering and Aeronautical Engineering are also offered by some institutions at the first degree or equivalent level.

POST-GRADUATE COURSES

Post-graduate courses leading to a Master's degree or equivalent award are generally of one or two years' duration, and provide for specialisation in a branch of a major field in formal instruction, project work and independent study of a chosen problem presented as a dissertation. Research degrees like the Ph.D. or D.Sc. are awarded on the basis of original research done by candidates at recognised centres. The normal period required is two to three years after a Master's degree.

DIPLOMA COURSES

Next to first degree courses, diploma courses occupy an important position in technical education in India. These courses are conducted by a large number of institutions called Polytechnics and Rural Institutes and are designed to train technicians who will eventually occupy supervisory positions like foreman, overseers etc., in industry and other technical organisations, in charge of engineering construction, production and operation and maintenance. Another function that the diploma-holders can perform is as engineer aide in design offices or on the shop floor or on field execution. The courses are three years long after a high school education and have a strong practical bias. The view has, however, been advanced in recent years that the practical knowledge and experience required by a technician cannot be given to him in an adequate measure in a course that is wholly institution-based, and that the present three-year diploma courses do not always produce the right type of personnel. The All-India Council for Technical Education has therefore designed a Sandwich Course of four years for diploma in mechanical engineering. In this course, practical training in industry and institutional studies alternate in suitable layers. The student spends stated periods in industry and in an educational institution, throughout the course and fulfils the academic requirements for the diploma. He also gains the practical experience necessary for a supervisory position. The scheme has been introduced at selected centres in co-operation with industry. The sandwich pattern is now the normal form of training technicians for mining industry, and has been adopted at all the mining schools. As training facilities in industry expand, the sandwich course will become an important feature of technical education in India.

The diploma courses are offered in the main fields of civil, mechanical and electrical engineering. A few institutions also offer Textile Technology, Leather Technology, Mining Engineering and other fields according to regional requirements for technical personnel at this level.

As a matter of established usage, the term "Polytechnic" represents in India today technical institutions that conduct diploma courses chiefly in civil, mechanical and electrical engineering. It indicates at once both the standard of training and the main fields of study. Except for a few institutions that are under the direct control of universities, all polytechnics are affiliated to State Boards of Technical Education in different States. The State Boards prescribe the courses of study, conduct examinations and award diplomas. Uniformity of standards on an All-India basis is maintained through the All-India Council for Technical Education which has formulated National Certificate courses to serve as a model for the diploma courses conducted at polytechnics.

TECHNICAL TRAINING AT SECONDARY STAGE

The Indian Constitution makes it essential for the State to provide free compulsory education for all children up to the age of 14 *i.e.* up to three classes below the new higher secondary course that is in process of being introduced. The question is how to provide diversified opportunities for education and training to a majority of students after 14, for gainful occupation in life. The issue partly arises from the fact that secondary education is a terminus for a majority of students and so, has to be a self-sufficient and practical preparation for entry to life. It is partly due also to the fact that the present menace of large numbers of students crowding aimlessly into universities and other higher institutions has to be eliminated. University education should be open only to those who can profit by it and have the necessary academic merit. For the rest, secondary education of diversified types that suits individual ability and aptitude should be provided. Therefore technical education and training at secondary level is of vital importance.

The Junior Technical School, a special type of secondary technical school, is designed specifically for students who wish to enter industry and other technical occupations. It offers a three-year integrated course in general education, technical education and technical training in various engineering trades. It accepts fully the concept of 'Double Finality' within its curriculum of educational development of the student from 14 to 17 and of his effective preparation for a definite technical occupation in life. In each year, general education, technical studies and workshop training are so integrated that all three elements constitute the base for the total development of the young student. Also, the work-load is so designed that the technical school functions as a cross between a factory and a school.

The workshop training that constitutes over 55% of the total course and conducted in well-equipped shops provides a good foundation for the development of the student as a skilled worker of a high order. The development of technical skill is facilitated by training in engineering drawing and in elementary mechanical and electrical engineering included in the course.

CHAPTER 3

Technical Institutions: Their Nature

Technical institutions in India at the post-school stage may be classified broadly into three categories viz. (a) those conducting post-graduate courses; (b) those conducting first degree courses; and (c) those conducting diploma courses. No institution, however, is meant exclusively for post-graduate courses. These courses are conducted at certain selected institutions belonging to the second category where facilities for advanced studies have been specially developed. Institutions for first degree courses are distinct from those for diploma courses except for a few that conduct both. The general policy of the All-India Council for Technical Education is that degree and diploma course should not be conducted at the same institution. Underlying this policy is the need to provide full scope to each to develop in accordance with its own aims and objects.

The Junior Technical Schools, of which there are about 55 at present, are a separate class. Some are attached to polytechnics and some work as independent institutions. In the former, substantial economy has been achieved in buildings, equipment and staff. It has also been possible to establish a rationale between secondary technical education and education at polytechnic level. The two educational cycles can be gradually integrated into one unified system that takes off immediately after the compulsory schooling age of 14.

Technical institutions may be characterised further by the particular administrative authority, the Central Government, the State Governments, Universities and private agencies—that is incharge of them. There are institutions set up by each of these authorities.

ENGINEERING COLLEGES AND POLYTECHNICS

There are at present 111 institutions for first degree or equivalent courses and 210 institutions for diploma courses. Except for the higher technological institutes at Kharagpur, Bombay, Madras and Kanpur and the Indian Institute of Science, Bangalore, which are in a class by themselves, all first degree institutions are either affiliated to universities or are functioning as departments of Universities and conduct courses as are prescribed by the Universities. The Higher Technological Institutes and the Indian Institute of Science, Bangalore, award their own degrees. The latter awarded till recently only diplomas and Associateships that had been recognised by the Central Government and other authorities, but since 1958 the Institute has been empowered to award conventional degrees. The Madras Institute of Technology, another institution not affiliated to any University awards diplomas for courses in Aeronautical Engineering, Instrument Technology, Automobile Engineering, Radio Engineering that are of first degree standard and the diplomas are recognised by the Central Government and other authorities.

A majority of the institutions offer only the three basic fields viz. Civil Engineering, Mechanical Engineering and Electrical Engineering. The other fields viz. Mining Engineering, Chemical Engineering, Metallurgy, Textiles Technology etc. are offered mainly by institutions that have been set up specially for the purpose. Historically, 'Engineering' and 'Technology' were used to represent different fields and that distinction was reflected too in the scope of work of technical institutions. Engineering colleges were set up mainly for Civil, Mechanical and Electrical Engineering and separate institutions for the so-called Technologies. The distinction was purely scholastic, but the pattern set by history for technical institutions continued. It is being increasingly realised that the progress of technological education and research depends in large measure upon the integration of fundamental and applied sciences with engineering studies. It is also accepted that the establishment of separate institutions for individual fields is not only uneconomical but restrictive. The move is to have composite institutions as far as possible, or to diversify and develop the activities of existing institutions. The new institutes of technology that offer facilities in a wide range of subjects are cases in point.

Except for the Higher Technological Institutes, practically all technical institutions had till recently a maximum admission capacity of about 120 students per year. Some had even less. As compared to institutions in the U.S.A., U.S.S.R. and other technologically advanced countries, our institutions were certainly small units. Perhaps in the past there was no alternative. For one thing, the demand for engineers and technicians was restricted; for another, regional aspirations for technical institutions could only be fulfilled on the basis of smaller units more widely dispersed. Also, there was no Central planning and co-ordination of technical education that could have ensured general principles governing the size and scope of work of institutions. In course of time, however, it was realised that large-sized institutions were necessary to meet the increasing demand for engineers and that such institutions should function on a national level. The Higher Technological Institutes have therefore been planned for an admission capacity of about 320 students per year (or a total student enrolment of about 1600) at the first degree level. A special scheme has been drawn up and is in process of implementation, to expand the training capacity of selected existing institutions and develop them into larger units. Some of these institutions are now admitting 250-300 students per year. The establishment of 15 large-sized Regional Engineering Colleges has also been planned, each capable of admitting 250 students per year. Eleven of these colleges have already started functioning. Some polytechnics capable of admitting upto 300 students per year have been sponsored by the Central Government. The advantages of large-sized institutions are many. They are more economical and more efficient than the equivalent in small colleges. Nevertheless, their effect is to restrict dispersal of educational facilities over wider geographical areas, a factor of some importance in a large country like India. Out of this arises the problem, should technical and economical factors alone govern the size and location of future institutions or regional and local demands for technical education facilities be considered?

In any scheme of organised development of technical education, super-imposition is necessary, and institutions should be related to the needs of a rapid industrial growth. Nevertheless, as a people becomes socially and economically conscious, the store set by an engineer or technician increases and the aspirations of the people assume new dimensions. In such a situation, all legitimate demands for the provision of technical education facilities have to be met. The aim of the Central Government in this direction is two-fold. A total view of technical education is taken in relation to five-year plans and no region or area is left without opportunities of advancement for its people.

Simultaneous with the establishment of higher technological institutes, and other all-India institutions, a wider geographical dispersal of engineering colleges and polytechnics is being deliberately promoted. The objective is that eventually every one of the districts in the country should have at least one polytechnic and that no State shall be without its own engineering college. The latter objective has been achieved in the last three to four years. As regards polytechnics, over 140 districts still require to have their own institutions. It is hoped that the new institutions to be established in the Third Plan period, will be located in these places.

ROLE OF PRIVATE ENTERPRISE

An important feature of technical education in India is the large role played by private enterprise. Of the 321 institutions in the country at present for first degree and diploma courses, 198 have been established by the Central Government and State Governments; 33 by universities and 90 by private agencies. In quantitative terms, the institutions established by private agencies account for nearly 35 percent of the total number of seats and this is a very substantial part. A definite policy is followed by the Central Government to encourage and assist private agencies. Under the Second Plan, wherever a private agency by itself or in association with the State Government raised enough funds to meet 50 percent of the non-recurring (college buildings and equipment) and 50 percent of the recurring expenditure for a technical institution, the Central Government provided the balance 50 percent required as grant-in-aid. The Central Government also gave interest-free loans for the construction of hostels. As a result of this policy, nine engineering colleges and 23 polytechnics were established by private agencies during the Second Plan period as against ten colleges and 46 polytechnics established by State Governments and Universities. Private enterprise therefore constitutes a very important element of technical education in India and supplements in a large measure the efforts of the State. In order to ensure that the private institutions are run on the right lines and maintain proper standards, governing bodies, that include representatives of the Central Government and State Governments and the All-India Council for Technical Education, have been set up to administer the affairs and finances of the institutions. The same policy of assisting private enterprise continues under the Third Plan but the matching share expected of private agencies has been slightly raised.

STANDARDS

Does the present system of a four-year or five-year undergraduate course after the Intermediate or Higher Secondary train adequately the type of engineers who could go in for post-graduate studies and research? Would it not be better to design a first degree course that aims at a higher standard of scientific and technological content and in which an adequate foundation is laid for advanced studies later on? Should the pattern of technical education not be flexible enough to permit of the training of different types of graduate-engineers, and particularly of those who can become 'Scientist-engineers'? These are some questions on post-graduate studies and research that have to be answered.

Most people agree that a University would not be doing its duty unless it gave its technological students an education in scientific principles; that a graduate course in technology requires a knowledge of fundamental mathematics and science and that unless this knowledge is acquired upto a high level the student will not be able to turn his practical experience to good account. In addition, the technologist must have enough knowledge in his speciality to qualify for entry to the profession which, with increasingly rapid advances in modern science and technology implies courses in electronics, ultrasonics, servo-mechanism, nuclear energy and other new material that was unknown upto 10 to 20 years ago. Above all, it is urged in many quarters that the courses should be devoted to teaching the future technologist to be a leader of men, to live a broader life and have an understanding of the arts and sciences which make life more pleasant and the world a better place to live in.

It is hard enough for any university with fully developed faculties in the liberal arts and sciences and technology to live up to the objective of inter-disciplinary development and also to meet the challenges of new situations that arise out of the ever-widening frontiers of knowledge. In a normal engineering college, with limited resources, the task is much more difficult. Nevertheless, as an essential measure towards improvement, the All-India Council for Technical Education has recommended that every engineering college should have full-fledged departments of Physics, Mathematics and Chemistry equal in status and importance to engineering departments. The degree course should aim at a more fruitful integration of the fundamental and applied sciences.

Then again, the pattern of employment of technical personnel is changing rapidly. The old concept of an all-purpose engineer is vanishing and job specifications are becoming ever more specific. The function of a technical institute is not to train a student for a particular job but to give him a broad-based education on which he may build later on a truly professional career in his chosen field. This education should enable him to fit into his field of engineering as a whole. Nevertheless, the pattern of education should be flexible enough to suit students of varying interests and abilities. It should also be responsive to the stimulus of change in industry and in research.

A majority of engineers required for industry and other activities are of a uniform type and can be trained in the present four or five-year course. The standard and content of the course is just sufficient to enable them to enter the profession. With experience gained in the field, they rise to higher levels of employment and professional competence. A limited number of engineers, however, is necessary for research, design and other kinds of original work. They constitute the sheet-anchor for all future technological progress. It is for the training of this small group, both at under-graduate and post-graduate levels, that special provision must be made in the existing pattern of technical education.

An important suggestion is to organise at selected centres a special three-year under-graduate course in engineering, admission to which should be restricted to first class graduates in physics, mathematics and chemistry. The course should lay special emphasis on advanced scientific principles as applied to engineering. Such courses have just been formulated in Engineering Science, Aeronautics, Instrument Technology, Electronics etc.

FACILITIES FOR SPECIAL SUBJECTS

Diversification in the field of training is an important aspect of technical education. As industrial development progresses, the need for personnel trained in different fields and possessing diverse skills becomes evident. As the areas of application of science enlarge, new technical disciplines are established which in turn create a demand for entirely different types of trained personnel. For instance, the application of nuclear science has established the new field of nuclear engineering and made it necessary for nuclear engineers to be specially trained. The application of electronics, transistors and circuitry to computors, servo-mechanisms and automatic controls has opened up new fields in which engineers are being trained in large numbers. It is, therefore, a primary function of technical education continually to respond to new developments in science and technology, identify new technical disciplines and provide training facilities in them.

In India, the full impact of scientific and technological advances on technical education has just started and a marked diversification of the field of training is noticeable. New faculties are being added in institutions whose activities were till recently restricted. For instance, Mining, Metallurgy, Chemical Engineering, Petroleum Technology, Geophysics, Production Technology are some of the subjects in which several institutions are today offering courses. This is largely due to a definite demand felt at present for technical personnel in these fields for various development projects under the five-year plans.

SCHOOL OF PLANNING

Among the facilities created for training in special fields, may be mentioned the School of Planning and Architecture, Delhi. The school has been established as a Central institution for the post-graduate training of architects, engineers and sociologists in civic design and planning, an activity of great importance to the country. The school also conducts a special course in Housing to provide the much-needed personnel for the housing projects undertaken by the Central and State Governments. A Department of Architecture has been added to the school, that conducts a full-fledged degree course as also a part-time course in the subject.

MANAGEMENT STUDIES

Scientific Management is another field that has recently attracted considerable attention in India. And rightly so, since for the success of the numerous industrial and commercial enterprises that have been undertaken both in the public and private sectors, good management is a *sine qua non.* The rapid changes that are taking place in the social, political and technological environment, are making it increasingly necessary for the modern manager to be specially trained for his profession rather than to come up the 'hard way' through the school of experience. His training is both a rigorous academic discipline, essentially educational in character and a practical down-to-earth mastery of tools, techniques and processes. Therefore, on the recommendations of the Board of Management Studies, specialised courses in Business Management & Industrial Administration have been organised at four selected centres in the country and it is proposed to extend the provision to a few more centres. The courses are essentially for persons who are engaged in management and have to be equipped to grow and for those who possess a minimum amount of practical experience and wish to enter the management field. In order that they may best serve this purpose, the courses are generally organised on a part-time basis. Two all-India Institutes of Management are being set up at Calcutta and Ahmedabad for post-graduate training and research in the field.

The Administrative Staff College, Hyderabad, established in 1957 as a joint enterprise of the Central Government and private industry and commerce offers a 12-week course to young administrators from all walks of national life in the principles and techniques of organisation, administration and leadership in civil life. It lays emphasis on team work, and upon the basic fact that those who are called upon to work together will be drawn from different apprenticeships. The task is to make a co-ordinated group out of individual specialists. It is one that grows with each further step in technological development. What the Staff College hopes to do is to bring together young administrators from all walks of national life at an age when their views are formed but not fixed, to provide for the exchange of ideas to the common advantage and to promote better understanding between those in charge in different spheres of activities. The resulting cross-fertilisation of ideas and techniques will be of advantage to all who participate and to the community as a whole.

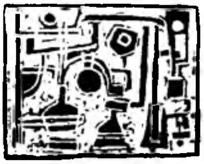
The different centres of Management Studies and the Administrative Staff College are complimentary to one another. The Staff College is not concerned with preparatory training. Its constituency is among men and women already expert but needing the opportunity to reflect, to compare notes and to equip themselves more fully for their services. A National Institute for Industrial Engineering proposed to be set up at Bombay will be an important component of the Management Complex that is gradually emerging.

PRINTING SCHOOLS

For the training of technicians of the supervisory cadre for printing industry, four Regional Schools of Printing have been established at Calcutta, Bombay, Madras and Allahabad. The schools, working in close association with industry offer National Certificate courses in the various branches of printing and each serves the States in the region where it is located. It is proposed to establish a Central Institute for advanced training and research in printing technology and allied fields.

In developing facilities for new or special fields, keeping pace with current advances is not by itself enough. To anticipate the future, to think and act ahead of the times is the challenge of technical education.

CHAPTER 4



Higher Technological Institutes

An impressive range of scientific discoveries and technological development characterises the present times.

Television and radar; electronic computers for the solution of complex mathematical problems and for business accounting; semi-conductor devices, known as Transistors as a replacement for the thermionic valves; electron microscopes with magnification exceeding 100,000; nuclear fission and fusion processes for power generation and for the production of radioactive materials that are of importance in agriculture, medicine and industry; new synthetic materials like polythene, terylene, silicones etc. that have a wide range of application in industry and in our daily life; gas turbines and jet propulsion. These are only a few examples of scientific and technological achievements of the modern world. These as also others in practically every field are the result of the creative effort of scientists and technologists working in many countries and as partners in a common enterprise, namely, to extend the frontiers of scientific knowledge and to apply scientific discoveries to practical technological problems. They emphasize the interdependence among the various branches of technology as well as the ever-increasing dependence of technology on the fundamental sciences. They have further demonstrated the increasing need for technologists to acquaint themselves with, and to interpret and apply, the work of chemists, physicists, metallurgists and mathematicians and for the representatives of the various scientific and technological disciplines to collaborate in team effort.

India cannot remain unaffected by these advances. We may not attempt space travel and rocketry, but scientific and technological discoveries that touch upon the utilisation of material and energy resources of the country are of great significance to us. We have not only to adapt and apply known knowledge and techniques to different situations in the country, but also to make our own contribution to scientific and technological progress. As the Scientific Policy Resolution approved by Parliament rightly points out, the key to national prosperity lies in the effective combination of the spirit of the people with technology, raw material and capital. Technology is more important than either raw material or capital, for the discovery and use of new techniques can make up for deficiencies in natural resources and reduce requirements of capital. Education is even more important, for "it is the function of education both to develop technology and to build up morale". India therefore needs quality scientists and technologists, who are not only specialists but are capable of looking well beyond their own fields, can understand the inter-relationships of different disciplines and co-ordinate a diversity of skills, techniques, materials and experience in the solution of engineering problems; can work as a team and "cross-fertilise" each other.

