

EIGHTH FIVE YEAR PLAN

REPORT OF THE WORKING GROUP

ON

TECHNICAL AND MANAGEMENT EDUCATION

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TECHNICAL AND MANAGEMENT EDUCATION

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EIGHTH FIVE YEAR PLAN

REPORT OF THE WORKING GROUP ON TECHNICAL AND MANAGEMENT EDUCATION

EXECUTIVE SUMMARY AND HIGHLIGHTS OF RECOMMENDATIONS

In the body of the report we have given a detailed description of the present scenario of technical and management education in the country and recommended several strategies for adoption in the Eighth Plan. We have also indicated a detailed budget at the end of the report. In what follows, we shall provide a brief summary of the crucial issues of concern and list the most important recommendations for the Eighth Plan.

2. It is important that our plans for technical education take into account the changing nature of our society. In the next few years, there will be an unprecedented growth in our industry. Knowledge-based industries will be on the increase and the level of skills required of our technicians and engineers is also going to be higher.

Although many of our graduates may be unemployed or under-employed, our requirements for highly competent technical manpower may continue to increase further in the next decade. It is not at all certain that we are fully prepared to meet this challenge. The mismatch between the manpower required and generated will increase unless the right steps are taken by the Centre and the States. Manpower planning needs more careful attention.

It is noteworthy that technology is a vehicle for development. Technical education, therefore, has a different dimension. Budget for technical education has to be viewed not as an expenditure but as an investment that is likely to yield results of value to society.

3. The rate of change of the science and technology scenario is very high today and this tends to make our present technical education system less relevant - and not infrequently obsolescent. There are many aspects of technical education that require immediate attention.

Our polytechnics are in a very bad state and need to be

overhauled with a sense of urgency. At present they are producing neither technicians nor artisans. Polytechnic and ITI (Industrial Training Institute) education has to be made more respectable, if we have to prevent the increasing rush for admission to colleges, often to study courses without much scope or substance. The role of technicians has to be recognised adequately and there should be a proper reward system for skilled technicians and such personnel. The performance of our polytechnics and ITIs will only improve when we expect more out of our technicians and craftsmen and also give them the due recognition.

Many of the engineering colleges do not have adequate infrastructure to impart meaningful education. Even the so-called centres of excellence are not geared to provide technical education at the highest level; they are not really comparable to similar institutions in the advanced countries.

4. Most of our technical institutions do not really enjoy autonomy. Better departments and colleges should be given increasing autonomy based on their track record. The educational system has become much too rigid. Flexibility is absolutely essential if any innovations have to be introduced, and innovations are essential for us to keep up with the changing times.

5. The All India Council for Technical Education (AICTE) is emerging to become an important organisation for technical education in the country. While this Council should coordinate technical education and take promotional measures as well as carry out performance evaluation, it is very important to ensure that institutions of excellence such as the Indian Institutes of Technology (IITs) and the Indian Institute of Science (IISc) have the necessary freedom and are not bogged down by procedures and bureaucratic impediments. Such institutions should not slowly become appendages to Government departments.

6. One of the main drawbacks in engineering education today is the gradual decline in the area of engineering design. This area has to be promoted. Experimental research, design and development (R, D & D) work is not being carried out to the desired extent in most engineering institutions. Instrumentation activity is also fading away from the scene.

7. Continuing education has to be strengthened at all levels and there is need for greater support for continuing education for teachers as well as for those in industry. Industries themselves have much to contribute to continuing education.

8. Our Institutes of Management (IIMs) as well as other institutions giving management degrees are heavily pre-occupied with business administration and industrial administration. It is important that they concern themselves with other important aspects of the national scenario in science and technology.

9. Education in entrepreneurship needs to be planned and promoted better.

10. There are many imbalances in our technical and management education system and these are dealt with in some detail in the main body of the report. The role of women in technical education deserves special mention.

11. Professional bodies should be involved in technical education and such involvement may be mutually beneficial, upgrading the quality of both.

12. Main Recommendations

12.1 In view of the deplorable state of our polytechnics, a complete overhaul of the technician education system should be taken up during the Eighth Plan. It is proposed that the Bureau of Technical Education of the Ministry of Human Resource Development establish a Commission or a Board to monitor and coordinate this overhauling. This will require a high investment and should be provided for in the Eighth Plan. It is proposed that around Rs.500 crores be invested in this project in the Central sector and another Rs.200 crores in the State sector.