The training of a technologist is not a mere course; it is a complex process that extends over a number of years. Part of the process takes place in an institution and part in industry or in professional field. Under-graduate studies are only the first cycle in which the young student is introduced to fundamental scientific and technological principles and given a general and broad education. Specialised training in a particular branch of technology to acquire depth of knowledge; practice in rigorous theoretical and experimental analysis; the ability to think independently and judge in a scientific way; an understanding of the inter-relationships between different branches of science and technology; and what is more important, an adequate preparation in mathematical and physical sciences that is necessary for advanced technological work. These are the other components in the training of a technologist. Organised post-graduate studies at institutions specially meant for the purpose are therefore a necessity.

An important step taken by the Central Government to develop facilities within the country for advanced technological training is to establish four higher technological institutes, one in each region, east, west, south and north. A plan for the institutes was first drawn up in 1946 by a Special Committee. The concept behind the institutes is that for the training of the highest possible grades of technologists, who are required in large numbers, national institutions provided with all the necessary resources and full freedom to adapt themselves to the fast-changing situations are necessary. In addition to the training of technical personnel, the institutions should be fountain-heads of scientific and technical knowledge and should contribute through research and other activities to the industrial advancement of the country.

The Indian Institute of Technology, Kharagpur, is the first higher technological institute to be established. It started functioning in 1951. Equipped with all the faculties viz. liberal arts, fundamental sciences and the various technologies, that are necessary for the realisation of the highest ideals of technological education, the institute provides facilities for the education and training of over 1,600 students in the undergraduate courses and about

320 students for post-graduate courses and research work. The subjects offered cover a wide range as for instance, Naval Architecture, Fuel and Combustion Engineering, Production Technology, Geophysics, Advanced Electrical Communication Engineering, Foundry Engineering, Concrete Technology, Agricultural Engineering, Architecture and Town Planning etc., which are all designed to meet the special requirements of industrial and other developmental projects for high grade technologists. The plan is to make provision for about 400 post-graduate students and research scholars eventually.

The other three higher technological institutes are in process of establishment at Bombay, Madras and Kanpur. The Bombay Institute started functioning in 1958, the Madras Institute in 1959, and the Kanpur Institute in 1960. All these institutes are being planned on the same comprehensive scale as the Kharagpur Institute, and when completed will take the technological education of the country several steps further. Each will be a fully residential institution designed to promote corporate life among students and teachers, and will provide facilities for about 1,600 students in the under-graduate courses and 400 students for post-graduate courses and research. While the nature and level of work of the institutes is the same, each will pay particular attention to certain special fields of technology that are vital to the industrial development of the country. Dead uniformity and duplication will be avoided as far as possible, and each institute will be allowed to develop in directions best suited to its own resources and genius. All four Higher Technological Institutes have been incorporated by an Act of Parliament as Institutions of National Importance.

In this, the foreign technical assistance that the Institutes are receiving is of great value. The Bombay Institute is being assisted by the Soviet Union (both directly and through Unesco), the Madras Institute by West Germany and the Kanpur Institute by the U.S.A. The assistance given by these countries covers scientific and technical equipment, services of expert professors for a period of about five years and facilities for the training of Indian teachers at Universities and Institutions in the Soviet Union, West Germany and U.S.A. All these countries are famous for the technological and industrial advancement achieved in different ways. The Bombay, Madras and Kanpur Institutes will, it is hoped, bear the imprint of the progress of the countries that assist them in their establishment and development. The Kharagpur Institute also has received some assistance from several countries through Unesco, Colombo Plan, Point-four Programme etc. All Higher Technological Institutes, therefore, represent a venture in international co-operation and understanding in scientific and technological fields.

INDIAN INSTITUTE OF SCIENCE

Another important centre of post-graduate studies in engineering is the Indian Institute of Science, Bangalore. Established in 1911 through the foresight and magnanimity of Jamshedjee Tata, the Institute has built up a high reputation in scientific research. In 1946, the Central Government decided to develop the Institute for advanced studies and research in technology and promote thereby the inter-action of pure and applied sciences. In the last 15 years the Institute has become a centre of advanced technology with particular reference to Power Engineering, Aeronautical Engineering, Metallurgy, Internal Combustion Engineering and Electrical Communication Engineering. The Power Engineering Department of the Institute is the only one of its kind in the country and provides facilities for advanced training and research in the various aspects of electrical power generation, transmission and distribution. This is a provision of great significance in the context of the big power projects undertaken in the country. Similarly, the Aeronautical Engineering Department is also the only centre for advanced training and research in aeronautics and related fields. The department has research, design and testing facilities that are of great value to aircraft industry. The other subjects offered by the Institute include Soil Mechanics and Foundation Engineering; Automobile Engineering; Industrial Engineering and Foundry Engineering. The Institute provides facilities for over 600 post-graduate students and research scholars in its various faculties.

OTHER CENTRES OF ADVANCED STUDIES

In an expanding system of education, institutions should have a capacity for growth and maturity; to project themselves into the future and anticipate changes; to prepare their products to meet the challenge of new situations. This is all the more necessary for technical institutions that are constantly exposed to the powerful influence of industrial development and scientific progress. How far the 111 institutions in the country that are conducting first degree courses will ultimately answer to this description depends on the opportunity provided to them to grow out of themselves and strive for higher levels of academic and technical performance. To confine the facilities for advanced work to the Higher Technological Institutes or a few selected institutions specially set up for the purpose is to deny them the much-needed opportunity of advancement. Therefore, on the recommendations of the All-India Council for Technical Education, a deliberate policy has been adopted to encourage as many institutions as possible, depending upon their resources and abilities, to conduct advanced courses in engineering, or to establish research units. A number of institutions as, for instance, the Bengal Engineering

College, Sibpur, Roorkee University, Guindy Engineering College, Madras, Poona Engineering College etc. that were till recently engaged in undergraduate work are now offering facilities for advanced studies in engineering. The fields of study include, Dam Construction and Irrigational Engineering, Structural Engineering and Concrete Technology, Public Health Engineering; Electrical Machines Design; Mechanical Engineering; Metallurgy; Electronics.

The present state of post-graduate studies and research in engineering and the lines on which further development should proceed have been examined by a Special Committee appointed by Government. The Committee has recommended that at the post-graduate level training should have two distinct objectives, immediate and long-range. The immediate objective is to train in a narrow field, an engineer-specialist who could readily apply his advanced knowledge to industrial operations relating to design, construction, manufacturing processes etc., in a scientific way and also to develop the results of research in their application to industry. The long-range objective is to train engineers with a deeper understanding of scientific principles underlying engineering who could undertake research and make fundamental contribution to the advancement of technology. In order to secure these objectives, the Committee has recommended a Master's degree course of two years and a post-graduate Diploma Course of one year. These and other important recommendations of the Committee have been accepted by the Central Government and post-graduate courses are in process of reorganisation at various institutions.

CHAPTER 5

Planning for Technical Manpower

In a planned economy, the demand and supply of man-power are vital ingredients. Unless an adequate supply of the necessary trained personnel is ensured, the progress of development projects in any field suffers. Unless the projects throw up a sufficient number of jobs to absorb the available manpower and provide employment opportunities in an increasing measure, the economic system becomes stagnant. Therefore, a balance between demand and supply of manpower must be maintained at all times. That calls for an integrated and statistical approach to the problem of technical education and training.

SCIENTIFIC MANPOWER COMMITTEE

The first attempt ever made to assess requirements for technical personnel over a given period and plan for the necessary training facilities was by the Scientific Manpower Committee in 1947-48 soon after Independence. At that time, however, no five-year plans had been formulated. Nevertheless, the Committee visualised a certain level of economic development to be reached by the country over a ten-year period, 1947-57 and estimated the requirements for technical personnel for industry, agriculture, transport and communication, defence and other fields. Qualitatively, it also classified the personnel required into different categories of engineers, scientists, technicians etc. and indicated the level of their training in terms of post-graduate and specialist qualifications, degrees and diplomas. For supply, it carried out a comprehensive survey of the state of scientific and technical education in the country, the available training capacity of the institutions, the shortages existing in the instructional facilities and the scope of development of the institutions. The Committee estimated that the requirements for technical personnel over the ten-year period 1947-57 would be of the order of 30,000 persons possessing post-graduate qualifications and first degrees in various fields of technology (including engineering) and 33,000 persons possessing diplomas. To meet this demand and also to improve the quality of technical education, the Committee recommended a number of schemes that include development of existing institutions and establishment of new institutions. A scheme was formulated for the institution of research scholarships for the training of research workers in science and technology and of practical training stipends to enable fresh graduates and diploma-holders to undergo a stated period of practical training in industry. Some of the schemes were accepted by the Central Government and were implemented. They were the forerunners of more vigorous efforts made in subsequent years particularly during the Second Plan period to develop technical education.

Curiously, doubts were raised in certain quarters about the estimates of manpower requirements prepared by the Scientific Manpower Committee. The critics said that the estimates were rather high and that the country did not need as many as 30,000 graduate-engineers and 33,000 diploma-holders over a period of ten years. According to them, the economic development of the country was not likely to proceed on a scale as large as envisaged by the Committee nor as speedily. Later events have, however, proved that the fears were unfounded.

TARGETS FOR FIVE-YEAR PLANS

In 1955 i.e. at the end of the First Five-Year Plan, technical institutions in the country produced 4,020 graduates and 4,500 diploma-holders. The number of institutions increased to 65 for degree courses and to 114 for diploma courses. Their admission capacity also increased to 5,890 students for degree courses and to 10,480 for diploma courses. When the Second Five-Year Plan was formulated, a target of nine additional institutions for degree courses and 21 additional polytechnics for diploma courses was proposed in the Plan that would have increased the admission capacity to 7,390 students for degree courses and to 13,080 students for diploma courses. This was the order of development visualised by the Scientific Manpower Committee. There was no noticeable unemployment among engineering graduates and diploma-holders. Quite the contrary. Doubts were expressed and rightly so, that the training of manpower was not being geared to the needs of the Five-Year Plan and difficulties were likely to be encountered in pressing on with the development projects. In fact, an acute shortage of personnel was reported in certain sectors. The Planning Commission therefore appointed in 1955 an Engineering Personnel Committee to make an estimate of the requirements for manpower for the Second Five-Year Plan, and to suggest measures to meet the shortage, if any. In its report submitted in May, 1956, the Committee estimated that for the various development projects included in the Second Plan, about 26,500 graduates and 50,500 diploma-holders in engineering would be required by 1960-61. The supply from the institutions during that period would not meet the demand in full and the shortage in 1960-61 would be of the order of 1,800 graduates and 8,000 diploma-holders. According to the programme of expansion of technical education then contemplated, the admission capacity of the institutions would reach only 7,390 students for degree courses and 13,080 students for diploma courses by the end of the Plan period. The Committee stressed that unless efforts were made towards a much larger expansion of technical education than then contemplated, and the gap between the demand and supply of technical manpower bridged, the economic development of the country could not progress. The Committee recommended that the targets of technical education should be increased by 2,790 seats for degree courses and 8,220 seats for diploma courses by the end of the Plan period. To that end, a number of new engineering colleges and polytechnics should be established in the country.

In consultation with the Planning Commission the Central Government decided in 1957 to increase immediately the training capacity of existing institutions by providing additional buildings, equipment and staff. An 'Open door policy of assisting private agencies in the establishment of technical institutions was adopted. This gave a great impetus to the development of technical education as nine colleges and 23 polytechnics were established by private agencies. The plans of State Governments were revised in stages and provision was made for the establishment of ten new colleges and 52 polytechnics. Finally, it was decided in 1958 to expand technical education on a much larger scale so as to meet the demand for technical personnel not only for the Second but for the Third and subsequent Plans. For that purpose, a special scheme of establishment of eight large-sized Regional Engineering Colleges and 27 additional polytechnics was formulated and steps were taken to implement it.

The targets of technical education were revised twice during the Second Plan period and by the end of 1960-61, the new target of about 13,500 admissions for degree courses and 27,000 admissions for diploma courses was nearly reached. If our experience in the Second Plan has taught us anything, it is that an integrative and statistical approach to the problem of manpower is essential. A certain measure of audacious planning for technical education and training yields rich dividends.

With this advance preparation, no serious shortage of technical personnel is anticipated for the successful execution of the Third Five-Year Plan. In fact, the supply will keep pace with the demand. For the Fourth Plan requirements, admissions are proposed to be raised to 20,000 for degree courses and 40,000 for diploma courses by the end of 1965-66. To this end, about 19 colleges and 80 polytechnics are proposed to be established and the existing ones expanded. The new institutions include seven more Regional Colleges in order that each state should have a Regional College functioning on an all-India basis.

RIGHT PROPORTION

While on the question of supply and demand, the right proportion in which graduate engineers and diploma-holders should be trained, is an important issue. The proportion in which graduates and diploma-holders are required varies from project to project and depends on a number of factors viz., the nature of technical operations involved, extent of supervisory and executive responsibilities to be discharged by personnel at different levels, degree of mechanisation, instrumentation and automatic controls adopted etc. Nevertheless, on an overall basis for the entire field of engineering, a proportion of 1:3 of graduates and diploma-holders is generally accepted. Our institutions, however, produced in 1947 graduates and diploma-holders in almost equal numbers. That was very unsatisfactory. The position improved gradually in subsequent years and in 1959, the proportion was 1:1.6. When the new institutions now being established start functioning and train additional graduates and diploma-holders, the proportion will reach 1:1.8 during the Third Plan period. Even so, that will not be wholly satisfactory. Therefore, one of the major problems of further planning for technical education is, how to bring about a balanced development of facilities for degree and diploma courses. This is not an educational matter only, but is related to the pattern of employment of technical personnel in industry, departments of government and other organisations. The present imbalance is in no small measure due to the employing organisation demanding graduate engineers for positions that can be filled by diploma-holders adequately or entrusting to graduate engineers work and responsibilities that can be discharged by personnel with lower qualifications. In several organisations, higher positions are filled exclusively by promoting persons from lower levels on the basis of length of service. Since the higher positions require personnel with better academic qualifications, the tendency is also to prescribe the same qualifications for initial recruitment to the services, irrespective of the actual requirements of the different job levels. Therefore, unless the pattern of employment of technical personnel in many organisations is re-organised and the available technical personnel is carefully husbanded, the present imbalance will continue. A disturbing situation may well develop in which the value of technical education and training will be at a discount.

Another important measure is to create special facilities of further education for persons in service, so that when they wish to advance in their profession on the basis of experience, they could be equipped with the necessary higher training. For instance, a part-time degree course for diploma-holders, who are in service and possess a certain minimum amount of practical experience should benefit many organisations and also reduce the demand for fresh graduates from universities. Further, it will give a great incentive to the diploma-holders for better technical performance. The fresh graduates could be absorbed into positions where they are really required. Such a part-time degree course in engineering is being conducted at two or three centres but enormous scope exists for extending it to other centres where the demand for graduates is increasing.

PATTERN OF ADMISSIONS

The pattern of admissions to different courses is closely related to planning for manpower. An interesting feature of the present pattern is the relative prominence of different fields of study, which is also an indication of the state of industrial development in the country. On the basis of 1959 admissions to degree and diploma courses, distribution of seats between the various fields of technology was as follows :—

Fields	Number of seats	
	Degree	Diploma
Civil Engineering	4192	10210
Mechanical Engineering	2325	4570
Electrical Engineering	2329	4580
Electrical Communication Engineering	375	240
Mining	290	455
Metallurgy	239	10
Chemical Engineering & Chemical Technology	485	—
Aeronautical Engineering	30	—
Textiles Technology	282	311
Leather Technology	20	115
Architecture	285	—
Other fields	658	819
Total:	11510	21310

Civil engineering accounts for nearly 40 per cent of the total seats at the first degree level and nearly 50 per cent at the diploma level. Next in order are Electrical and Mechanical engineering that enjoy equal importance. This distribution is not accidental. It is the result of the development of the institutions over the past 50 years in accord with the pattern of employment of technical personnel. Civil engineering has constituted so far the largest field of activity in the country, and in terms of employment potential it has offered the largest scope for graduates and diploma-holders. Due to lack of industrial development, particularly in manufacturing industries, Mechanical Engineering, Electrical Engineering, Chemical Engineering, Metallurgy and other branches have been rather restricted in so far as employment opportunities go. However, this is changing very rapidly. The future trend will be for larger numbers of mechanical, electrical, chemical, metallurgical engineers as the industrial development of the country in these fields progresses. Such trends are already clear and a stage will soon be reached when the demand for civil engineers will settle at a level not very different from the existing provision of training facilities, and the demand for other types of engineers will steadily increase. In order to meet the latter as it arises, diversification of courses of study in the existing as well as in the new institutions has to be planned well in advance and adequate provision to be created to train in various branches.

CHAPTER 6

Technical Education: Its Administration

The organisation of technical education in India reflects characteristic features of the Indian Constitution and a strong bais in favour of central planning and co-ordination. India is a union of States that are autonomous in certain subjects that include education. The Union comprises 16 States, each with its own legislature and a government formed on the basis of universal adult franchise. It is, therefore, the primary responsibility of the States to organise, develop and administer technical education and training within their respective areas.

The constitutional position notwithstanding, the organisational and administrative set-up in many States was till recently unsatisfactory. There was no single department in the state government fully responsible for technical education and a variety of arrangements existed. In some states technical institutions were under the administrative control of Industries Departments; in some under the Public Works Departments; and in others under the Education Departments. In a few states, Industries Departments and Public Works Departments performed overlapping functions. In the same states, the Industries Department was in charge of certain technical institutions and the Public Works Department in charge of others. Each department laid down its own standards for the courses conducted by non-university institutions under its control, held examinations departmentally and awarded diplomas and certificates.

As schemes for the expansion of technical education on a large scale were formulated under the Five-Year Plans, it was realised that a unified approach to the problems of organisation and administration of institutions was necessary at the State level. More important, when a large number of institutions, especially polytechnics were established in all states, it became necessary to ensure that the institutions maintained high standards of instruction, and their examinations were conducted by an independent body on a uniform basis. The All-India Council for Technical Education, therefore, recommended that in each state there should be set up a Directorate of Technical Education in the Government and a State Board of

Technical Education. The State Board should include *inter alia* representatives of industry, commerce, universities, technical institutions and other interests concerned with technical education. It should prescribe courses of study for institutions not affiliated to universities, inspect institutions from time to time to ensure maintenance of standards, hold examinations and award diplomas and certificates. The Directorate, as the administrative agency of the government, should be in charge of the organisational and management aspects of the institutions. The recommendations of the Council have been accepted generally by all states, which have set up their own State Boards of Technical Education. In most states one single government department is now in administrative charge of technical institutions. The establishment of this new organisational set-up for technical education in the states is of great importance. It has not only helped in ensuring uniform standards on an all-India basis, but in associating various interests with the development of technical education and co-ordinating their efforts.

The concept of central planning and co-ordination has resulted in the Central Government's playing an active role in the development of technical education and training in the country as a whole. This concept is justified by several important considerations. First, in any system of planned economic development a clear perspective of the different sectors is an essential pre-requisite to action, whether at local, regional or central level. Second, when the programmes of economic development include large-sized projects for key industry, power, fuel, transport and communications etc. in the public sector, it is the primary responsibility of the Centre to ensure that the manpower required for the projects is made available. Third, on a national level, facilities for advanced technological studies and research can be organised satisfactorily only by the Centre, which has also to ensure that the institutions established for the purpose play their due role in the development of the country as a whole. Fourth, the expansion of technical education in a developing country like India involves a heavy financial outlay that is beyond the resources of the states. The Centre, therefore, has to bear a major part of the expenditure both directly and as grants to the states. Fifth, the Seventh Schedule of the Constitution places upon the Centre the responsibility for co-ordinating and determining standards in institutions for higher education or research and scientific and technical institutions.

In view of the above considerations, the Centre's role in technical education has a four-fold objective viz.

(a) to prepare an integrated plan of development of technical education for the country as a whole;

(b) to establish higher technological institutions, institutions for specialised courses and other institutions of all-India importance;

(c) to assist financially and otherwise state governments, universities and other agencies in the establishment of technical institutions;

(d) to watch over the progress of technical education and to ensure the maintenance of high standards.

These are essentially in the nature of educational leadership which the Centre has to provide.

COUNCIL FOR TECHNICAL EDUCATION

The most important machinery set up by the Central Government to provide this leadership is the All-India Council for Technical Education, that consists of representatives of all State Governments, Ministries of the Central Government, Industry, Commerce, Labour, Professional and Learned Societies, Universities, Technical Institutions, Parliament and various other interests concerned with technical education. As a national body, the All India Council advises the Centre, the states, University Grants Commission and other authorities on all aspects of improvement and development of technical education. Its functions include *inter alia*, the preparation of plans for the development of technical education on an all-India basis; to assess the requirements for technical manpower of different types and to suggest measures required to meet them; to suggest improvements in the pattern of technical education from time to time to suit changing conditions; to establish liaison between industry, government departments and other organisations, on the one hand, and technical institutions, on the other; to co-ordinate the activities of State Boards of Technical Education; to recommend grants and other forms of assistance that may be given by the Centre to the states, universities and other organisations in the development of technical education. Presided over by the Minister of Scientific Research and Cultural Affairs and with the Ministry of Scientific Research and Cultural Affairs as its secretariat, the Council functions with fewer handicaps than most other advisory bodies, whose relations with the administrative authorities are not so very closely knit and whose recommendations are subject to further examination. As a matter of convention the recommendations of the Council are accepted by the Central and State Governments. The fact that technical education is not a controversial subject has facilitated the work of the Council.

For the correct discharge of its functions the All-India Council for Technical Education has set up a Co-ordinating Committee, four Regional Committees and seven Boards of Technical Studies. The Co-ordinating Committee is the Executive Committee of the Council and co-ordinates the work of the Regional Committees and Boards of Studies.

The importance of Regional Committees in promoting a co-ordinated development of technical education in the different parts of the country cannot be overemphasized. The vastness of the country explains the number and variety of problems of development that require to be examined in the light of conditions and needs of each region. Schemes for the establishment of new and improvement and development of existing institutions have to be formulated and implemented on a regional basis. A constant watch over the progress of institutions, spread over the whole country, has to be maintained and expert advice and assistance to them have to be provided. These and other tasks can be performed satisfactorily only through appropriate regional agencies specially set up for the purpose and working in close co-operation with local authorities.

The four Regional Committees of the All-India Council for Technical Education deal with the following areas :—

Northern Region: Jammu & Kashmir; Himachal Pradesh; Punjab; Rajasthan; Delhi; Uttar Pradesh.

Eastern Region: Assam; Manipur; Tripura; West Bengal; Bihar; Orissa; Andaman & Nicobar; Nagaland.

Western Region: Maharashtra; Madhya Pradesh; Gujarat.

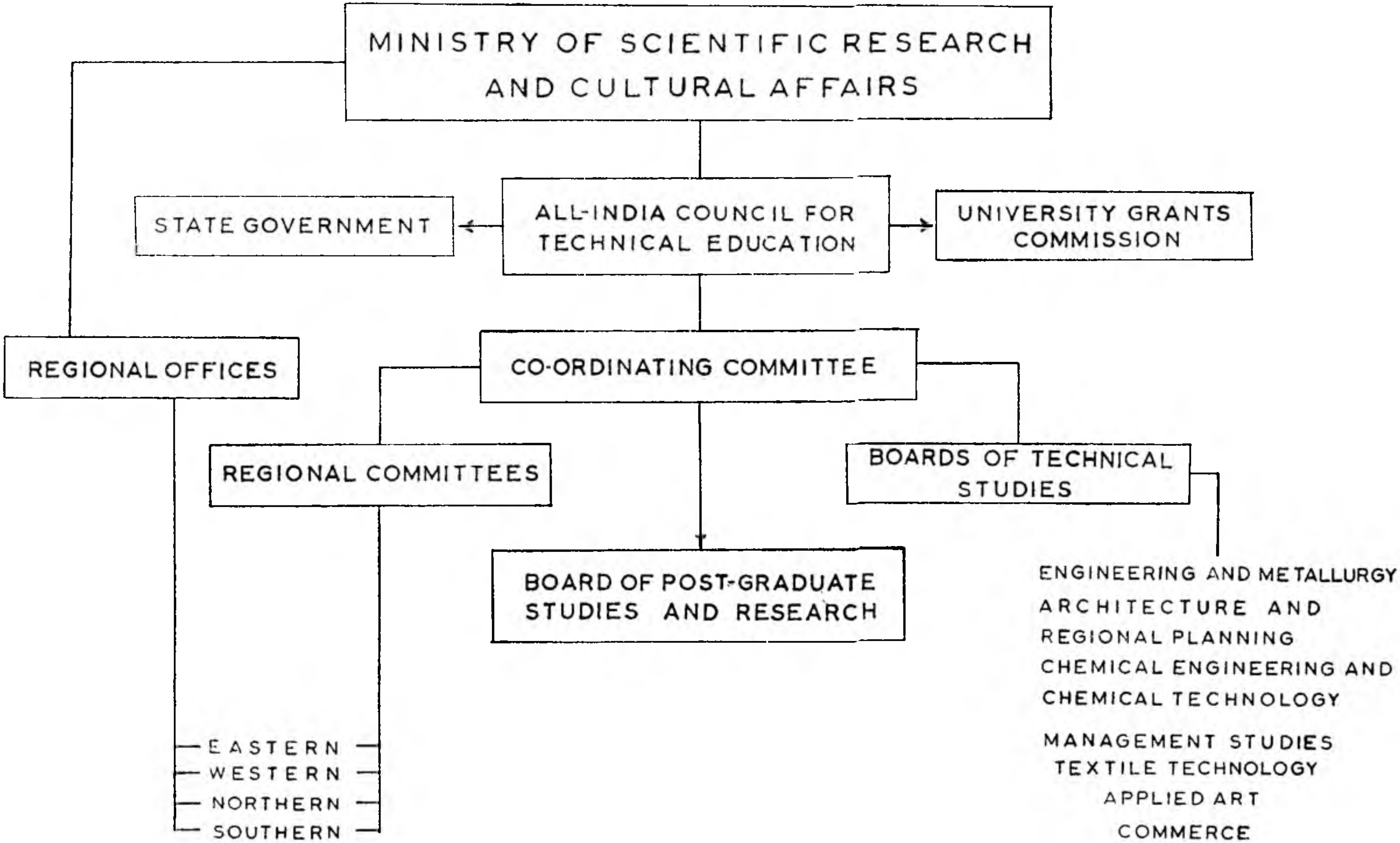
Southern Region: Mysore; Madras; Andhra Pradesh; Kerala & Pondicherry; Laccadive; Minicoy & Aminnidevi Islands.

Each Regional Committee consists *inter alia* of representatives of the state governments within its area, representatives of industry, commerce and labour, technical institutions, State Boards, universities and experts. Constituted in this manner the Committees are fully representative of all authorities and interests concerned with technical education in their respective areas. Their main functions are :—

(a) to survey facilities for technical education at all stages and to make recommendations on the development of technical education, including the establishment of new institutions wherever necessary;
(b) to make a preliminary examination of any institution seeking recognition;
(c) to tender advice and guidance to technical institutions within the region;
(d) to promote liaison between technical institutions and industry;
(e) to assist the states and institutions in securing practical training facilities.

The Boards of Technical Studies advise the All-India Council on all academic aspects, viz. the pattern of technical education, duration, standard and contents of courses, admission requirements etc. They also lay down the

ORGANISATIONAL STRUCTURE FOR TECHNICAL EDUCATION



minimum standards of instructional facilities required for the conduct of various courses by technical institutions. The seven Boards that have been set up deal with the following fields :—

Engineering & Metallurgy
Chemical Engineering and Chemical Technology
Textile Technology
Architecture and Town Planning
Commerce
Management
Applied Art and Crafts.

In addition to representatives of technical institutions, universities, industry and commerce, each Board has experts appointed by the All-India Council in order to bring to bear on the work of the Boards, expert knowledge and guidance in various fields. In the 14 years that the Boards have functioned, much valuable work has been done in formulating courses of study in various branches, on an all-India basis that have served as a guide to technical institutions. The standards of instructional facilities like buildings, equipment and staff suggested by the Boards have formed the basis on which the Regional Committees assess the requirements of institutions and recommend grants. The Boards have also advised the Council from time to time on specialised courses to meet the needs of industry and commerce and formulated various schemes for the purpose.

Thus, with a Co-ordinating Committee, four Regional Committees and seven Boards of Technical Studies, the All-India Council for Technical Education has become a most effective national body for technical education in the country. Recently, a Board for post-graduate studies and research has also been set up.

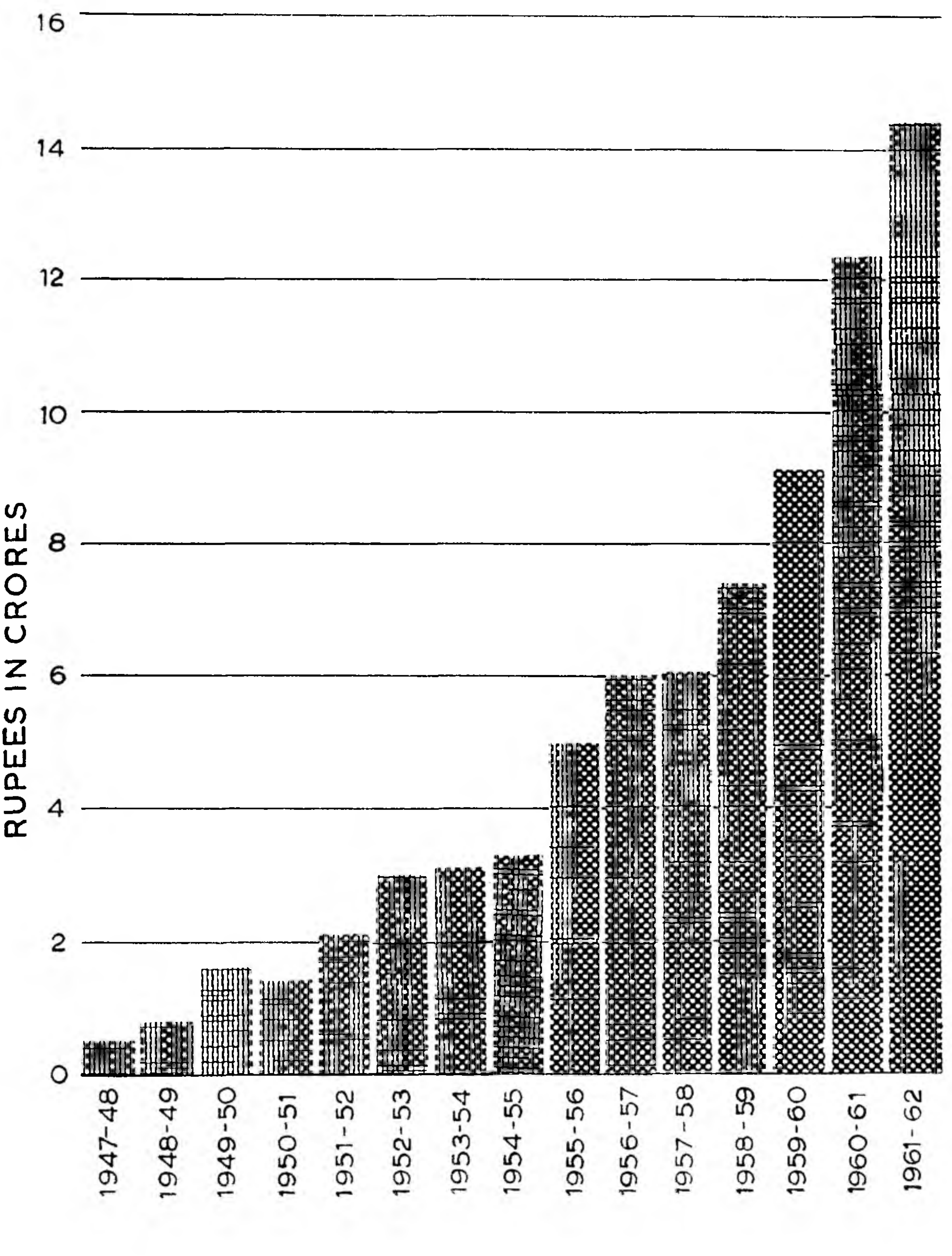
The University Grants Commission set up by the Central Government in 1956 is concerned with the co-ordination of standards and development of university education as a whole. Where technical education at universities is concerned as, for instance, post-graduate courses and research, first degree courses etc., the Commission acts on the advice of the All-India Council for Technical Education. This has ensured a unified approach to technical education in all sectors.

In the Ministry of Scientific Research and Cultural Affairs, there is a separate Division for technical education to assist in the formulation and execution of policies and programmes. The existence of advisory and administrative functions in the same organisation is a feature characteristic of the Ministry and one that has made for much progress in technical education. The Division has also four Regional Offices, at Calcutta, Bombay, Kanpur and Madras whose respective territorial coverage corresponds to that of the Regional Committee of the All-India Council. Working in close association with the state governments, and as secretariat to the Regional Committees, the offices are concerned with actual field work and provide the much-needed link between the Centre and the States. Among their more important functions are making arrangements for the practical training of graduates and diploma-holders; keeping a close watch over the progress of development schemes approved by the All-India Council for Technical Education; providing assistance to technical institutions in various matters; ensuring the correct utilisation by institutions of funds provided by the Centre.

PROGRESS OF TECHNICAL EDUCATION IN INDIA

(1947–62)

CENTRAL GOVERNMENT'S EXPENDITURE



CHAPTER 7

Financing Technical Education

The expenditure on technical education reflects not only the progress achieved in the field but also the organisational structure. Prior to Independence, the expenditure of the Central Government on technical education was negligible, and the bulk of the finances required was provided by the States and this was meagre. The contribution of private agencies was also negligible. As the Centre's initiative in the development of technical education grew, the Central Government has provided funds in an incrasing measure every year, not only for its own institutions but as aid to State Governments and private institutions. There was a corresponding increase in expenditure on the part of the State Governments and private agencies. Today, finances for technical education as a whole are derived mainly from these three sources viz., the Central Governments, State Governments and private agencies.

The first great fillip came with the First Five-Year Plan. During that Plan period the Centre provided about Rs. 163.3 m. for technical education. A much larger outlay, viz., Rs. 400m. which is more than twice that in the First Plan was provided for the Second Plan. These amounts include both developmental and normal expenditure. So far as the States are concerned, the outlay during the First Plan was of the order of Rs. 70.0m. and about Rs. 266.6 m in the Second Plan, exclusive of the assistance received from the Centre.

Exact figures of the expenditure incurred by private agencies are not readily available, but it is estimated that this sector has contributed on an average about Rs. 5.0 m. *i.e.* Rs. 50,00,000, per year in the last three to four years.

The importance of technical education to the national plan is further underlined by the fact that a much larger outlay is being made in the Third Five-Year Plan. According to the present estimates, an amount of about Rs. 1450m. is proposed to be spent by the Central and State Governments on the expansion of technical education at all levels.

RISING COSTS AND ECONOMY MEASURES

The increasing outlay on technical education is not entirely due to the establishment of an increasing number of institutions and a similar quantitative expansion of the facilities. It is in part due to the fact that the cost of technical education is rising sharply. No reliable data are available regarding the cost of establishment of an engineering college or polytechnic prior to 1948, since few, if any, new institutions, were then established. Also, no standards of instructional facilities required for degree or diploma courses in various subjects were laid down. On the basis of the standards now laid down by the All-India Council, an engineering college with an annual admission capacity of 120 students for Civil, Mechanical and Electrical engineering costs today over Rs. 4.5m for buildings and equipment alone. The cost of land and its development for the establishment of the college, providing essential services, hostels, staff quarters, etc. are all extra. The running expenses of the college are of the order of Rs. 0.8m per year, if the salary scales recommended by the All-India Council are offered to the staff. Not more than 25 per cent of the running expenditure is met by the income from tuition fees. Similarly, the cost of polytechnics also has gone up and is of the order of Rs. 1.8—2.0m for buildings and equipment and Rs. 300,000 per year for recurring expenditure. When courses in special fields as, for instance, Mining, Metallurgy, Chemical Engineering etc. are added to a college, the cost goes up further.

A major financial and organisational problem confronting planners therefore, is how to bring down the cost without sacrificing standards. The problem is twofold. The first involves a consideration of the *per capita* expenditure. If the *per capita* expenditure is brought down by making an institution work longer hours and train a larger number of students, a quantitative expansion of the facilities can be secured at less cost than otherwise. An attempt in this direction has already been made during the last four years and the training capacity of a number of institutions has been expanded in preference to new institutions being established for the additional number of students. The same principle is being extended to new programmes, a substantial part of the Third Plan targets are proposed to be reached through an expansion of the existing institutions.

The second aspect involves the development of an indigenous scientific instruments industry. According to the present estimates, at least 50 per cent of the equipment required by an engineering college and 30 per cent of the equipment required by a polytechnic have to be imported. The prices of imported equipment are rising steeply and in the last three years alone, the prices of many items have gone up by about 50 per cent on an average. Apart from foreign exchange difficulties, such a large increase in the prices can upset completely the targets of a plan. The institutions will be hard put to, to equip themselves fully within the allotted funds. The solution to the problem lies in the development of an indigenous industry and by making the country self-sufficient in essential scientific equipment of quality and precision. The institutions should be encouraged to make in their own workshops as many items as possible of equipment required by them. An expert Committee of the All-India Council has gone into this question and suggested measures to secure economy in equipment for technical institutions.

There is also the question of buildings that account for 50 per cent of the capital cost of a technical institution. Good laboratories, classrooms, drawing halls, library, workshop and other facilities are, no doubt, necessary. But, grand and expensive buildings constructed with an eye to architectural impressiveness are not synonymous with good institutions. The expenditure on building should be reduced to the barest minimum possible by adopting purely functional and economical designs as also by employing modern construction techniques. We need to revise our order of priority, to give the first place to staff, the second to equipment and only the last to buildings.

FOREIGN AID

No report on Technical Education in India would be complete without a reference to Foreign Aid, that has played no small part in the recent developments in this field. The aid has been given by many countries generously and in a spirit of co-operation and has been readily accepted by India. It consists of scientific and technical equipment, and library; the services of expert professors in various branches of technology; and facilities for the training of the teachers of our institutions abroad. These are the three essential things that we need for the establishment and development of institutions of advanced technological studies.

Foreign Aid first came under the Unesco Programme. Since 1951 this aid has been extended every year for developing facilities for advanced studies and research at selected centres. Aid under other programmes, as, for instance, U.S. Agency For International Development, Colombo Plan etc., followed in increasing measure. Recently, under bilateral and other arrangements, very large assistance has been provided by certain countries in the establishment and development of entire technological institutions. Special mention must be made of the assistance provided by the U.S.S.R. for the Western Higher Technological Institute at Bombay; by the Federal Republic of Germany for the Southern Higher Technological Institute at Madras; by the United Kingdom for the College of Engineering & Technology at Delhi; and by the U.S.A. for the Higher Technological Institute at Kanpur. It is the valuable aid of these countries that will accelerate the establishment and development of these important institutions.

The extent of Foreign Aid provided or promised so far, for technical education in India is as below:

(a) Number of experts :	245
(b) Equipment:	Rs. 55.0 million
(c) Number of Fellowships for the training of teachers abroad :	607

In addition, at least about 200 teachers have been trained or are under training on fellowships offered by various countries under other programmes. This is exclusive of aid given by certain countries such as the USA, Canada, etc., for rupee-expenditure on certain projects of technical education.

CHAPTER 8

Practical Training

The practical work done by students of technical institutions is an integral part of their training in becoming engineers and an important pre-requisite to successful technical studies. It serves many purposes. It acquaints students in practice (depending upon their field of study) with the production of materials, their moulding and processing, as well as with the finished products in composition, structure and mode of action. In addition, it familiarises them with the testing of a finished workpiece and with the assembly of machines and apparatus, installation on the site, and control. In Civil Engineering, the training has to deal with actual construction methods and techniques, stability and strength of structures and various other aspects relevant to that field. This is also true of other engineering fields in which appropriate to each of them the training has to deal broadly with the processes and techniques, operations and controls, the functioning and capacity of machines, all geared to the attainment of a pre-determined objective.