12.2 It is extremely important to improve the general infrastructure of our engineering institutions. Unless we do this, the very purpose of engineering education would be lost and the investment made all these years would come to waste. It is proposed that around Rs.1150 crores be made available in the Central sector and another Rs.200 crores in the State sector for modernisation and removal of obsolescence and development

of thrust areas in engineering colleges and such other institutions.

12.3 With regard to institutions of excellence such as the IITs, IISc, University of Roorkee etc., we have to make heavy investments during the Eighth Plan if they have to become comparable to some of the best institutions elsewhere. This is an urgent need. Adequate budget provision should be made available during the Eighth Plan to augment the facilities of these institutions and to promote certain well-defined programmes. Budget provisions are indicated in the relevant schemes. These institutions should be required to take up new challenging areas in addition to instrumentation, design activities and experimental R&D. Gradually, efforts should be made to see that more and more technical institutions (e.g. Regional Engineering Colleges) transform themselves into institutions of excellence.

Outstanding individuals and groups in technical institutions should be given special support by recognising them as units of excellence.

12.4 There are many new areas of science and technology that require immediate attention. Typical of these are ceramics and advanced materials technology, manufacturing processes and the interface between biological sciences and engineering. We have to invest specially in such areas. Institutions of excellence such as IITs should take up programmes in these emerging areas in the Eighth Plan. Some of the national laboratories should be utilised fully for post-graduate degree courses in specialised areas of engineering and technology.

12.5 For continuing education of teachers, technicians and professional engineers, we have to make special funds available. A budget to the tune of Rs.15 crores in the Central sector and Rs.30 crores in the State sector should be made available for this purpose.

12.6 At least four Regional Libraries in science, engineering and technology should be set up during the Eighth Plan. A budget to the tune of Rs.32 crores would be required for this purpose in the Central sector.

12.7 Special attention is required in the Eighth Plan not only for education of women in technical and management professions, but also for providing suitable employment and other opportunities for trained women. A budget allocation of Rs.100 crores in the Central sector and Rs.40 crores in the State sector is proposed for the purpose.

12.8 With reference to engineering research, it is strongly recommended that a National Science and Engineering Research Board be established during the Eighth Plan. Budget allocation for this body should be made separately. A similar recommendation has been made by the working group on basic research. The Science Advisory Council to the Prime Minister has also recommended the establishment of a national body with the main objective of funding science and engineering research in the country. This idea has the support of the Ministry of Human Resource Development and of the University Grants Commission.

12.9 Management education has to be diversified with greater care. It must be ensured that different sectors of science and technology and many other important aspects of our society (including the service sector) are given adequate attention by the Institutes of Management (IIMs).

12.10 Entrepreneur education also requires to be emphasised and made part of the instruction programme in many of the engineering colleges and also in management institutions. Entrepreneurship in different sectors of industry has to be catered to in the proposed training programmes. A provision of Rs.5 crores in the Central sector and another Rs.3 crores in the State sector is recommended for entrepreneurship development programmes.

12.11 Science education at the college level deserves special consideration. Today, we do not have good under-graduate science programmes (similar to the engineering programmes in IITs and a few other institutions). New programmes/centres devoted to science education have to be developed through a consortium of universities and involvement of institutions such as the IISc and Tata Institute of Fundamental Research (TIFR).

12.12 The University Grants Commission (UGC) is supporting well over 80 universities/institutions offering courses/programmes

in engineering and technology, management, pharmacy etc. A provision of Rs.150 crores is recommended for these UGC programmes.

C.N.R. Rao
CHAIRMAN

EIGHTH FIVE YEAR PLAN

1.0 PRESENT SCENARIO

1.1 Introduction

Technical education (which in our context includes also management education) is one of the most crucial components of human resource development with great potential for adding value to products and services, for contributing to the national economy, and for improving the quality of life of the people. In recognition of the importance of this sector, successive Five Year Plans have laid great emphasis on the development of technical education.

During the past four decades, there has been a phenomenal expansion of technical education sector in the country. Today, we have over 184 recognised technical education institutions at the first degree level (including IITs, deemed universities, university departments and RECs) and more than 444 polytechnics at the diploma level with annual admission capacities of 36,600 and 74,100 respectively. They offer a variety of courses in several areas of engineering and technology including management. About 140 institutions offer facilities for post-graduate studies and research in several specialised areas with an annual capacity of about 9,400 students.

1.2 Seventh Five Year Plan

Taking stock of the position then existing in the field of technical education, the Seventh Plan laid emphasis on the following aspects:-

- (i) consolidation of infrastructure and facilities already created,
- (ii) optimum utilisation of the existing facilities with attention to cost-effectiveness,
- (iii) identification of critical areas with a view to strengthening the facilities in the fields where weaknesses exist,
- (iv) creation of infrastructure in new areas of emerging technology vital for the development of the country.