THREE-FOLD OBJECTIVE

According to this, the practical training has to fulfil three tasks. First, to acquaint the student with the production or construction methods. The training, for which only a limited time is available (contrary to conditions in the training of specialist skilled workers), has to be systematic so that the trainee may become acquainted with a whole range of methods and thus gain wider experience. The trainee should also try to understand the principles underlying the various methods of production and extend his knowledge in that field. The training of specialist skilled workers and the practical training of students of engineering, are quite different things. The purpose in training the former is to impart to them the manual skill that is required in their occupation and that is acquired by repeatedly practising on the same workpiece. The training of an engineering student, on the other hand, is intended to show him how the same final shape of a workpiece can be produced by means of different methods in accordance with constructional requirements. The workers' training is intensive; the students' practical training is more extensive, although the latter cannot dispense with a certain degree of manual skill. The knowledge and experience which he gains during his practical training are essential later on, to his professional work.

Next, the prospective engineer must become acquainted with works organisation which governs the structure and functioning of a factory. Third, the trainee should get to know the Works Community; the sociological problems of that community; the worker as an individual, his strivings, his urges and his psychology; and the relationships between labour and management.

Only when an engineering student has completed a definite programme of practical training on these lines, can he be regarded as possessing the minimum experience required for entry to the profession. The young medico has to 'walk the wards' and serve a minimum period of internship in a hospital before he is qualified to enter the medical profession. Even so the engineer in his field.

FORMS OF TRAINING

The way in which practical training is given to engineering students varies from country to country. In Germany every student has to serve as an apprentice in industry for a minimum period of six months before he is admitted to a technical university. While at the university, he works as an apprentice in industry during his vacations. Apprenticeship after graduation is also a common feature. The university has no workshops of its own for the preliminary practical training of students, which is looked after by industry. In the U.K. and U.S.A., although a preliminary practical training of six months is not prescribed generally as an essential requirement for entry to technical institutions, the institutions assume no responsibility for giving such training during the course in their workshops. The students have to undergo the necessary training in industry during the vacation or as graduate apprentices after their studies. The institutions, however, assist students in obtaining the necessary training facilities in industry. This system has worked well since, in these countries, organised facilities exist for practical training and apprenticeship schemes are an important feature of industrial organisations. The time spent by a student at the institution is devoted entirely to his course of studies which comprises theoretical and laboratory work and drawing.

In India, the situation is very different. For many reasons, particularly the absence of organised practical training and apprenticeship facilities in industry, technical institutions have had to establish their own workshops where the students could be given necessary preliminary training during the course. The degree and diploma courses have, therefore, been so designed that their curriculum includes workshop practice. Depending upon the particular branch of engineering chosen by him, a student spends from 20 per cent to 35 per cent of the course time on workshop practice.

This position has raised two important issues. First, how far should workshop practice, that does not strictly constitute academic studies, cut into the course work of a student for degree or diploma? Second, should a technical institution spend large sums in the establishment of training workshops, when that amount could be better utilised for scientific equipment for the laboratories and research work?

Both questions would be valid if conditions in India were different, and alternative arrangements could be made for the workshop training of technical students. As explained earlier, such training facilities provided in industry are extremely limited and generally not organised on satisfactory lines. Until the situation improves, and industry not only expands but is made to accept apprenticeship as its own responsibility, existing technical institutions have necessarily to continue to provide workshop training within the curriculum of the courses, under their own auspices.

At this stage, a better and more economical way of organising workshop training might be suggested. Instead of giving each technical institution its own training workshop, central workshops could be set up at selected places where the students could undergo the necessary training before joining technical institutions, or during their vacations or both. Such central workshops can serve specific areas or specific groups of institutions. The advantages of this arrangement are many. First, a central workshop can be better equipped for the same amount as is required for a group of institutions each with its own workshop. The better the equipment the better the standard and the wider the scope of training. Second, in actual practice, the workshop of an engineering college or polytechnic is utilised effectively in the training of students only up to a maximum of 40-50 per cent of the total time for which the workshop could work in a year. That is due to the requirements of the time-table of the various courses of study conducted at the institutions, interruptions due to vacations and so on. There are no such limitations in the working of a central workshop and therefore, a larger number of students can be trained with the same facilities, than is otherwise possible. Third, experience in Germany, U.K. and elsewhere shows that if students joined technical institutions after a preparatory workshop training, they could do their courses better, and the entire time available could be devoted to academic studies. Fourth, a central workshop with an organisational frame-work different from institutions and with better facilities could simulate the actual conditions of a factory and thereby impart to students practical training in such aspects, as production methods and techniques etc. If the principle of preparatory workshop training at a central workshop is accepted, the duration of the actual courses at the institutions for degree or diploma could be reduced. Any additional training required by the students for a successful completion of the studies could be given during the vacations in the Central Workshop.

POST-INSTITUTIONAL TRAINING

Workshop training prior to or during technical studies is only one aspect of practical experience. The other, and perhaps more important consideration is the actual practical training in the field that every engineer or technologist should have in order to enter his chosen profession. That training is generally taken by a candidate after he has completed his academic studies at the technical institution. The duration of the training varies from subject to subject, but it is generally accepted that a two-year apprenticeship at a factory or similar organisation is necessary if a graduate or diploma holder has to be conditioned for gainful employment in his profession.

Prior to 1949, organised apprenticeship facilities for graduates and diploma-holders were available in industry or government departments on an extremely limited scale. Even where such facilities were provided by the organisations at the specific request of the candidates or their institutions, the training was generally not supervised; nor, were the trainees paid a stipend. The candidates were left to fend for themselves and that reduced enthusiasm for practical training. There were, of course, exceptions where some industrial concerns did offer practical training under proper supervision, but generally the position was far from satisfactory. The Scientific Manpower Committee that examined the matter from the standpoint of supply of trained technical manpower for various development projects recommended that the Central Government should assume a primary responsibility for arranging practical training of graduates and diploma holders. The Central Government accepted the recommendation and in 1949 formulated a scheme of Practical Training Stipends and initiated it.

Under the scheme, practical training places are secured in industrial concerns, technical departments of the Central and State Governments and in other organisations where graduates and diploma-holders can learn in practice the application of the general principles and techniques of technology in their chosen fields as also the organisational and human relations aspects of industrial enterprise. The duration of training varies from a year to two depending upon the particular fields and the establishments covered by the scheme. The programme of training is generally drawn up in advance in consultation with the establishment and every effort is made to follow it. During training, a graduate is paid a stipend of Rs. 150 p.m. and a diploma-holder Rs. 100 p.m. to enable them to meet expenditure on board and lodging.

In the last ten years, the scheme has been gradually expanded both in the number of training places and the range of fields of training. There are at present over 2,000 training places available every year for fresh entrants in about 500 establishments, that include industrial concerns in the public and private sectors, railway workshops, defence organisations, power projects, transport and communications organisations etc. An important feature of the scheme is that a large number of industrial concerns in the private sector not only provide the necessary training facilities but contribute towards a part of the expenditure on the stipends. The contribution varies from concern to concern, but is generally between 40 and 50 per cent of the expenditure.

Since the training establishments are located at large cities or industrial areas, accommodation for the trainees, who come from every part of the country, is a major problem. An attempt is, however, made to construct hostels, wherever possible by advancing interest-free loans to industrial concerns and other organisations for the purpose.

The Practical Training Stipends Scheme is not in itself a complete answer to the problem of professional development of fresh graduates and diploma-holders. The maximum number of training places secured so far under the scheme is about 2000 as against the present output of about 7030 graduates and 10350 diploma-holders from all technical institutions. It is true that a certain number of the graduates and diploma-holders as soon as they leave the institutions secure jobs and the employers concerned give them the necessary practical training as a kind of in-service training. It is also true that because of the present unusual demand for technical personnel, fresh graduates and diploma-holders without practical experience are able to get jobs and, therefore, all the training places available are not always fully utilised. Nevertheless, unless a graduate or diploma-holder has had a broad-based practical training in his field, he is not developed professionally and he is not fit to be employed in any responsible supervisory or executive position. Therefore, when the demand and supply of technical personnel reaches an even level, a one to two-year practical training has to be made compulsory for all graduates and diploma-holders. Then, a national apprenticeship scheme becomes necessary that will require every industrial organisation to provide facilities for practical training commensurate with its size. A National Apprenticeship Act has just been passed by Parliament mainly for the training of skilled workers but, the Act also makes some provision for the training of graduates and diploma-holders.

CHAPTER 9

The Technical Teacher

The heart of every educational institution is the teacher. It is the quality of staff that in the final analysis makes for the success of an institution. This is even more so for a technical institution where the nature of studies makes close contact between teacher and taught imperative, and demands of the former academic excellence and professional competence.

A serious problem confronting all our institutions today is the shortage of teachers, that has been variously estimated as ranging from 40 per cent to 50 per cent of the required strength. In certain categories the shortage is said to be as high as 60 per cent in a number of institutions. Not merely the existing shortage, but the fact that it will increase as new institutions are established and existing ones expand, causes concern. The difficulty in obtaining staff of the right calibre and in the required numbers is a serious check to the further development of technical education. If in spite of this new institutions are established in large numbers, we run the risk of lowering standards of education and training. This should be avoided at all costs. It is better to train one competent engineer than five inadequate ones. In fact, several educationists hold the view that all further expansion of technical education should be stopped till the staff position at existing institutions has been improved.

The problem of shortage of staff is a complex of various factors. First, the teaching profession is not financially as attractive as industrial or departmental career, which offers far better opportunities of professional advancement, better salaries and what is erroneously regarded a superior 'social status'. The wide disparity between salaries of teachers of technical institutions and professional engineers in government departments is not just an accident of history. It is the result of a deliberate view held over a long period that the latter are more important to the economic and social life of the country. The difference is so marked that till recently, the salary of a professor of engineering in a large number of institutions was half that of a superintending engineer in the Public Works Departments; and a lecturer was considered less valuable than an assistant engineer. In these circumstances, it is hardly to be expected that well-qualified and competent engineers would prefer to work as teachers than as professional engineers.

The second factor is that no organised effort has been made by the institutions themselves to attract bright young graduates to the teaching profession when their ideas are just being formed, to train them further and to offer them suitable positions on their staff. Instead, they depend on the market supply, which more often than not fails them. Good teachers have to be created through a long process, wisely planned on the same lines as the investment policy of an industrial or commercial organisation. That is essentially a responsibility of the institutions themselves.

The third factor is that few technical institutions are involved continuously with industry, technical departments of governments and other organisations. They tend to function in isolation from each other. It is only when an institution builds up a living contact with industry that it is able to attract experts in industry as part-time teachers initially and later on, in full-time teaching positions. The part-time staff not only helps to fill vacant positions that cannot otherwise be filled, but brings to bear on the teaching a quality that only professional experience in the field can supply. To that extent, the standards of education and training are bound to improve. There are always persons in industry who at some time or other in their career show a genuine interest in 'academic' work and could be won over to technical institutions.

There are several other factors, as for instance, lack of housing for staff and other amenities, an over-whelming demand for well-qualified engineers in industry and other organisations, inordinate delays involved in the recruitment procedures etc., that have contributed their share, large or small, to the present serious staff shortage.

IMPROVED SALARY SCALES

The problem has to be solved by the collective effort of all concerned, the Central Government, State Governments, Universities and institutions. A uniform policy for all institutions has to be adopted. The most important step taken by the Central Government is to accept revised salary scales for teachers of all technical institutions that compare favourably with the salary scales of technical personnel in Government departments. It has also agreed to bear the entire additional expenditure involved for a period of five years in the first instance. The revised salary scales provide for a uniform improvement as shown below:

(a) *For institutions conducting first degree courses:*

(i) Principal or Head of Institution:	The Salary scale should be the same as for the Chief Engineer in the State Public Works Department.

(ii) Professors	:	The salary scale should be the same as for the Superintending Engineer in the State Public Works Department.
(iii) Assistant Professors	:	Rs. 600-40-1000-50/2-1150.
(iv) Lecturers	:	Rs. 350-350-380-380-30-590-30-770-40-850.
(v) Associate Lecturers	:	Rs. 300-25-500-30-560.
(b) *For Polytechnics:*		
(i) Principal or Head of Institution	:	Rs. 800-50-1250.
(ii) Heads of Departments	:	Rs. 600-40-1000.
(iii) Lecturers	:	Rs. 350-350-380-380-30-590-30-770-40-850.
(iv) Instructors (Senior scale)	:	Rs. 260-10-300-15-450-25/2-500.

The salary scales prescribed for Assistant Professors and Lecturers in all degree institutions are uniform. It is in these categories that the largest migration of persons takes place from one institution to another or from institutions to industry and government departments. By making the salary scales uniform, the migration could be minimised. Also, the revised salary scales compare favourably with Class-I senior and junior scales respectively of the Central Engineering Services. The same general principles govern the sanction of uniform scales for Principals, Heads of Departments and Lecturers of Polytechnics.

At the level of Principals and Professors of engineering colleges, parity with Chief Engineers and Superintending Engineers of the concerned Public Works Departments has to be accepted. The migration of Principals and Professors from one region to another takes place only on a very limited scale. Perhaps, because they are older implying domestic and other responsibilities; greener pastures far from home do not attract them. Parity with the scales of Chief Engineers and Superintending Engineers ensures that the opportunities of advancement that the Principals and Professors would have had, had they joined the departments, are not denied to them. It also offers attractive enough terms to engineers in service to join technical institutions as teachers.

The importance and urgency of adopting the revised scales at all institutions need no underlining. Even if the outlay on equipment and buildings has to be reduced in order to meet the additional expenditure on staff salaries, that is well worth doing, since richer dividends can be expected in the long run.

TEACHER TRAINING

The mere offering of higher salaries is not by itself a complete solution to the problem of staff shortage at technical institutions. The problem has to be tackled from many directions, the most important of which is continuously to train and create a cadre or pool of Technical Teachers. The Central Government initiated in 1959 a scheme of training of technical teachers at five selected centres. About 240 young graduates have so far been selected and sent for training at the Indian Institute of Technology, Kharagpur, Bengal Engineering College, Sibpur, Roorkee University, Engineering College, Poona and Engineering College, Guindy, Madras. The programme of training that extends over a period of two to three years covers three distinct aspects viz. a course of advanced studies or research in a selected branch; participation in actual teaching work of the college as understudy to a professor including a course in educational psychology and practical training in industry. The course of advanced studies or research is intended to give the teacher-trainee a depth of knowledge in his own field, an essential qualification of a good teacher. As an understudy to a professor, the trainee is introduced gradually to actual teaching work for the under-graduate classes and is made to participate in lecturing, supervision of laboratory practicals, tutorials and other aspects of work of a regular teacher. This is a sort of 'Practice-School' method in which the trainee gains actual teaching experience under supervision. This experience is supplemented by a course in pedagogy specially organised for the purpose. Part of the time, especially the vacations, is spent in industry or a technical organisation to acquire the necessary practical experience in the field that makes of an individual a good teacher.

Each teacher-trainee is paid a stipend of Rs. 350-25-400 during training and is also assured of a position on the staff of technical institution after the training.

This integrated programme of Teacher Training will produce a fresh pool of teachers from which both existing and new institutions could draw their future staff. It is necessary to develop the programme in the coming years and train larger numbers of persons as teachers, not only for engineering colleges but for polytechnics. The details of the training for the latter have, however, to be adjusted to the requirements of polytechnics.

In addition to training within the country, a large number of persons, who are either working as teachers or are sponsored by technical institutions has been sent to the U.S.A., U.K., U.S.S.R., West Germany and other countries for training under various Foreign Aid Programmes. Over 600 teachers have so far been trained or are under training abroad.

Another measure necessary for the improvement of the staff position is that the recruitment policy of technical institutions should be revised and made more flexible. At present institutions generally create only as many posts as are strictly required each year for the teaching work. They rarely plan ahead by anticipating their future requirements for staff, create the necessary positions in advance, recruit potentially suitable persons, train them and employ them. The existing arrangement would work if there were a steady supply of trained teachers at all times. Where this fails, the demand as it arises remains unmet and the shortage of staff is felt keenly. The institutions should therefore look beyond their immediate requirements and follow a more progressive recruitment policy.

Housing for teachers is becoming a matter of increasing concern to educational administrators and institutions alike, who hold the view that in the absence of this essential amenity the prospects of attracting well qualified persons to teaching positions are very restricted. Also, the nature of work of technical institutions seems to require residential staff. On several occasions in the past, the All-India Council has stressed the problem of housing and recommended that institutions should be assisted in the construction of staff quarters. Owing to inadequate financial resources, however, the recommendation has not so far been implemented. It is estimated that to provide residential accommodation to 25 per cent of the staff, over Rupees 50 m would be required. That is large by comparison with the estimates of cost of other aspects of technical education. Nevertheless, if the problem of housing for technical teachers has to be solved in the larger interests of technical education as a whole, some priority must be given to this matter in allocating resources in the Third Five-Year Plan.

PROFESSIONAL DEVELOPMENT

A last word about teachers of technical institutions. We may offer the most attractive salaries possible; provide residential accommodation and create other amenities of life. No teacher is worth any of these unless he is not only knowledgeable in his own subject but also a competent engineer. It should be his constant endeavour to improve both his academic scholarship and professional experience. Teaching out of texts that he studied as a student is dead work. Nothing survives but what is alive and adapts itself dynamically to living conditions.

In all first-rate technological institutions elsewhere in the world, a good teacher is engaged constantly in research, in industrial or professional consultative work and in many other activities that bring him into close contact with the current developments in his own field. It is this primary activity that keeps him a living force in the institution, raises the standard and improves the quality of his teaching work. At technical universities in Germany, professors as a rule work as industrial consultants. Even their selection as professors is made *inter alia* on the basis of their standing in the professional field. In fact, it is through the association of their professors with industry that the universities are able to secure large sums for laboratories, special research facilities etc. and not depend upon the State to provide them. Similar arrangements are a common feature of all institutions in other advanced countries.

The position in India has yet to be improved in this direction, and the rules of service in government and non-government institutions which are inhibitive have to be changed. A deliberate effort should be made by technical institutions to encourage their teachers to work on research projects sponsored by industry and to accept professional consultative work. For its part, industry, including technical departments of government should refer its problems requiring research investigations and design, production and construction problems to institutions and pay for the services rendered by the institutions or the professors concerned. They should also invite the teachers to spend stated periods in their own organisation; extend to them the facilities and opportunities whereby they may enrich their professional experience and stimulate them to work on and find solutions to technical problems.

All these are rendered possible by mutual understanding and co-operation between technical institutions and industry. A mental revolution in both is what India needs badly today.

CHAPTER 10

The Technical Student

If the pattern of courses, organisational structure, staffing, equipment, buildings etc. are all important aspects of technical education, equally important, if not more so, is the student himself. Ultimately, it is he who has to benefit from the educational facilities created at great cost and effort. His selection and admission to the course of his choice, his residence, cost of education, welfare etc. are all important questions. They affect the quality and standard of the future engineers and technicians.

In the last eight to ten years, a revolutionary change has taken place in the attitudes and values of the student community in the country. It is now the ambition of many students going up to university to secure admission to an engineering college and become engineers. The reasons are not far to seek. The attraction of a technical career in life with the higher economic status or earning power implied, as also the higher store set by the engineering profession are the main reasons. The ambitions of parents, the more pronounced for age and experience, set a high premium on engineering education for their children. The frantic efforts made by tens of thousands of young students each year to secure admission, bear ample testimony to the importance given to technical education in present-day Indian society. For every seat at an engineering college, there are expectedly at least ten qualified applicants. In this great rush for admission, how are the institutions to select the best students?

METHODS OF SELECTION

The methods followed in the selection of students vary from institution to institution. Some institutions select candidates on the basis entirely of the marks secured by them at the qualifying examination viz. Intermediate in Science or Higher Secondary. Some throw in an interview or *viva* which lasts from three to ten minutes for each candidate, but otherwise depend on the performance at the qualifying examination. Others again hold an admission examination of their own both with or without *viva* and select on the basis of the performance of candidates at this examination. The reason advanced for a separate admission examination is that the standards of the qualifying examinations of Universities or State Boards of Secondary Education vary widely and when students who have passed these examinations apply to the same institution, the institution is hard put to to adopt a uniform standard of assessment of the applicants. A separate admission examination at which the *inter se* merit of the applicants could be judged on a uniform basis is therefore necessary.

There is not much to be said either in favour of or against any particular method. The question is one of each institution selecting as many candidates as the seats available out of a group of eligible applicants. Until a few years ago, this did not present a serious problem either to the institutions or to the candidates. The number of engineering colleges was small and the attempts of the applicants were confined mostly to institutions in their own states. Recently, with a large increase in the number of institutions, some of which are making admissions on an all-India basis, and a great rush for seats, the problem has assumed different dimensions. The position today is that a candidate for admission to an engineering course generally takes many tests and many interviews. He can avoid such multiple tests and interviews only if he decides to take his chance at only one institution. Such a decision requires not only great self-confidence but also a knowledge of the possibilities regarding admission to various institutions which a young student cannot generally be expected to have.

So far as the institutions are concerned, their difficulties have increased. Their main concern should be to admit students of the right calibre according to certain definite and uniform standards. If each one of them conducts its own admission examination, it has to make the necessary arrangements at a number of centres to suit the convenience of the candidates. Its programme of examinations may clash with those of other institutions and this may lead to various complications. Even after making a first selection of candidates, the institution is not always sure that all of them will join since some candidates delay till the results of selection at other institutions where they have tried to obtain, are known. The institution is, therefore, forced to extend the last date of joining in order to ensure that all the seats are filled.

In order to remove these various difficulties of both students and institutions and to ensure some uniformity in the standards of admission, the All-India Council recommended some time ago that a common admission examination should be held for all institutions which could be taken by any eligible student. The examination should be held on a regional basis through regional boards set up for the purpose and the standards should be co-ordinated on an all-India basis by a Central Co-ordination Board. On the basis of the results of this common examination, individual institutions should select candidates from among those who have applied for admission to them.

Unfortunately, this important recommendation has not found favour with institutions under the control of State Governments, Universities and other authorities. The All-India Council has therefore recommended that pending a final decision on the question of a common entrance examination at least within a State selections to all institutions should be made on a uniform basis and for that purpose, a single Selection Board should be set up. The seats of all institutions should be pooled and admission should be made through the State Selection Board. This has been accepted by several States which regulate admissions to institutions within their respective areas through a single Selection Board.

A Common admission examination is, however, being held for all the Higher Technological Institutes. This at least represents some progress made towards ensuring uniformity of the standards of admission to these important all-India institutions. It is hoped that in the larger interests of students and technical education all institutions will accept the scheme of common examination, before long.

APTITUDE TEST

The question of an 'Aptitude Test' for admission to technical institutions has often been discussed by various committees, and individuals, but opinion remains sharply divided. Those in favour of it suggest that if, in addition to academic suitability, the candidates are proved to have an aptitude for engineering studies, the wastage during the course could be minimised. Those who do not favour it question, not the principle but the practicability of conducting such a test in the present circumstances. They point out that at least for higher engineering studies no reliable and objective aptitude tests have been designed so far and if tests on an *ad hoc* basis that involve several subjective factors are conducted, the results may be misleading and unjust. According to them the results of the tests conducted as an experimental measure at certain institutions at different times contradict one another.

There is much force in these arguments. Some kind of objective tests can, perhaps, be designed to test the aptitude of a student for purely mechanical skills as, for instance, machining, turning, welding, carpentry etc., in which he wishes to be trained as a skilled worker. Such a test may even be necessary in the selection of a candidate for training at this level. For higher engineering studies, however, the term 'aptitude' has an entirely different significance. Here it is not so much the so-called 'mechanical aptitude' of a candidate as his intellectual capacity to understand the basic principles of physics, mathematics and other fundamental sciences and their application to problems of engineering design, construction and production that is important. That intellectual capacity is best determined as at present, by his academic career or performance at a separate admission examination held for the purpose. An interview of candidates by a competent committee will ensure that only those who are potentially capable of undergoing engineering studies are selected. These considerations apart, the so-called 'mechanical aptitude' of a student depends largely on his environment and other external factors. If he has had opportunities of fiddling with things mechanical at home or elsewhere, he may impress others with his so-called 'technical bent' of mind. But, that does not necessarily mean he will make a good engineer. On the other hand, if he is born of poor parents and has few opportunities of coming into contact with things mechanical, he may fail to measure up to the usual aptitude tests. That does not mean he will fail to become a good engineer given the necessary education and training. The intellectual ability of a prospective engineer-student cannot and should not be subordinated to an aptitude test that is at best purely arbitrary at present. Until more reliable and objective tests are designed that take fully into account the actual requirements of engineering studies, the present methods of selecting candidates on the basis of their academic record will have to continue. There is, however, no gain-saying the fact that ample opportunities should be provided to young students in their early years to develop an interest in science and technology.

SCHOLARSHIPS AND STIPENDS

The next important point is the expenditure incurred by a student on his engineering education. This expenditure as compared to other fields of education, has always been high and is increasing every year. It is estimated that a student of an engineering degree course has to spend today about Rs. 100-150 a month on his fees, lodging and boarding at a college hostel and other items. He has also to spend at least about Rs. 1,000 on books, instruments, tours etc. for the entire course. For the diploma course, the average expenditure varies from Rs. 75-100. In our present economic position, that is undoubtedly beyond the resources of a large number of our students; many deserving students in indigent circumstances are either unable to continue technical studies or do so with extreme difficulty. State aid to them in the form of scholarships, stipends etc. is necessary.

Till 1959, the number of scholarships and stipends available at a majority of our technical institutions was extremely small. It covered barely 5 per cent of the students studying at institutions. Their value too, was inadequate. To improve the position, the Central Government in 1959 formulated and implemented a scheme of Merit-cum-Means Scholarships for students of all technical institutions. Under the scheme over 1,000 scholarships are being awarded each year to fresh entrants to degree and diploma courses. Each scholarship is tenable for the full course of studies of the students concerned and is of the value of Rs. 75 p.m. for degree students and Rs. 50 p.m. for diploma students. The scholarship-holders are either exempted from the tuition fees by their own institutions or have their scholarships increased by an amount equal to the fees payable by them.

In addition, all four Higher Technological Institutes as also the Regional Engineering Colleges, have made provision for the award of scholarships to 25 per cent of their students. Some of the State Governments also have made provision in their Five-Year Plans for scholarships in their own institutions.

Nevertheless, even with these Merit-cum Means Scholarships and the provision made at the Higher Technological Institutes and Regional Colleges, less than 15 per cent of the new entrants to technical institutions are covered by scholarships. The rest have to depend upon their own meagre resources to finance their technical studies. It is, therefore, unnecessary to argue the urgent need to increase the number of scholarships and stipends for meritorious poor students. A minimum coverage of 50 per cent has to be aimed at in all institutions in progressive stages. Half of that may be in the form of 'Loan Scholarships'.

So far as post-graduate studies and research are concerned, the position is more satisfactory. From the beginning, the All-India Council insisted that at least 50% of the places in post-graduate courses should carry scholarships of the value of Rs. 150 p.m. This was accepted by the Central Government and a provision was accordingly made at all centres of post-graduate studies. After a further review of the matter, the Council recommended recently that a hundred per cent of the places should carry scholarships and the value of the scholarships should be increased to Rs. 250 p.m., in view of the high cost of education at this level and the need to attract to post-graduate studies really first-rate students who would otherwise seek attractive professional appointments after graduation. This has also been accepted by the Central Government. As a result nearly 500 Scholarships of a reasonably good value are available for post-graduate studies in various branches of technology.

On the recommendations of the Scientific Manpower Committee, the Central Government in 1949 implemented a scheme of Research Training Scholarships to encourage bright young students to do research in basic sciences after M.Sc. or in Technology after graduation in that field, at Universities and other educational centres. Initially 200 scholarships were sanctioned. In the course of the last ten years, the number has been increased to 800. Each research scholarship is of the value of Rs. 250 p.m. and is tenable for a period of three years for an individual scholar. A number of scholarships of the value of Rs. 400 p.m. have been made available at various technical institutions for research in technology.

HOSTELS

The next question is the provision of adequate facilities for the students of technical institutions. With a large increase in the number of institutions and the student enrolment exceeding the 100,000 mark, the demand for hostel accommodation has increased correspondingly. When a large number of students have to leave their homes to join technical institutions located far away, their residence, their healthy and corporate life, their discipline are all matters that concern educational authorities and parents alike. It is only when an institution has its own hostel to provide the necessary residential facilities to its students that it can ensure their care and welfare. The establishment of a hostel is, therefore, an integral part of a technical institution.

Fortunately, owing to the enlightened policy followed by the Central Government since 1947, the present position in hostels for technical students is satisfactory. The Government has helped institutions in building hostels by advancing interest-free loans repayable in easy instalments. Definite standards of hostel accommodation to be provided at an institution, the cost of the hostel etc. have been worked out. On the basis of these standards is determined the loan to be given for the construction of hostels. For example, it has been accepted that for a residential institution, the hostel facilities should cover the entire student body, and in the case of a non-residential institution, they should be for 50% of the students. In the later case, the remaining 50% of the students are expected to live with their parents or guardians or find suitable lodging elsewhere. However, if the institution is located in a large town or city where outside students are unable to find suitable lodgings, the scale of hostel accommodation is increased to meet the requirements. Similar standards have also been laid down for the type of hostel to be constructed and the various amenities to be provided.

So far, loans amounting to Rs. 68 m. have been sanctioned for the construction of hostels. This will rise to about Rs. 130 m. by the end of the Third Plan period. In terms of actual hostel seats provided it covers over 40,000 students. This is in addition to the hostels constructed at all Higher Technological Institutions and other institutions of the Central Government, the entire cost of which is borne by the Centre.

The Role of Professional Societies

The function of a professional society of engineering is two-fold. First to promote and advance the science and practice of engineering. Second, to ensure that only persons of the right type and with the requisite qualifications enter the profession and that they follow the correct code of professional conduct. This two-fold function has a direct bearing on technical education and training and, therefore, professional societies are, and should be intimately concerned with former. In the interests of the engineering profession, the societies should constantly strive to raise the standard of technical education. In the light of new developments in the field, they should advise institutions on other improvements necessary to ensure that the future engineers who join the profession are trained along correct lines.

In India, the first professional engineering society to be established is the Institution of Engineers which came into being in 1920. It was organised and developed on the same lines as the Institutions of Civil, Mechanical and Electrical Engineers (London), and received a Royal Charter in 1935. As the field of engineering widened and new branches were added, separate professional societies were established to promote the new branches. There are today three other professional societies viz. The Indian Institute of Chemical Engineers, The Institution of Tele-Communication Engineers (India) and the Aeronautical Society of India that are concerned respectively with Chemical Engineering, Electrical Communication Engineering and Aeronautical Engineering. There are also other societies as, for instance, the Mining, Metallurgical and Geological Institute of India, and the Institute of Metals which are both scientific and professional bodies. For Architecture and Town Planning, there are the Indian Institute of Architects and the Institute of Town Planners (India).

It is only in the last 10-12 years that the business of technical education has been pursued vigorously on a national basis; as such, the time will come when the impact of the professional bodies on the advance of technical education will be felt, both quantitatively and qualitatively. The various professional bodies are represented on the All-India Council for Technical

Education, its Boards of Studies and other Committees where the benefit of their advice and counsel on various problems are sought. The Institution of Engineers, however, has for a long time been working hard to revise the standards of degree courses in engineering through a system of recognition of the degrees for its professional membership.

PROFESSIONAL EXAMINATIONS

An important aspect of the activity that is closely related to professional development is the examinations held by the societies to admit candidates to the fraternity of engineers. The Institution of Engineers first instituted the examination in 1928 to admit candidates to the Associate Membership who have not had the benefit of formal education and training at a university or technical institution but who are nevertheless fit to enter the profession as qualified engineers by virtue of their experience and knowledge in the field gained through apprenticeship or service or in any other way. The Institution of Tele-communication Engineers (India) and the Aeronautical Society followed suit. The Associate Membership Examinations of these three professional bodies are recognised by the Central Government for purposes of appointment to superior posts in the relevant fields. It is understood that nearly 1,500 candidates sit for the examination every year and about 250 of them succeed and join the ranks of full-fledged engineers. These numbers are expected to go up as a result of the Defence Ministry's Scheme of Part-time Courses. Under this scheme, part-time training for professional examinations has been organised at about 19 centres with a total enrolment of over 3,000 candidates.

Doubts have been raised in certain quarters, about the examinations of professional bodies. In the context of present-day advances in science and technology how far are we justified in admitting a candidate to the profession of engineering merely on the basis of an examination passed by him when he has not gone through a rigorous training in engineering and associated scientific disciplines at a recognised university or institution? Advocates of this view argue that the practical experience gained by a candidate in the field is all right in so far as the particular job held by him is concerned. That, however, does not give him either the extent or the depth of knowledge in the broad field of engineering and the underlying scientific principles, which can be acquired only through a process of academic training at an institution that includes not only theoretical studies but also practical work in laboratories, drawings halls etc. Professional experience is itself a term of varying import and significance and no uniform yardstick can be devised to measure the experience of candidates doing various types of jobs. Even more difficult to assess is the quality of that experience, and how far that has helped a candidate in his understanding of engineering. If these important considerations notwithstanding, a candidate is declared fit to enter the fast developing and complex field of engineering on the basis of the examinations passed by him, our future engineers will not be of the highest calibre. We do not want institutions to be mills of mediocrity.

Perhaps, these views are of an extreme section of the engineering or academic fraternity. Nevertheless, they raise an important issue of standards of training and professional competence, that deserves careful consideration.

To hold examinations by a professional body of engineers is a special feature of the British scene. The Institution of Engineers (India) has followed the British example very closely. The main concept is that an engineer is trained not exclusively through an organised course conducted at a technical institution for students specially selected and admitted for the purpose. An engineer also comes up the hard way, through apprenticeship and professional experience gained over a number of years in factory or field. He should be given every opportunity to supplement his practical experience with the theoretical knowledge of his subject and to qualify as a professional engineer. His chances of advancement should not be the lower because he has not had the chance of a formal education at a university, provided he has the capacity to become an engineer through self-effort.

The success of this concept in the United Kingdom is largely due to two factors. First, industry and other organisations there have a highly-developed and well organised system of apprenticeship. Second, facilities for part-time courses are organised on a large scale, for the benefit of those who are working in industry. A deliberate policy of encouraging their employees and apprentices to take full advantage of these part-time courses is being followed by industry. It is understood that for every full-time student in engineering, there are over 30 part-time students. The part-time courses are specially designed to complement the practical experience of an individual. The two together equip him to sit for professional examinations and qualify as an engineer.

Our problem in India is that we have yet to organise on correct lines and on an adequate scale a system of apprenticeship training. Facilities for part-time courses also are extremely limited. This difficulty places on our professional bodies a heavy responsibility in evaluating correctly the practical experience of a candidate, the effort made by him to equip himself with the theoretical knowledge of his subject and to decide whether or not he is fit to enter the profession as a qualified engineer.

PART-TIME COURSES

The importance of part-time courses in the expansion of technical education in the country and the urgent need to improve the facilities for such courses needs to be emphasised. As against a present enrolment of over 100,000 students in full-time courses, the enrolment of part-time students in recognised technical institutions is hardly 1000, somewhat less than one percent of the total student body. This is an unsatisfactory state of affairs and for two reasons. First, industries and other organisations are leaning heavily on university graduates even for routine engineering activity like construction and production, and operation and maintenance of plant etc. Graduates, however, should be used for other aspects of work like design, research, development, management, etc., where their higher education could be put more to profitable use. Second, the chances of advancement for persons working within an organisation are limited notwithstanding their actual practical experience. They could assume higher executive or supervisory responsibilities only if their practical experience were supplemented with an adequate theoretical knowledge of their fields.

There are many reasons for the lack of development of part-time courses. The most important are that the general educational level of an average skilled-worker in industry has in the past been somewhat poor; a general apathy on the part of industrial organisations to encourage their workers to improve themselves through part-time courses; and our technical institutions confining their efforts exclusively to full-time courses. In the interests of the country's development these should change, and the sooner the better. There has to be a mental revolution on the part of the management of industry, workers and technical institutions. All should co-operate to build up the facilities for part-time courses as an integral part of the technical education system in the country.

To suggest that the existing institutions should also conduct part-time courses, does not take us far. These institutions are much too pre-occupied with their normal activity of full-time courses and are unable to devote the time and effort required to organising and developing part-time courses. The lack of contact between industry and institutions that exists at present is also a serious handicap. It requires a better undestanding of the needs of industrial workers and capacity to adjust the programmes of education and training to those needs. The present institutions, regulated in their thinking and action within a rigid framework of full-time courses prescribed by universities and state boards, are not in a position to venture into uncharted waters. At the same time, establishment of separate institutions for part-time courses might not be a very desirable step. In the circumstances, the best course is to set up at the existing institutions a separate wing for part-time courses that could draw upon the available facilities but, work with complete freedom.

Organisationally and administratively, it should have an identity of its own in relation to the aims and objects of part-time courses and involve itself with industry.

These special wings should work in close collaboration with industrial concerns and other organisations which are served by them. The collaboration should not be a one-way traffic. Industry should not only advise the institutions on the types of courses to be conducted for the benefit of the workers and similar aspects, but should participate actively in the working of the institutions. It should be an important part of the participation that industry provides the services of its experts as part-time teachers at the institutions. Industry should encourage its promising workers to join the courses and offer them suitable incentives for the purpose in the form of part-day release from work, tuition fees etc. Professional advancement of the workers should follow as a recognition of the successful completion of the courses.

It is also necessary to bring the professional societies into this picture. The societies should advise the institutions on the standards of courses, and suitable arrangements should be developed whereby candidates completing the prescribed courses satisfactorily are considered as having fulfilled the requirements for the corporate membership of the societies and are thus recognised as professional engineers. To this end, the examinations may be held jointly by the institutions and professional societies or, alternatively, the examinations held by the institutions are recognised by the societies after due assessment.

The institutions should offer a wide range of courses to meet the requirements of different groups of workers. Some may be short courses to improve the operational efficiency of workers in their own fields. Some may be to prepare the workers for the state board diploma examinations and others to prepare them for the membership of professional societies. The question of conducting at the institutions university degree or equivalent courses on a part-time basis should also be seriously considered.

It is important that the training at the institutions is not narrowly professional but broad-based, educationally. This will not only advance the technical efficiency of the workers, but will raise their general educational level. The worker of today is the executive of tomorrow. He should be equipped for his new responsibilities through an educational process specially designed for the purpose. The institutions should, therefore, adopt a comprehensive and integrated approach to the problem, keeping in view at all stages the full social implications of technological progress.

CHAPTER 12

Technology and The Man

"If the humanities cannot be of service to man during his busiest and most critical hours, then assuredly they are merely a frill for the home-spun of life. The Romans understood by the word *Humanitas* the practical, daily use of great literature, art and philosophy by those men who had learned the moral, intellectual and imaginative power which habitual association with the best minds of civilization confers. The function of the course, then, is to enable students to think somewhat as the masters have thought about divine, human and eternal nature, and to enable them to feel to some extent the wonder, and awe, the spiritual elevation and power that the masters have felt when their insight into the forces of life has compelled them to produce artistic imitations or philosophic or scientific analyses so that lesser men might also penetrate the abstractions of the world."