- (v) improvement of quality and standards,
- (vi) removal of obsolescence,
- (vii) modernisation of engineering laboratories and workshops,
- (viii) effective management of the overall system of technical education,
- (ix) innovative measures to improve existing facilities, to provide low cost alternatives, and to achieve various goals and objectives laid down in the Plan, and
- (x) institutional linkages between technical education on the one hand and rural development and other development sectors on the other.

The original allocation of funds for technical education in the 7th Plan was a total of Rs.681.79 crores (Central sector: Rs.220 crores, States/UTs sector: Rs.461.79 crores). However, the total Plan expenditure during the 7th Plan ending March 1990 is expected to be of the order of Rs.1230 crores (Central sector: Rs.700 crores, States/UTs sector: Rs.530 crores).

1.3 The New National Policy on Education

The National Policy on Education (NPE) formulated in 1986 took into account the status of the technical education system, the factors which are important to revitalise the system as well as the challenges posed by the rapid advances in science and technology. The Programme of Action (POA) which was prepared in pursuance of the NPE indicated several initiatives to be launched during the 7th Plan and thereafter. As many of these ideas were worked out midway through the 7th Plan, when the Plan priorities and allocations had already been finalised, much of the follow-up measures envisaged could not be taken up. It is expected that the 8th Plan will properly reflect the initiatives and programmes envisaged in the Policy.

1.4 The All India Council for Technical Education (AICTE)

The AICTE was set up in 1945 as a national expert body to advise the Central and State Governments on all aspects of the development of technical education. However, since it did not have statutory powers, it was not possible to enforce many of the recommendations relating to maintenance of standards and coordinated development of technical education. The AICTE has

- proper planning and coordinated development of technical education system throughout the country,
- promotion of qualitative improvement of technical education in relation to planned quantitative growth, and
- regulation of the system and proper maintenance of norms and standards.

The AICTE Act of 1987 has come into force with effect from March 28, 1988. Further action is in progress to make the statutory AICTE operational.

1.5 Institutions and Programmes under the Central Sector

1.5.1 Institutions under the Central Sector

The Central Government has established several pace-setting institutions and introduced quite a few programmes from time to time to promote the quality and standards of technical education. There are 33 institutions in operation under the Central sector. They are:

- 5 Indian Institutes of Technology (IITs)
(Established: Kharagpur 1950; Bombay 1953; Madras 1959; Kanpur 1960; Delhi 1961)
- 4 Indian Institutes of Management (IIMs)
(Established: Calcutta 1961; Ahmedabad 1962; Bangalore 1972; Lucknow 1984)
- 17 Regional Engineering Colleges (RECs)
(14 of them were established during the Second and Third Five Year Plans, the one at Silchar in 1977, Hamirpur in 1986, and Jalandhar in 1987. These are joint enterprises of the Central and State Govts.)
- 4 Technical Teachers' Training Institutes (TTTIs)
(Established in mid-1960s one each at Madras, Bhopal, Chandigarh and Calcutta)
- National Institute for Training in Industrial Engineering (NITIE), Bombay.
(Established: 1963)
- National Institute of Foundry and Forge Technology (NIFFT), Ranchi.
(Established: 1966)
- School of Planning & Architecture (SPA), New Delhi
(Established: 1955)

It is not necessary to dilate on the roles and contributions of these institutions. Even though they have gained considerable stature over the years, all of them need proper consolidation and strengthening through adequate infrastructural inputs, efforts to remove obsolescence and introduction of innovative programmes. All these institutions have re-defined their institutional goals and targets, and prepared perspective plans for further development during the remaining period of the 7th Plan and during the 8th Plan period, on the basis of the NPE. Funds for the development of these institutions are provided under the Central sector.

Two more institutions have been cleared to be established under the Central sector. They are:

1. The Longowal Institute of Engineering & Technology in Punjab, and
2. The Indian Institute of Technology in Assam.

Necessary formalities for setting up these institutions are now in progress.

1.5.2 Programmes under the Central sector

There are several on-going programmes under the Central sector. They include:

(i) Quality Improvement Programme (QIP): Launched in 1970-71, programmes of faculty development, curriculum development, and practical training of teachers in industry are implemented under this scheme.

(ii) Apprenticeship Training: Under the Apprentices Act 1961 (amended in 1973) engineering graduates and diploma holders are provided training facilities in industry under this programme.

(iii) Community Polytechnics: Instituted in 1978-79, today 109 such polytechnics interact with the community training rural youth for productive employment, helping in transfer of technology, and providing technical and support services to the people in the locality.

(iv) Development of post-graduate courses: Under this programme initiated in 1961, the Central Government promotes post-graduate education and research in 15 State Government and 24 non-Government post-graduate institutions.

(v) Centres for development of rural technology (CDRT): Started in 1980-81, under this programme such centres have been established in 15 diploma level institutions for developing, modifying and adopting technology relevant to rural needs.

(vi) Modernisation and removal of obsolescence: Started in 1981-82, the scheme aims at modernisation and removal of obsolescence of technical education institutions at all levels.

(vii) Thrust areas in technical education: Instituted during the 6th Plan, the scheme includes expansion of facilities in areas of weakness and creation of infrastructure in areas of emerging technologies.

(viii) Institutional network scheme: Initiated in 1981-82, highly developed institutions such as the IITs are linked to comparatively less developed institutions like the RECs and other engineering colleges to promote collaboration between them.

(ix) National Technical Manpower Information System (NTMIS): Instituted in the year 1983-84, the scheme attempts to provide upto date and meaningful manpower projections on a continuing basis.

(x) Advanced technician courses: Started in 1981-82, under this programme 10 institutions are given support to offer advanced level courses for technicians possessing diploma qualifications.

(xi) International Centre for Science & Technology Education (ICSTE): Initiated in 1986, this Centre will be a national institution with an international outlook, and will operate through a network of existing institutions in the country to serve as a resource centre and a centre for cooperative research.

Of the programmes mentioned above, the scheme of community polytechnics has been subjected to a review and it is proposed to further expand its scope and dimensions. The schemes of advanced technician courses and National Technical Manpower Information System are now under evaluation. All the above on-going programmes will need considerable strengthening during the 8th Plan.

Several new programmes/schemes have been introduced as part of the implementation of NPE 1986. They include:

(i) Programmes of new and/or improved technologies and offering new courses in specialised fields: Initiated in 1987-88, the scheme aims at developing technical manpower in new technology areas through a diversity of programmes.

(ii) Continuing education: Introduced in 1987-88, several activities have been undertaken to promote continuing education programmes.

(iii) Restructuring courses/programmes: Started in 1987-88, the scheme aims at introducing multi-point entry and credit system, inter-disciplinary and multi-disciplinary programmes, etc.

(iv) Curriculum development: Started in 1987-88, the scheme aims at producing multi-media learning packages, establishing resource development centres, strengthening existing curriculum development centres, etc.

(v) R&D in selected technical institutions: Introduced in 1987-88, the scheme aims at promoting research culture in technical education institutions.

(vi) Industry-institution interaction: Introduced in 1988-89, the scheme aims at promoting interaction between academic institutions and industry in a variety of ways.

(vii) Residential polytechnics for women: The scheme which has been approved for promoting technical education of women aims at establishing 4 such polytechnics during 1988-89.

(viii) Strengthening existing institutions for non-corporate and unorganised sectors: The scheme which has been cleared for implementation to cater to the special needs of the non-corporate and un-organised sectors is expected to go into operation during 1988-89.

Because of inadequate resources, the scope and dimensions of these new Plan schemes based on the NPE have been reduced considerably. The scope and dimensions of these new schemes will have to be expanded during the 8th Plan.

1.6 Institutions and Programmes under the State Sector

1.6.1 Institutions under the State sector

Polytechnic education at diploma level is primarily the concern of the State Governments. Funds for the establishment and

the vast majority of technical education institutions at graduate and post-graduate levels also come under the State sector. Departments of engineering and technology of the State universities are partly supported by the University Grants Commission (UGC). The States have been requested to formulate perspective plans for development of the institutions under their charge based on the NPE.

1.6.2 Programmes under the State sector

The States depend heavily on the programmes and schemes formulated under the Central sector (see 1.5.2 above) for improving the quality and standards of technical education in the institutions under their control. While the States do incur some expenditure on their own in implementing these schemes and programmes in their institutions, they have not so far come up with any major programmes or schemes of their own. In the context of the implementation of NPE, the States have been requested to come up with their own programmes and schemes to supplement and complement the Central efforts. It is necessary that the States are provided with adequate funds for this purpose.

1.7 Unrecognised self-financing/capitation fee institutions

In the recent past, a large number of unrecognised private self-financing/capitation fee institutions have come into existence in several States. They have been established in an ad-hoc manner without proper planning and without the approval of the AICTE. Most of them are sub-standard institutions run on commercial basis. There are today 148 engineering colleges and 407 polytechnics coming under this category. Their annual student intake capacities are 31,800 and 51,100 respectively. There are 2 unrecognised institutions offering post-graduate courses with a total annual student intake capacity of 18.