Grand words—but the truth assumes a more practical form when a broad view is taken of the potential professional character of engineering as well as of the values that are inherent in the Humanities and Social Sciences. In the education of the professional engineer, the function of the Humanities and Social Sciences is not limited to the improvement of communication skills and the emergence of amiable employees. Nor is the primary function to provide a history of the arts, a convenient catalogue of factual information which is quickly consulted and used in conversation with cultured business associates. It is comparatively unimportant whether students know that the theory of flux preceded Plato's ideal of unvarying truth or that Bach was celebrated for polyphonic harmony and 20 children. The engineer is a responsible professional man, whose every professional act has human and social consequences. Whether he is aware of it or not, he is instrumental in the creation of a new society and a new economic order, as well as a new physical environment. One result of his professional accomplishments is that he is called upon to accept an increasingly responsible role as leader of his community. To discharge his growing responsibilities the engineer needs both professional competence, a sure understanding of himself and of the world in which he lives. He needs 'depth, flexibility and a capacity for growth in directions in which we ourselves can today only dimly visualise'. The business of an engineering education is to provide him with a foundation upon which he may build a career of genuinely professional stature.

With this in view, the Humanities and Social Sciences can for us take their appropriate place as an integral part of total education. They do not stand apart from the rest of the curriculum; they support the scientific-technical training, and are in turn supported by it. They contribute to professional competence not merely in the narrowly vocational sense but in the broad sense of enabling the engineer to see his own activities in their human and social contexts. Even beyond this broad concept of professional development, the Humanities and Social Sciences represent for the engineer, as for all men, the heart of an inherited human experience.

For well over 20 years, all advanced countries have given much attention to the crucial problem of how to develop and maintain an effective programme of humanistic-social studies in technological education. In the U.S.A. alone nearly 80 universities and technical institutions are actively engaged in this work and the American Society for Engineering Education has done much to promote an educational philosophy that is acceptable to the engineering and liberal arts faculties. The large volume of literature that has emerged on the subject bears ample testimony to the importance of the problems.

Both at our universities and technical institutions in general, not much effort has been made to integrate humanistic-social studies into technological courses and to realise the full value of the contributions that the liberal arts can make to the training of engineers. The curriculum of many institutions are conspicuous for the absence of any reference to the humanities; in some, only a passing reference has been made but the subjects suggested viz. English Composition and Report Writing are intended only to improve the communication skill of the students. At the Higher Technological Institutes, however, a purposeful attempt is being made to profit by the valuable experience of other countries in this respect. A full-fledged Department of Humanities and Social Sciences has been established at the Indian Institute of Technology, Kharagpur, whose objectives are defined as below :

> "In order to broaden the student's outlook beyond the limits of his immediate academic and professional interest, all undergraduate courses include a certain amount of non-technical, cultural and social studies which are grouped under the general designation of the Humanities".

The recommendations of the Hammond Report to the American Society for Engineering Education are of particular value to our universities. The goals of what that report called the "humanistic-social stem" were stated, not in terms of subject-matter, but in terms of competences which the

Humanities and Social Sciences could help the student acquire:

(a) An understanding of the evolution of the social organisation within which we live and of the influence of science and engineering on its development.

(b) The ability to recognise and make a critical analysis of a problem involving social and economic elements, to arrive at an intelligent opinion about it, and to read with discrimination and purpose towards these ends.

(c) The ability to organise thoughts logically and to express them lucidly and convincingly in oral and written English.

(d) An acquaintance with some of the great masterpieces of literature and an understanding of their setting in and influence on civilization.

(e) The development of moral, ethical, and social concepts essential to satisfying personal philosophy, to a career consistent with the public welfare and to a sound professional attitude.

(f) The attainment of an interest and pleasure in these pursuits and thus of an inspiration to continued study.

The time has now come for Indian universities to address themselves to this problem of humanistic social studies and to reconstruct their technological curriculum along more enduring and useful lines.

POSTSCRIPT

The present national emergency has demanded large numbers of technicians trained for the defence effort. The All India Council for Technical Education has also considered how the present polytechnic diploma courses should be reorganised in order to make them more useful to industry. A scheme has been formulated for a two-year diploma course for the training of technicians with Higher Secondary as admission qualification. The scheme aims at giving specialised training in particular fields of engineering directly related to the functions of a diploma-holder in industry. The scheme also stresses practical work so as to equip the technician with ability to apply scientific principles to production, construction and field operations. The new course will be introduced gradually starting with adequately equipped and staffed polytechnics.

Another scheme has been formulated for part-time diploma courses in engineering, for persons working in industry. To begin with, 25 centres with about 2,500 annual admissions will be organised at existing polytechnics.

To increase the output of engineers and technicians, admissions to degree and diploma courses will be increased at existing institutions which will work on a 'double shift' basis and use available facilities to the maximum extent possible. Special three-year degree courses in engineering for graduates in science will be organised at selected centres.

An important aspect of expansion of technical education is to reduce wastage in institutions. The earlier estimates were that about 85 percent of the students admitted to degree courses and at least 65 percent of the students admitted to diploma courses complete their studies successfully within the prescribed normal period. The present estimates are that the wastage exceeds 20 percent for degree and 40 percent for diploma students. Such a high wastage means the loss of precious resources, human, material and financial, that the country can ill afford at any juncture and particularly now. We need to study in detail the causes of the wastage. We also need to adopt urgent measures to reduce the wastage.

In 1962-63, technical institutions admitted 17,500 students for degree courses and 29,100 students for diploma courses. The output was 8,370 graduates and 12,050 diploma-holders.

APPENDIX

Technical Institutions in India (1961)

A. POST-GRADUATE COURSES

1. L.M. COLLEGE OF PHARMACY, AHMEDABAD

   Pharmacy.

2. L.D. COLLEGE OF ENGINEERING, AHMEDABAD

   Electrical Machine Design.

3. INDIAN INSTITUTE OF SCIENCE, BANGALORE

   Automobile Engineering. Power Engineering (Electrical). Power Engineering (Mechanical). Foundry Engineering. Power Engineering (Civil & Hydraulics). High Voltage Engineering. Soil Mechanics and Foundation Engineering. Electronics Engineering. Acoustical Engineering. Line Communication Engineering. Ultrashort and Microwave Engineering. Aeronautical Engineering. Internal Combustion Engineering.

4. FACULTY OF TECHNOLOGY & ENGINEERING, BARODA

   Highways and Bridges. Advanced Irrigation and Hydraulics. Public Health Engineering. Soil Mechanics. Electrical Engineering. Mechanical Engineering.

5. DEPARTMENT OF CHEMICAL TECHNOLOGY, BOMBAY UNIVERSITY, BOMBAY

   Food Technology. Chemical Engineering. Textile Chemistry. Technology of Intermediates & Dyes. Technology of Plastics. Technology of Pigments, Paints and Varnishes. Technology of Oils, Fats and Waxes. Technology of Pharmaceuticals and Fine Chemicals.

6. VICTORIA JUBILEE TECHNICAL INSTITUTE, BOMBAY

Automobile Engineering. Industrial Engineering and Industrial Administration (Industrial and Production Engineering). Advanced Textile Technology. Electrical Engineering. Mechanical Engineering. Civil Engineering.

7. INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

Industrial Electronics. Electro-Vacuum Technology. Design of Chemical Plant. Technology of Fine Organic Chemicals. Technology of Heavy Inorganic Chemicals. Technology of Silicates. Electro-Chemical Technology. Ferrous Products Metallurgy. Soil Engineering. Automation in Chemical Industry. Technology of Cellulose & Paper. Technology of Fuels. Structural Engineering. Design of Electrical Machines and Switchgear. Machine Tools Designs.

8. INSTITUTE OF RADIO PHYSICS & ELECTRONICS, CALCUTTA UNIVERSITY, CALCUTTA

Advanced Electronics.

9. P. S. G. & SONS CHARITY COLLEGE OF TECHNOLOGY, COIMBATORE

Electrical Machine Design.

10. PUNJAB ENGINEERING COLLEGE, CHANDIGARH

Highway Engineering.

11. DEPARTMENT OF PHARMACY, CHANDIGARH

Pharmacy.

12. SCHOOL OF PLANNING AND ARCHITECTURE, DELHI

Post-Graduate Diploma in Town & Country Planning. Housing.

13. INDIAN SCHOOL OF MINES, DHANBAD.

Mining Engineering. Applied Geophysics. Applied Geology.

14. DEPARTMENT OF CHEMICAL TECHNOLOGY, OSMANIA UNIVERSITY, HYDERABAD

Chemical Technology. Chemical Engineering.

15. GOVERNMENT ENGINEERING COLLEGE, JABALPUR

Advanced Electronics. Carrier & V. F. Telephone Engineering Soil Mechanics & Foundation Engineering. Internal Combustion Engineering. High Voltage Engineering. U.H.F. Engineering.

16. COLLEGE OF ENGINEERING AND TECHNOLOGY, JADAVPUR UNIVERSITY, JADAVPUR

Chemical Engineering. Food Technology. Mechanical Engineering. Electrical Engineering. Civil Engineering. Telecommunication Engineering.

17. INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Farm Power & Machinery. Soil & Water Conservation Technical Gas Reaction & High Pressure Technology. High Polymer & Rubber Technology. Synthetic Drugs & Fine Chemicals. Architecture & Regional Planning. Structural Engineering. Water Power & Dam Construction. Soil Mechanics & Foundation Engineering. Highway Engineering. Harbour Engineering. Municipal Engineering. Electrical Machine Design. Control System Engineering. Radio Broadcasting Engineering. Ultra High & Microwave Engineering. Industrial Electronics. Applied Geology. Exploration Geophysics. Geo-Chemistry. Non-linear Mechanics. Foundry Engineering. Industrial Engineering. Machine Design. Mechanical Handling. Production Technology. Refrigeration and Air Conditioning Plant Design. I. C. Engines and Gas Turbines. Ferrous Metallurgy. Industrial Physics. Meteorology. Industrial Psychology & Industrial Relations. Applied Botany. Combustion Engineering & Fuel Economy. Chemical Plant Design & Fabrication. Mechanism & Vibration.

18. H. B. TECHNOLOGICAL INSTITUTE, KANPUR

Oils, Fats & Waxes. Paints & Varnishes. Applied Microbiology.

19. COLLEGE OF ENGINEERING, GUINDY, MADRAS

Dam Construction, Irrigation Engineering & Hydraulics. Foundation Engineering & Soil Mechanics. Structural Engineering including Concrete Technology. Public Health

Engineering. Electrical Machine Design. Internal Combustion Engineering.

20. A. C. COLLEGE OF TECHNOLOGY, MADRAS

Chemical Engineering. Textile Technology. Leather Technology.

21. LAXMINARAYAN INSTITUTE OF TECHNOLOGY, NAGPUR

Chemical Engineering. Oil Technology.

22. BIRLA COLLEGE OF ENGINEERING, PILANI

Advanced Electronics.

23. COLLEGE OF ENGINEERING, POONA

Dam Construction, Irrigation Engineering & Hydraulics. Foundation Engineering & Soil Mechanics. Structuarl Engineering including Concrete Technology. M.E. (Met.) Advanced Metallurgy. M.E. (Electrical). M.E. (Civil).

24. ROORKEE UNIVERSITY, ROORKEE

Highway Engineering. Dam Construction, Irrigation Engineering & Hydraulics. Foundation Engineering & Soil Mechanics. Structural Engineering & Concrete Technology. Public Health Engineering. Photogrammetric Engineering. Applied Thermodynamics. Electrical Machine Design.

25. DEPARTMENT OF PHARMACY, UNIVERSITY OF SAUGAR, SAUGAR

Pharmacy.

26. BENGAL ENGINEERING COLLEGE, SIBPUR

Foundation Engineering & Soil Mechanics. Structural Engineering & Concrete Technology. Prime Movers. Electrical Machine Design. Advanced Metallurgy.

27. BIHAR INSTITUTE OF TECHNOLOGY. SINDRI

Heat Engineering.

28. COLLEGE OF ENGINEERING, TRIVANDRUM

Dam Construction, Irrigation Engineering & Hydraulics. Structural Engineering. Electrical Machine Design.

29. DEPARTMENT OF SILICATE TECHNOLOGY, BANARAS HINDU UNIVERSITY, VARANASI

Silicate Technology.

30. DEPARTMENT OF PHARMACY, BANARAS HINDU UNIVERSITY, VARANASI

Pharmacy.

31. COLLEGE OF TECHNOLOGY, BANARAS HINDU UNIVERSITY, VARANASI

Chemical Engineering.

32. COLLEGE OF MINING AND METALLURGY, BANARAS HINDU UNIVERSITY, VARANASI

Mining Engineering. Advanced Metallurgy.

33. ENGINEERING COLLEGE, BANARAS HINDU UNIVERSITY, VARANASI

Electrical Machine Design.

34. J.V.D. COLLEGE OF SCIENCE & TECHNOLOGY, ANDHRA UNIVERSITY, WALTAIR

Chemical Engineering. Chemical Technology with (a) Sugar and (b) Pharmaceuticals and Fine Chemicals. Ore Dressing. Electro-Chemical Technology.

B. FIRST DEGREE COURSES

Northern Region

DELHI

1. DELHI POLYTECHNIC, DELHI (200)(CG)
   Civil, Mechanical, Electrical and Chemical Engineering. Textile Technology.

2. COLLEGE OF ENGINEERING & TECHNOLOGY, HAUZ KHAS, DELHI (250)(CG)
   Civil, Mechanical, Electrical and Chemical Engineering. Textile Technology.

3. SCHOOL OF PLANNING & ARCHITECTURE, DELHI (60)(CG)
   Architecture.

PUNJAB

4. GURUNANAK ENGINEERING COLLEGE, LUDHIANA (120)(P)
   Civil, Mechanical and Electrical Engineering.

5. PUNJAB ENGINEERING COLLEGE, CHANDIGARH (240)(SG)
   Civil, Mechanical and Electrical Engineering.

6. THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY, PATIALA (120)(P)
   Civil, Mechanical and Electrical Engineering.

7. TECHNOLOGICAL INSTITUTE OF TEXTILES, BHIWANI (60)(P)
   Textiles.

(a) The figures in brackets are the sanctioned admission capacity per year.

(b) The symbols in brackets represent:

- CG : Central Government Institution
- SG : State Government Institution
- CSG : Central Government and State Government Institution
- P : Private Institution

8. DEPARTMENT OF PHARMACY, PUNJAB UNIVERSITY, CHANDIGARH (15)(U)
   Pharmacy.

9. DEPARTMENT OF CHEMICAL ENGINEERING & TECHNOLOGY, PUNJAB UNIVERSITY, CHANDIGARH (30)(U)
   Chemical Engineering.

10. PUNJAB COLLEGE OF ARCHITECTURE, CHANDIGARH (30)(SG)
    Architecture.

RAJASTHAN

11. BIRLA COLLEGE OF ENGINEERING, PILANI (210)(P)
    Civil, Mechanical, Electrical and Tele-communication Engineering.

12. M.B.M. ENGINEERING COLLEGE, JODHPUR (175)(SG)
    Civil, Mechanical, Electrical and Mining Engineering.

13. BIRLA COLLEGE, PILANI (20)(P)
    Pharmacy.

UTTAR PRADESH

14. COLLEGE OF ENGINEERING & TECHNOLOGY, MUSLIM UNIVERSITY, ALIGARH (120)(U)
    Civil, Mechanical and Electrical Engineering.

15. ENGINEERING COLLEGE, BANARAS HINDU UNIVERSITY, VARANASI (270)(U)
    Civil, Mechanical and Electrical Engineering.

16. ENGINEERING COLLEGE, DAYALBAGH, AGRA (60)(P)
    Mechanical and Electrical Engineering.

17. UNIVERSITY OF ROORKEE, ROORKEE (290)(U)
    Civil, Mechanical, Electrical and Tele-communication Engineering. Architecture.

U : University Institution

18. COLLEGE OF MINING AND METALLURGY, BANARAS HINDU UNIVERSITY, VARANASI (100) (U)
    Mining. Metallurgy.

19. COLLEGE OF TECHNOLOGY, BANARAS HINDU UNIVERSITY, VARANASI (82) (U)
    Chemical Engineering. Silicate Technology. Pharmacy.

20. H.B. TECHNOLOGICAL INSTITUTE, KANPUR (30)(SG)
    Chemical Engineering.

21. GOVERNMENT CENTRAL TEXTILE INSTITUTE, KANPUR (30)(SG)
    Textile Technology. Textile Chemistry.

22. NATIONAL SUGAR INSTITUTE, KANPUR (15)(CG)
    Sugar Technology.

23. ALLAHABAD AGRICULTURAL INSTITUTE, ALLAHABAD (40)(P)
    Agricultural Engineering.

24. INDIAN INSTITUTE OF TECHNOLOGY, KANPUR (100)*(CG)
    Civil, Mechanical, Electrical and Chemical Engineering. Metallurgy.

25. MOTILAL NEHRU REGIONAL COLLEGE OF ENGINEERING, ALLAHABAD (250)(CSG)
    Civil, Mechanical and Electrical Engineering.

JAMMU & KASHMIR

26. REGIONAL ENGINEERING COLLEGE. SRINAGAR (120)(CSG)
    Civil, Mechanical and Electrical Engineering.

Eastern Region

ASSAM

27. ASSAM ENGINEERING COLLEGE, JHALUKBARI, GAUHATI (120)(SG)
    Civil, Mechanical and Electrical Engineering.

*The Ultimate Admission Capacity of the Institute is 320 Students.

28. JORHAT ENGINEERING COLLEGE, JORHAT (120)(SG)
Civil, Mechanical and Electrical Engineering.

BIHAR

29. BIHAR COLLEGE OF ENGINEERING, PATNA UNIVERSITY, PATNA (120)(U)
Civil, Mechanical and Electrical Engineering.

30. BIHAR INSTITUTE OF TECHNOLOGY, SINDRI (316)(SG)
Civil, Mechanical (including Production), Electrical, Telecommunication and Chemical Engineering. Metallurgy.

31. BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI (270)(P)
Civil, Mechanical and Electrical Engineering.

32. MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR (120)(SG)
Civil, Mechanical and Electrical Engineering.

33. INDIAN SCHOOL OF MINES, DHANBAD (150)(CG)
Mining. Petroleum Technology. Applied Geology. Applied Geophysics.

34. REGIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR (250)(CSG)
Civil, Mechanical and Electrical Engineering. Metallurgy.

35. BHAGALPUR ENGINEERING COLLEGE, BHAGALPUR (120)(SG)
Civil, Mechanical and Electrical Engineering.

ORISSA

36. UNIVERSITY COLLEGE OF ENGINEERING, BURLA (120)(U)
Civil, Mechanical and Electrical Engineering.

37. ROURKELA ENGINEERING COLLEGE, ROURKELA (250)(CSG)
Civil, Mechanical and Electrical Engineering.

WEST BENGAL

38. BENGAL ENGINEERING COLLEGE, SIBPUR, HOWRAH (400) (SG)

    Civil, Mechanical, Electrical and Tele-communication Engineering. Mining. Metallurgy. Architecture.

39. COLLEGE OF ENGINEERING AND TECHNOLOGY, JADAVPUR (370) (U)

    Civil, Mechanical, Electrical, Tele-communication and Chemical Engineering.

40. DEPARTMENT OF APPLIED PHYSICS, CALCUTTA UNIVERSITY, CALCUTTA (25) (U)

    Applied Physics.

41. INSTITUTE OF RADIO PHYSICS AND ELECTRONICS, CALCUTTA UNIVERSITY, CALCUTTA (20) (U)

    Radio Physics and Electronics.

42. INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR (384) (CG)

    Civil, Mechanical, Electrical, Electrical Communication Engineering. Mining. Metallurgy. Chemical Engineering. Architecture. Naval Architecture. Agricultural Engineering. Applied Geology. Geophysics.

43. COLLEGE OF TEXTILE TECHNOLOGY, SERAMPORE (30) (SG)

    Textile Technology.

44. DEPARTMENT OF APPLIED CHEMISTRY, CALCUTTA UNIVERSITY, CALCUTTA (36) (U)

    Chemical Engineering and Chemical Technology.

45. COLLEGE OF TEXTILE TECHNOLOGY, BERHAMPORE (30) (SG)

    Textile Technology.

46. COLLEGE OF LEATHER TECHNOLOGY, CALCUTTA (10) (SG)

Leather Technology.

47. REGIONAL ENGINEERING COLLEGE, DURGAPUR (250) (CSG)

Civil, Mechanical and Electrical Engineering. Metallurgy.

48. JALPAIGURI ENGINEERING COLLEGE, JALPAIGURI (150) (SG)

Civil, Mechanical and Electrical Engineering.

Western Region

MAHARASHTRA

49. COLLEGE OF ENGINEERING, POONA (310) (SG)

Civil, Mechanical, Electrical and Tele-communication Engineering. Metallurgy.

50. COLLEGE OF ENGINEERING, AURANGABAD (120) (SG)

Civil, Mechanical and Electrical Engineering.

51. VICTORIA JUBILEE TECHNICAL INSTITUTE, BOMBAY (160) (P)

Civil, Mechanical and Electrical Engineering. Textile Technology.

52. WALCHAND COLLEGE OF ENGINEERING, SANGLI (120) (P)

Civil, Mechanical and Electrical Engineering.

53. DEPARTMENT OF CHEMICAL TECHNOLOGY, BOMBAY UNIVERSITY, BOMBAY (159) (U)

Chemical Engineering. Pharmacy. Food Technology. Pharmaceutical and Fine Chemicals. Textile Chemistry. Chemical Technology of Paints and Varnishes. Technology of Intermediates and Dyes. Technology of Plastics. Technology of Oils, Fats and Waxes.

54. LAXMINARAYAN INSTITUTE OF TECHNOLOGY, NAGPUR (36) (U)

Chemical Engineering.

55. INDIAN INSTITUTE OF TECHNOLOGY, POWAI, BOMBAY (320) (CG)

Civil, Mechanical, Electrical and Chemical Engineering. Metallurgy.

56. SIR J. J. COLLEGE OF ARCHITECTURE, BOMBAY (100) (SG)

Architecture.

57. REGIONAL COLLEGE OF ENGINEERING, NAGPUR (250) (CSG)

Civil, Mechanical and Electrical Engineering.

58. COLLEGE OF ENGINEERING, KARAD (120) (SG)

Civil, Mechanical and Electrical Engineering.

59. GOVERNMENT POLYTECHNIC, NAGPUR (30) (SG)

Architecture.

GUJARAT

60. BIRLA VISHWAKARMA MAHAVIDYALAYA, P.O. VALLABH VIDYA NAGAR, KAIRA (240) (P)

Civil, Mechanical and Electrical Engineering.

61. FACULTY OF TECHNOLOGY AND ENGINEERING, M. S. UNIVERSITY, BARODA (305) (U)

Civil, Mechanical and Electrical Engineering. Textiles. Architecture.

62. L.D. COLLEGE OF ENGINEERING, AHMEDABAD (300) (SG)

Civil, Mechanical and Electrical Engineering.

63. LUKHDHIRJI ENGINEERING COLLEGE, MORVI (120) (SG)

Civil, Mechanical and Electrical Engineering.

64. L.M. COLLEGE OF PHARMACY, AHMEDABAD (75) (P)

Pharmacy.

65. SARDAR VALLABHBHAI COLLEGE OF ENGINEERING & TECHNOLOGY, SURAT (250) (CSG)

Civil, Mechanical and Electrical Engineering.

MADHYA PRADESH

66. GOVERNMENT ENGINEERING COLLEGE, JABALPUR (280) (SG)

Civil, Mechanical, Electrical and Electrical Communication Engineering.

67. MADHAV ENGINEERING COLLEGE, GWALIOR (120) (P)

Civil, Mechanical and Electrical Engineering.

68. SHRI GOVINDRAM SEKSARIA TECHNOLOGICAL INSTITUTE, INDORE (180) (P)

Civil, Mechanical and Electrical Engineering.

69. GOVERNMENT COLLEGE OF ENGINEERING & TECHNOLOGY, RAIPUR (180) (SG)

Civil, Mechanical and Electrical Engineering. Mining. Metallurgy.

70. DEPARTMENT OF PHARMACY, SAUGAR UNIVERSITY, SAUGAR (15) (U)

Pharmacy.

71. MAULANA AZAD COLLEGE OF TECHNOLOGY, BHOPAL (250) (CSG)

Civil, Mechanical and Electrical Engineering.

72. SAMRAT ASHOK TECHNOLOGY INSTITUTE, VIDISHA (120) (P)

Civil, Mechanical and Electrical Engineering.

Southern Region

ANDHRA PRADESH

73. COLLEGE OF ENGINEERING, ANANTAPUR (150) (SG)
Civil, Mechanical and Electrical Engineering.

74. COLLEGE OF ENGINEERING, KAKINADA (150) (SG)
Civil, Mechanical and Electrical Engineering.

75. COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY, HYDERABAD (255) (U)
Civil, Mechanical, Electrical and Tele-communication Engineering. Mining.

76. COLLEGE OF ENGINEERING, ANDHRA UNIVERSITY, WALTAIR (120) (U)
Civil, Mechanical and Electrical Engineering.

77. DEPARTMENT OF CHEMICAL TECHNOLOGY, OSMANIA UNIVERSITY, HYDERABAD (60) (U)
Chemical Engineering.

78. J.V.D. COLLEGE OF SCIENCE & TECHNOLOGY, WALTAIR (75) (U)
Chemical Engineering. Pharmacy.

79. REGIONAL ENGINEERING COLLEGE, WARANGAL (250) (CSG)
Civil, Mechanical and Electrical Engineering.

80. S.V. UNIVERSITY COLLEGE OF ENGINEERING, TIRUPATHI (120) (U)
Civil, Mechanical and Electrical Engineering.

81. GOVERNMENT COLLEGE OF FINE ARTS AND ARCHITECTURE, HYDERABAD (25) (SG)
Architecture.

KERALA

82. COLLEGE OF ENGINEERING, TRIVANDRUM (210) (SG)
Civil, Mechanical and Electrical Engineering.

83. ENGINEERING COLLEGE, TRICHUR (120)(SG)
Civil, Mechanical and Electrical Engineering.

84. T.K.M. ENGINEERING COLLEGE, QUILON (120)(P)
Civil, Mechanical and Electrical Engineering.

85. NAIR SERVICE SOCIETY ENGINEERING COLLEGE, PALGHAT (120)(P)
Civil, Mechanical and Electrical Engineering.

86. ENGINEERING COLLEGE, KOTHAMANGALAM (120)(P)
Civil, Mechanical and Electrical Engineering.

87. REGIONAL ENGINEERING COLLEGE, KOZHIKODE (250)(CSG)
Civil, Mechanical and Electrical Engineering.

MADRAS

88. A.C. COLLEGE OF ENGINEERING AND TECHNOLOGY, KARAIKUDI (120)(P)
Civil, Mechanical and Electrical Engineering.

89. COLLEGE OF ENGINEERING, ANNAMALAI UNIVERSITY, ANNAMALAINAGAR (120)(U)
Civil, Mechanical and Electrical Engineering.

90. DEPARTMENT OF CHEMICAL TECHNOLOGY, ANNAMALAI UNIVERSITY, ANNAMALAINAGAR (30)(U)
Chemical Engineering.

91. COLLEGE OF ENGINEERING, GUINDY (275)(SG)
Civil, Mechanical, Electrical and Tele-communication Engineering. Mining.

92. COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE (120)(P)
Civil, Mechanical and Electrical Engineering.

93. GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE (120) (SG)

Civil, Mechanical and Electrical Engineering.

94. MADRAS INSTITUTE OF TECHNOLOGY, CHROMPET, MADRAS (85) (P)

Electrical Communication Engineering. Aeronautical Engineering. Instrument Technology. Automobile Engineering.

95. THIAGARAJAR ENGINEERING COLLEGE, MADURAI (120) (P)

Civil, Mechanical and Electrical Engineering.

96. P.S.G. COLLEGE OF TECHNOLOGY, PEELAMEDU, COIMBATORE (120) (P)

Civil, Mechanical and Electrical Engineering.

97. SCHOOL OF ARCHITECTURE, MADRAS UNIVERSITY, MADRAS (20) (U)

Architecture.

98. A.C. COLLEGE OF TECHNOLOGY, GUINDY (82) (U)

Chemical Engineering. Textile Technology. Leather Technology.

99. DEPARTMENT OF PHARMACY, MADRAS MEDICAL COLLEGE, MADRAS (15) (SG)

Pharmacy.

100. INDIAN INSTITUTE OF TECHNOLOGY, MADRAS (120)*(CG)

Civil, Mechanical, Electrical and Chemical Engineering. Metallurgy.

MYSORE

101. B.D.T. ENGINEERING COLLEGE, DAVANGERE (120) (SG)

Civil, Mechanical and Electrical Engineering.

*The ultimate admission capacity of the Institute is 320 students.

102. B.M.S. COLLEGE OF ENGINEERING, BANGALORE (120)(P)

Civil, Mechanical and Electrical Engineering.

103. B.V. BHOOMRADDI COLLEGE OF ENGINEERING & TECHNOLOGY, HUBLI (120)(P)

Civil, Mechanical and Electrical Engineering.

104. COLLEGE OF ENGINEERING, BANGALORE (210)(U)

Civil, Mechanical and Electrical Engineering.

105. NATIONAL INSTITUTE OF ENGINEERING, BANGALORE (120)(P)

Civil, Mechanical and Electrical Engineering.

106 INDIAN INSTITUTE OF SCIENCE, BANGALORE (90)(U)

Electrical Technology. Tele-communication Engineering. Metallurgy.

107. S.K.S.J. TECHNOLOGICAL INSTITUTE, BANGALORE (20)(SG)

Textile Technology.

108. ENGINEERING COLLEGE, GULBARGA (120)(P)

Civil, Mechanical and Electrical Engineering.

109 MANIPAL ENGINEERING COLLEGE, MANIPAL (182)(P)

Civil, Mechanical and Electrical Engineering.

110. KARNATAKA REGIONAL ENGINEERING COLLEGE, SURATHKAL (SOUTH KANARA) (250)(CSG)

Civil, Mechanical and Electrical Engineering.

111. MALNAD ENGINEERING COLLEGE, HASAN (120)(P)

Civil, Mechanical and Electrical Engineering.

C. DIPLOMA COURSES

Northern Region

DELHI

1. DELHI POLYTECHNIC, DELHI (60)(CG)
   Civil, Mechanical and Electrical Engineering.

2. G. B. PANT POLYTECHNIC, OKHLA, DELHI (240)(SG)
   Civil, Mechanical and Electrical Engineering.

PUNJAB

3. GOVERNMENT POLYTECHNIC, AMBALA (240)(SG)
   Civil, Mechanical and Electrical Engineering.

4. GURUNANAK ENGINEERING COLLEGE, LUDHIANA (120)(P)
   Civil, Mechanical and Electrical Engineering.

5. MEHR CHAND POLYTECHNIC, JULLUNDUR (120)(P)
   Civil, Mechanical and Electrical Engineering.

6. NATIONAL INSTITUTE OF ENGINEERING, HOSHIARPUR (120)(P)
   Civil, Mechanical and Electrical Engineering.

7. PUNJAB POLYTECHNIC, NILOKHERI (240) (SG)
   Civil, Mechanical and Electrical Engineering.

8. RAMGARHIA POLYTECHNIC, PHAGWARA (180) (P)
   Civil, Mechanical and Electrical Engineering.

9. S.D. POLYTECHNIC, BAIJNATH (60) (P)
   Civil Engineering.

10. THAPAR POLYTECHNIC, PATIALA (120)(P)
    Civil, Mechanical and Electrical Engineering.

11. PUNJAB INSTITUTE OF TEXTILE TECHNOLOGY, AMRITSAR (30)(SG)
    Textile Technology.

12. GOVERNMENT TANNING INSTITUTE, JULLUNDUR (10)(SG)
    Leather Technology.

13. CENTRAL POLYTECHNIC, CHANDIGARH (240)(SG)
    Civil, Mechanical and Electrical Engineering.

14. GOVERNMENT POLYTECHNIC, JHAJJAR (120)(SG)
    Civil, Mechanical and Electrical Engineering.

RAJASTHAN

15. JODHPUR POLYTECHNIC, JODHPUR (240)(SG)
    Civil, Mechanical and Electrical Engineering.

16. AJMER POLYTECHNIC, AJMER (120)(SG)
    Civil, Mechanical and Electrical Engineering.

17. UDAIPUR POLYTECHNIC, UDAIPUR (160)(SG)
    Civil, Mechanical and Electrical Engineering.

18. GOVERNMENT POLYTECHNIC, KOTAH (120) (SG)
    Civil, Mechanical and Electrical Engineering.

19. ALWAR POLYTECHNIC, ALWAR (120) (SG)
    Civil, Mechanical and Electrical Engineering.

JAMMU & KASHMIR

20. KASHMIR GOVERNMENT POLYTECHNIC, SRINAGAR (120)(SG)
    Civil, Mechanical and Electrical Engineering.

21. GOVERNMENT POLYTECHNIC, JAMMU(120)(SG)
    Civil, Mechanical and Electrical Engineering.

UTTAR PRADESH

22. LUCKNOW POLYTECHNIC, LUCKNOW (120)(P)
    Civil, Mechanical and Electrical Engineering.

23. HEWETT POLYTECHNIC, LUCKNOW (120)(P)
Civil, Mechanical and Electrical Engineering.

24. GOVERNMENT POLYTECHNIC, LUCKNOW (240)(SG)
Civil, Mechanical and Electrical Engineering.

25. GOVERNMENT POLYTECHNIC, GORAKHPUR (240)(SG)
Civil, Mechanical and Electrical Engineering.

26. P.M.V. POLYTECHNIC, MATHURA (120) (P)
Civil, Mechanical and Electrical Engineering.

27. TECHNICAL COLLEGE, DAYALBAGH, AGRA (90)(P)
Mechanical and Electrical Engineering.

28. UNIVERSITY POLYTECHNIC, ALIGARH (240)(U)
Civil, Mechanical and Electrical Engineering.

29. UNIVERSITY OF ROORKEE (240)(U)
Civil, Mechanical and Electrical Engineering.

30. GOVERNMENT CENTRAL TEXTILE INSTITUTE, KANPUR (30)(SG)
Textile Technology & Textile Chemistry.

31. GOVERNMENT LEATHER INSTITUTE, KANPUR (10)(SG)
Leather Technology.

32. NORTHERN REGIONAL SCHOOL OF PRINTING TECHNOLOGY, ALLAHABAD (120)(SG)
Printing Technology.

33. CHANDAULI POLYTECHNIC, CHANDAULI (60)(P)
Civil Engineering.

34. M.G. POLYTECHNIC, HATHRAS (120)(P)
Civil, Mechanical and Electrical Engineering.

35. TECHNICAL INSTITUTE, HANDIA (60)(P)
Civil Engineering.

36. NAINITAL POLYTECHNIC, NAINITAL (60) (P)
Civil Engineering.

37. GOVERNMENT POLYTECHNIC, BAREILLY (120) (SG)
Civil, Mechanical and Electrical Engineering.

38. GOVERNMENT POLYTECHNIC, JHANSI (120) (SG)
Civil, Mechanical and Electrical Engineering.

39. S.G. POLYTECHNIC, KHURJA (120) (SG)
Civil, Mechanical and Electrical Engineering.

HIMACHAL PRADESH

40. GOVERNMENT POLYTECHNIC, SUNDERNAGAR [illegible]
Civil, Mechanical and Electrical Engineering.

Eastern Region

ASSAM

41. ASSAM ENGINEERING INSTITUTE, GAUHATI (180) (SG)
Civil, Mechanical and Electrical Engineering.

42. H.R.H. PRINCE OF WALES INSTITUTE OF ENGINEERING AND TECHNOLOGY, JORHAT (180) (SG)
Civil, Mechanical and Electrical Engineering.

43. GOVERNMENT POLYTECHNIC, SILCHAR (120) (SG)
Civil, Mechanical and Electrical Engineering.

44. NOWGONG POLYTECHNIC, NOWGONG (180) (SG)
Civil, Mechanical and Electrical Engineering.

BIHAR

45. BHAGALPUR SCHOOL OF ENGINEERING AND TECHNOLOGY, BHAGALPUR (180) (SG)
Civil, Mechanical and Electrical Engineering.

46. RANCHI SCHOOL OF ENGINEERING, RANCHI (180) (SG)
Civil, Mechanical and Electrical Engineering.

47. DHANBAD POLYTECHNIC, DHANBAD (240)(SG)
    Civil, Mechanical and Electrical Engineering.

48. TIRHUT SCHOOL OF ENGINEERING, MUZAFFARPUR (180) (SG)
    Civil, Mechanical and Electrical Engineering.

49. MINING INSTITUTE, JHARIA, P.O. MAITHON DAM, DHANBAD (40)(SG)
    Mining.

50. MINING INSTITUTE, KODARMA (40)(SG)
    Mining.

51. PATNA SCHOOL OF ENGINEERING, PATNA (180)(SG)
    Civil, Mechanical and Electrical Engineering.

52. GAYA SCHOOL OF ENGINEERING, GAYA (180)(SG)
    Civil, Mechanical and Electrical Engineering.

53 PURNEA SCHOOL OF ENGINEERING, PURNEA (180) (SG)
    Civil, Mechanical and Electrical Engineering.

54. DARBHANGA SCHOOL OF ENGINEERING, DARBHANGA (180) (SG)
    Civil, Mechanical and Electrical Engineering.

ORISSA

55. JHARASAGUDA SCHOOL OF ENGINEERING, JHARASAGUDA (180)(SG)
    Civil, Mechanical and Electrical Engineering.

56. ORISSA SCHOOL OF ENGINEERING, CUTTACK (180)(SG)
    Civil, Mechanical and Electrical Engineering.

57. BERHAMPORE ENGINEERING SCHOOL, BERHAMPORE (180)(P)
    Civil, Mechanical and Electrical Engineering.

58. ORISSA SCHOOL OF MINING ENGINEERING, KEONJHAR (40) (SG)

Mining.

59. SCHOOL OF ENGINEERING, BHADRAK (180) (SG)

Civil, Mechanical and Electrical Engineering.

60. KENDRAPARA SCHOOL OF ENGINEERING, KENDRAPARA (120) (P)

Civil, Mechanical and Electrical Engineering.

MANIPUR

61. ADIMJATI TECHNICAL INSTITUTE, IMPHAL, MANIPUR (60) (SG)

Civil, Mechanical and Electrical Engineering.

TRIPURA

62. POLYTECHNIC INSTITUTE, P.O. AGARTALA, TRIPURA (120) (SG)

Civil, Mechanical and Electrical Engineering.

WEST BENGAL

63. ASANSOL POLYTECHNIC, ASANSOL (80) (SG)

Mechanical and Electrical Engineering. Mining.

64. CALCUTTA TECHNICAL SCHOOL, CALCUTTA (340) (P)

Mechanical and Electrical Engineering.

65. B.P.C. INSTITUTE OF TECHNOLOGY, KRISHNAGAR (180) (SG)

Civil, Mechanical and Electrical Engineering.

66. HOOGHLY INSTITUTE OF TECHNOLOGY, HOOGHLY (180) (SG)

Civil, Mechanical and Electrical Engineering.

67. JADAVPUR POLYTECHNIC JADAVPUR (180) (SG)

Civil, Mechanical and Electrical Engineering.

68. JALPAIGURI POLYTECHNIC INSTITUTE, JALPAIGURI (180) (SG)

Civil, Mechanical and Electrical Engineering.

69. JHARGRAM POLYTECHNIC, JHARGRAM (180) (SG

Civil, Mechanical and Electrical Engineering.

70. K.G. ENGINEERING INSTITUTE, BISHNUPUR (180) (SG

Civil, Mechanical and Electrical Engineering.

71. M.B.C. INSTITUTE OF ENGINEERING AND TECHNOLOGY, BURDWAN (180) (SG)

Civil, Mechanical and Electrical Engineering.

72. MURSHIDABAD INSTITUTE OF TECHNOLOGY, P.O. COSSIMBAZAR, MURSHIDABAD (180) (SG)

Civil, Mechanical and Electrical Engineering.

73. PURULIA POLYTECHNIC, PURULIA (180) (SG)

Civil, Mechanical and Electrical Engineering.

74. R.K. MISSION SHILPAMANDIR, BELURMATH (180) (P

Civil, Mechanical and Electrical Engineering.

75. SHRI RAMAKRISHNA SHILPA VIDYAPEETH, SURI (120) (SG)

Civil, Mechanical and Electrical Engineering.

76. SHRI JNAN CHANDRA GHOSH POLYTECHNIC, CALCUTTA (120) (SG)

Civil, Mechanical and Electrical Engineering.

77. SCHOOL OF PRINTING TECHNOLOGY, CALCUTTA (80) (SG)

Printing.

78. R.K. MISSION SHILPA PEETH, BELGHORIA (180) (SG)

Civil, Mechanical and Electrical Engineering.

79. BIRLA INSTITUTE OF TECHNOLOGY, CALCUTTA (40)(P)

Sandwich Course in Mechanical Engineering.

80. MALDA POLYTECHNIC, MALDA (180)(SG)

Civil, Mechanical and Electrical Engineering.

Western Region

MAHARASHTRA

81. GOVERNMENT POLYTECHNIC, POONA (320)(SG)

Civil, Mechanical, Electrical and Tele-communication Engineering, Metallurgy.

82. GOVERNMENT POLYTECHNIC, AURANGABAD (120)(SG)

Civil, Mechanical and Electrical Engineering.

83. GOVERNMENT POLYTECHNIC, KARAD (120)(SG)

Civil, Mechanical and Electrical Engineering.

84. GOVERNMENT POLYTECHNIC, AMRAVATI (120)(SG)

Civil, Mechanical and Electrical Engineering.

85. GOVERNMENT POLYTECHNIC, NAGPUR (180)(SG)

Civil, Mechanical, Electrical and Automobile Engineering.

86. GOVERNMENT POLYTECHNIC, SHOLAPUR (120)(SG)

Civil, Mechanical and Electrical Engineering.

87. INSTITUTE OF ENGINEERING AND TECHNOLOGY, DHULIA (60)(P)

Civil Engineering.

88. SIR CUSROW WADIA INSTITUTE OF ELECTRICAL TECHNOLOGY POONA (140)(P)

Civil, Mechanical, Electrical and Radio Engineering.

89. GOVERNMENT TANNING INSTITUTE, BANDRA, BOMBAY (15)(SG)

Leather Technology.

90. PURANMAL LAHOTI SMARAK TECHNICAL COLLEGE, LATUR (60)(P)

Civil Engineering.

91. ST. XAVIER'S TECHNICAL INSTITUTE, BOMBAY (60) (P)
Radio Engineering.

92. VICTORIA JUBILEE TECHNICAL INSTITUTE, BOMBAY (220) (P)
Civil, Mechanical, Electrical and Automobile Engineering. Textile Technology. Chemical Technology.

93. WALCHAND COLLEGE OF ENGINEERING, SANGLI (120) (P)
Civil, Mechanical and Electrical Engineering.

94. SCHOOL OF PRINTING TECHNOLOGY, BOMBAY (50) (SG)
Printing Technology.

95. GOVERNMENT POLYTECHNIC, KOLHAPUR (120) (SG)
Civil, Mechanical and Electrical Engineering.

96. GOVERNMENT POLYTECHNIC, RATNAGIRI (120) (SG)
Civil, Mechanical and Electrical Engineering.

97. GOVERNMENT POLYTECHNIC, KHAMGAON (120) (SG)
Civil, Mechanical and Electrical Engineering.

98. M.H. SABOO SIDDIK POLYTECHNIC, BOMBAY (60) (P)
Civil Engineering.

99. GOVERNMENT POLYTECHNIC, BOMBAY (300) (SG)
Civil, Mechanical and Electrical Engineering.

100. GOVERNMENT POLYTECHNIC, JALGAON (120) (SG)
Civil, Mechanical and Electrical Engineering.

GUJARAT

101. BHAILALBHAI BHIKHABHAI POLYTECHNIC, P.O. VALLABH VIDYA NAGAR, DISTT. KAIRA (150) (P)
Civil, Mechanical and Electrical Engineering.

102. DR. S. & S. S. GHANDHY COLLEGE OF ENGINEERING AND TECHNOLOGY, SURAT (140) (SG)
Civil, Mechanical, Electrical and Automobile Engineering.

103. POLYTECHNIC, M.S. UNIVERSITY, BARODA (300) (U)

Civil, Mechanical and Electrical Engineering.

104. FACULTY OF TECHNOLOGY AND ENGINEERING, M.S. UNIVERSITY, BARODA (60) (U)

Textile Technology. Textile Chemistry.

105. GOVERNMENT POLYTECHNIC, AHMEDABAD (300) (SG)

Civil, Mechanical and Electrical Engineering.

106. LUKDHIRJI COLLEGE OF ENGINEERING, MORVI (120) (SG)

Civil, Mechanical and Electrical Engineering.

107. SHRI A. V. PAREKH TECHNICAL INSTITUTE, RAJKOT (10) (SG)

Radio Engineering.

108. SIR BHAVSINGHJI POLYTECHNIC INSTITUTE, BHAVNAGAR (180) (SG)

Civil, Mechanical, Electrical and Automobile Engineering. Textile Technology.

109. R.C. TECHNICAL INSTITUTE, AHMEDABAD (45) (SG)

Textile Technology.

110. GOVERNMENT POLYTECHNIC, DOHAD (120) (SG)

Civil, Mechanical and Electrical Engineering.

111. K.D. POLYTECHNIC, PATAN (120) (SG)

Civil, Mechanical and Electrical Engineering.

112. GOVERNMENT POLYTECHNIC, PORBANDER (120) (SG)

Civil, Mechanical and Electrical Engineering.

113. SHRI KRISHAN LAL JHAVERI POLYTECHNIC, BROACH (120) (SG)

Civil, Mechanical and Electrical Engineering.

114. GANDHIDHAM CIVIL ENGINEERING INSTITUTE, ADIPUR, KUTCH (60) (P)

Civil Engineering.

MADHYA PRADESH

115. CENTRAL TECHNICAL INSTITUTE, GWALIOR (140)(SG)

Civil, Mechanical and Electrical Engineering. Textile Technology.

116. GOVERNMENT POLYTECHNIC, UJJAIN (132)(SG)

Civil, Mechanical, Electrical and Automobile Engineering.

117. GOVERNMENT POLYTECHNIC, JABALPUR (120)(SG)

Civil, Mechanical and Electrical Engineering.

118. GOVERNMENT POLYTECHNIC, NOWGONG (120)(SG)

Civil, Mechanical and Electrical Engineering.

119. GOVINDRAM TODI GOVERNMENT POLYTECHNIC, JAORA (90)(SG)

Civil, Mechanical and Electrical Engineering.

120. SAMARAT ASHOK TECHNOLOGICAL INSTITUTE, VIDISHA (60)(P)

Civil Engineering.

121. KIRODIMAL GOVERNMENT POLYTECHNIC, RAIGARH (120)(SG)

Civil, Mechanical and Electrical Engineering.

122. S.V. GOVERNMENT POLYTECHNIC, BHOPAL (210)(SG)

Civil, Mechanical and Electrical Engineering.

123. SRI GOVINDRAM SEKSARIA TECHNOLOGICAL INSTITUTE, INDORE (150)(P)

Civil, Mechanical and Electrical Engineering.

124. LEATHER TECHNOLOGICAL INSTITUTE, MORAR, GWALIOR (10)(SG)

Leather Technology.

125. MINING INSTITUTE, CHHINDWARA (40)(SG)

Mining.

126. GOVERNMENT POLYTECHNIC, KHANDWA (120)(SG)

Civil, Mechanical and Electrical Engineering.

127. GOVERNMENT MINING POLYTECHNIC, SHAHDOL (40) (SG)

Mining

Southern Region

ANDHRA PRADESH

128. ANDHRA POLYTECHNIC, KAKINADA (240) (SG)

Civil, Mechanical, Electrical, Tele-communication and Automobile Engineering.

129. GOVERNMENT POLYTECHNIC, ANANTAPUR (120) (SG)

Civil, Mechanical and Electrical Engineering.

130. GOVERNMENT POLYTECHNIC, VISAKHAPATNAM (200) (SG)

Civil, Mechanical and Electrical Engineering, Sandwich course in Mechanical Engineering.

131. GOVERNMENT POLYTECHNIC, HYDERABAD (270) (SG)

Civil, Mechanical, Electrical, Tele-communication and Automobile Engineering.

132. GOVERNMENT POLYTECHNIC, WARANGAL (120) (SG)

Civil, Mechanical and Electrical Engineering.

133. GOVERNMENT POLYTECHNIC, TIRUPATHI (180) (SG)

Civil, Mechanical and Electrical Engineering.

134. HYDERABAD POLYTECHNIC, HYDERABAD (120) (P)

Civil, Mechanical and Electrical Engineering.

135. GOVERNMENT POLYTECHNIC, VIJAYAWADA (180) (SG)

Civil, Mechanical and Electrical Engineering.

136. GOVERNMENT MINING INSTITUTE KOTHAGUDEM (40) (SG)

Mining.

137. GOVERNMENT MINING INSTITUTE, GUDUR (40) (SG)

Mining.

138. GOVERNMENT CERAMIC INSTITUTE, GUDUR (25) (SG)

Glass & Enamel Technology, Pottery & Ceramics Technology

139. GOVERNMENT POLYTECHNIC, PRODDATUR (120) (SG)
Civil, Mechanical and Electrical Engineering.

140 GOVERNMENT POLYTECHNIC, NIZAMABAD (120) (SG)
Civil, Mechanical and Electrical Engineering.

141. KRISHNA DEVARAYA POLYTECHNIC, WANAPARTHY (120)(P)
Civil, Mechanical and Electrical Engineering.

142. M.V.M. POLYTECHNIC, TANUKU (120)(P)
Civil, Mechanical and Electrical Engineering.

143. GOVERNMENT POLYTECHNIC, MAHBOOBNAGAR (120)(SG)
Civil, Mechanical and Electrical Engineering.

144. GOVERNMENT POLYTECHNIC, GUNTUR (120)(SG)
Civil, Mechanical and Electrical Engineering.

145. GOVERNMENT POLYTECHNIC, NANDYAL (120)(SG)
Civil, Mechanical and Electrical Engineering.

146. GOVERNMENT POLYTECHNIC, NELLORE (120)(SG)
Civil, Mechanical and Electrical Engineering.

147. GOVERNMENT POLYTECHNIC, SRIKAKULAM (120)(SG)
Civil, Mechanical and Electrical Engineering.

KERALA

148. THIAGARAJAR POLYTECHNIC, ALGAPPANAGAR (120)(P)
Civil, Mechanical and Electrical Engineering.

149. GOVERNMENT POLYTECHNIC, KALAMASSERY (170)(SG)
Civil, Mechanical, Electrical and Automobile Engineering.

150. KERALA POLYTECHNIC, KOZHIKODE (200)(SG)
Civil, Mechanical and Electrical Engineering.

151. MAHARAJA'S TECHNOLOGICAL INSTITUTE, TRICHUR (120)(SG)
Civil, Mechanical and Electrical Engineering.

152. SHRI NARAYANA POLYTECHNIC, KOTTAYAM, QUILON (120) (P)

Civil, Mechanical and Electrical Engineering.

153. GOVERNMENT POLYTECHNIC, CANNANORE (144) (SG)

Civil, Mechanical and Electrical Engineering. Textile Technology.

154. CENTRAL POLYTECHNIC, TRIVANDRUM (120) (SG)

Civil, Mechanical and Electrical Engineering.

155. CARMEL POLYTECHNIC, ALLEPPEY (120) (P)

Civil, Mechanical and Electrical Engineering.

156. N.S.S. POLYTECHNIC, PANDALAM (120) (P)

Civil, Mechanical and Electrical Engineering.

157. SRI RAMA POLYTECHNIC, VALPAD (120) (P)

Civil, Mechanical and Electrical Engineering.

158. GOVERNMENT POLYTECHNIC, KOTTAYAM (120) (SG)

Civil, Mechanical and Electrical Engineering.

159. GOVERNMENT POLYTECHNIC, PERINTHALAMANA (120) (SG)

Civil, Mechanical and Electrical Engineering.

MADRAS

160. ALAGAPPA POLYTECHNIC, KARAIKUDI (120) (P)

Civil, Mechanical and Electrical Engineering.

161. M.C.M. POLYTECHNIC, AVADI (120) (P)

Civil, Mechanical and Electrical Engineering.

162. ANNAMALAI POLYTECHNIC, CHETTINAD (120) (P)

Civil, Mechanical and Electrical Engineering.

163. CENTRAL POLYTECHNIC, MADRAS (390) (SG)

Civil, Mechanical and Electrical Engineering (including part-time) Radio Engineering and Line Communication. Fisheries Technology and Navigation. Sandwich course in Mechanical Engineering.

164. C.N.T. INSTITUTE, VEPERY, MADRAS (120)(P)

Civil, Mechanical and Electrical Engineering.

165. GOVERNMENT POLYTECHNIC, COIMBATORE (160)(SG)

Civil, Mechanical and Electrical Engineering. Agricultural Engineering.

166. INSTITUTE OF LEATHER TECHNOLOGY, MADRAS (15)(SG)

Leather Technology.

167. RAMAKRISHNA MISSION TECHNICAL INSTITUTE, MYLAPORE, MADRAS (60)(P)

Mechanical and Automobile Engineering.

168. NACHIMUTHU POLYTECHNIC, POLLACHI (120)(P)

Civil, Machanical and Electrical Engineering.

169. P.S.G. POLYTECHNIC, COIMBATORE (167)(P)

Civil, Mechanical and Electrical Engineering. Production Engineering. Textile Chemistry. Textile Technology.

170. SESHASAYEE INSTITUTE OF TECHNOLOGY, TIRUCHIRAPALLI (120)(P)

Civil, Mechanical and Electrical Engineering.

171. TAMILNAD POLYTECHNIC, MADURAI (200)(SG)

Civil, Mechanical, Electrical and Automobile Engineering.

172. GOVERNMENT POLYTECHNIC, NAGERCOIL (120)(SG)

Civil, Mechanical and Electrical Engineering.

173. GOVERNMENT POLYTECHNIC, VELLORE (120)(SG)

Civil, Mechanical and Electrical Engineering.

174. REGIONAL SCHOOL OF PRINTING, MADRAS (95)(SG)

Printing Technology.

175. VALIVALAM DESIKAR POLYTECHNIC, NAGAPATTINAM, TANJORE (120)(P)

Civil, Mechanical and Electrical Engineering.

176. SANKAR INSTITUTE OF POLYTECHNIC, SANKARNAGAR (120) (P)

Civil, Mechanical and Electrical Engineering.

177. THIAGARAJAR POLYTECHNIC, SALEM (150) (P)

Civil, Mechanical and Electrical Engineering, Textile Technology.

178. MUTHIAH POLYTECHNIC, ANNAMALAINAGAR (120) (U)

Civil, Mechanical and Electrical Engineering.

179. VIRUDHUNAGAR S. V. NADAR POLYTECHNIC, VIRUDHUNAGAR (120) (P)

Civil, Mechanical and Electrical Engineering.

180. BHAKTAVATSALAM POLYTECHNIC, KANCHEEPURAM (120) (P)

Civil, Mechanical and Electrical Engineering.

181. SRINIVASA SUBBARAYA POLYTECHNIC, SIRKALI (120) (P)

Civil, Mechanical and Electrical Engineering.

182. RAJAGOPAL POLYTECHNIC, GUDIYATHAM (120) (P)

Civil, Mechanical and Electrical Engineering.

183. GOVERNMENT POLYTECHNIC, PONDICHERRY (60) (SG)

Civil Engineering.

184. COIMBATORE INSTITUTE OF TECHNOLOGY, SANDWICH POLYTECHNIC, COIMBATORE (50) (P)

Sandwich course in Mechanical Engineering.

MYSORE

185. S.K.S.J. TECHNOLOGICAL INSTITUTE, BANGALORE (10) (SG)

Textile Technology.

186. SILVER JUBILEE POLYTECHNIC, BANGALORE (220) (SG)

Civil, Mechanical, Electrical and Tele-communication Engineering.

187. SCHOOL OF MINES, OORGAUM (40) (SG)
Mining.

188. B.V. BHOOMRADDI COLLEGE OF ENGINEERING AND TECHNOLOGY, HUBLI (120) (SG)
Civil, Mechanical and Electrical Engineering.

189. D.R.R. POLYTECHNIC, DAVANGERE (130) (SG)
Civil, Mechanical and Electrical Engineering.

190. GOVERNMENT POLYTECHNIC, GULBARGA (120) (SG)
Civil, Mechanical and Electrical Engineering.

191. KARNATAKA POLYTECHNIC, MANGALORE (170) (P)
Civil, Mechanical, Electrical and Automobile Engineering.

192. K. H. KABBUR INSTITUTE OF ENGINEERING, DHARWAR (120) (P)
Civil, Mechanical and Electrical Engineering.

193. NATIONAL INSTITUTE OF ENGINEERING, MYSORE (60) (P)
Civil Engineering.

194. POLYTECHNIC, CHINTAMANI (120) (SG)
Civil, Mechanical and Electrical Engineering.

195. GOVERNMENT POLYTECHNIC, BELLARY (120) (SG)
Civil, Mechanical and Electrical Engineering.

196. POLYTECHNIC, TUMKUR (120) (SG)
Civil, Mechanical and Electrical Engineering.

197. POLYTECHNIC, CHANNAPATNA (120) (SG)
Civil, Mechanical and Electrical Engineering.

198. M.I.S.W. SILVER JUBILEE POLYTECHNIC, BHADRAVATI (120) (SG)
Civil, Mechanical and Electrical Engineering.

199. SMT. L.V. POLYTECHNIC, HASAN (120) (SG)
Civil, Mechanical and Electrical Engineering.

200. M.E.I. POLYTECHNIC, RAJAJINAGAR, BANGALORE (120) (P)

Civil, Mechanical and Electrical Engineering.

201. ACHARYA PATHSHALA POLYTECHNIC, BANGALORE (120) (P)

Civil, Mechanical and Electrical Engineering.

202. B.V.V.S. POLYTECHNIC, BAGALKOT (120) (P)

Civil, Mechanical and Electrical Engineering.

203. GOVERNMENT POLYTECHNIC, KARWAR (120) (SG)

Civil, Mechanical and Electrical Engineering.

204. GOVERNMENT POLYTECHNIC, BELGAUM (120) (SG)

Civil, Mechanical and Electrical Engineering.

205. D.A.C.G. POLYTECHNIC, CHICKMAGLUR (120) (SG)

Civil, Mechanical and Electrical Engineering.

206. C.P.C. POLYTECHNIC, MYSORE (160) (SG)

Civil, Mechanical and Electrical Engineering. Automobile Engineering.

207. GOVERNMENT POLYTECHNIC, KRISHNARAJAPET (120) (SG)

Civil, Mechanical and Electrical Engineering.

208. GOVERNMENT POLYTECHNIC, BIDAR (120) (SG)

Civil, Mechanical and Electrical Engineering.

209. GOVERNMENT POLYTECHNIC, FRAZERPET (120) (SG)

Civil, Mechanical and Electrical Engineering.

210. GOVERNMENT POLYTECHNIC, RAICHUR (120) (SG)

Civil, Mechanical and Electrical Engineering.