These institutions have had adverse effects on the technical education system. The new statutory AICTE will have to take appropriate action either to close them down or to bring them up to the required standards.

1.8 Some imbalances and distortions

Over the years and for a variety of reasons, several imbalances and distortions have crept into the technical education system.

They include:

- While a large number of habitations in the country are even today without any facilities for technical education, about 38% of the degree level institutions and 30% of the diploma level institutions recognised by the AICTE are concentrated in 4 States - namely, Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu. Almost all the engineering colleges and polytechnics unrecognised by the AICTE are in these 4 States.
- The enrolment of girls in technical education institutions at degree level is only 12%, while that at diploma level it is about 17%.
- The enrolment of SC/ST students in degree level institutions is less than 5% and in diploma level institutions less than 9%.
- In most of the institutions, both at degree and diploma levels, there is hardly any R&D activity. R&D activities generally take place in the IITs, IISc (Bangalore) and a few universities and colleges.
- The annual student intake of unrecognised institutions is almost the same as that of recognised institutions.
- There is serious unemployment among engineers and technicians. Employment Exchange records indicate that as on 31.12.1987, we had 57,292 graduate and post-graduate engineers and 2,48,179 diplomate technicians un-employed. At the same time, there is a shortage of highly trained engineers/technologists in certain areas such as polymers, engineering design, advanced materials, turbo-machinery, computer science and micro-electronics. There is a mis-match between production and demand. With the anticipated industrial growth and economic development by the turn of the century, we may have to produce many more qualified engineers and technicians than at present.
- Wastage in the system is enormous. An analysis of the intake and out-turn figures of recognised institutions shows that wastage at degree level is about 30%, at diploma level 35%, and at post-graduate level 45%. The situation

1.9 Bird's eye-view of the real situation

In spite of all that has been achieved so far in the area of technical education, the picture that emerges today is a somewhat mixed one.

There is considerable ad-hocism in our approach to technical manpower generation. Consequently, several imbalances and distortions have crept into the system. Even our premier institutions are struggling to keep themselves up-to-date. The infrastructural facilities available in the vast majority of our technical education institutions are alarmingly inadequate. The quality of training in most of the institutions is poor. Many of the courses offered in these institutions are outdated. Teaching competency is low, while the management system continues to be rigid.

There is acute shortage of manpower in many emerging areas of technology. At the same time high quality engineers and technologists trained in these very areas in some of our prestigious institutions migrate abroad. In addition, many good graduate engineers take up management as a profession and this causes a great shortage of talent. There is unemployment among our engineers and technicians.

The polytechnics have become badly out-dated and are today producing diploma holders who are neither good technicians nor skilled craftsmen.

Technical education institutions by and large function in isolation. In spite of all that has been talked about on the matter, linkages and interaction between technical education institutions and user agencies (such as industry, R&D organisations and development sectors) are not sufficiently strong.

In short, while there are some isolated institutions of excellence in the system, a lot more remains to be done to improve the overall quality of technical education. Taking into account the scenario by the turn of the century in socio-economic, industrial and technological areas, more concerted efforts need to be made to enable the technical education system play the desired role.

2.0 PERSPECTIVES OF DEVELOPMENT

2.1 National Development Goals

Effective planning should be based on a vision of the future. A long-term perspective is necessary to translate the vision into reality and to make it operational. The 8th Plan should therefore be set within a 15-year perspective. We should aim at creating by the year 2005, the conditions necessary for self-sustaining growth and to provide the basic material requisites for the well-being of all our people.

High priority should be given to energy, communication, transportation, food production and processing, industrial development and rural reconstruction. The building up of a modern society devoid of poverty making optimal use of science and technology should be the basic objective of our planning. For achieving self-reliant growth, domestic technological capabilities are of strategic importance. To strengthen the country's scientific and technological base, it is necessary to enhance domestic technological capabilities and to initiate research and development in frontier areas of science and technology to enable the country to play a significant role in the world technology market. As she enters the 21st century, India will have to keep abreast of developments in several areas such as micro-electronics, informatics, telematics, bio-technologies, material sciences, oceanography, instrumentation and space technology. A well conceived and coordinated approach to the introduction of emerging technologies in our industry will further accelerate the pace of our development and socio-economic growth. This is specially required in the export-oriented sector which has to be promoted in a big way, if our resource-position has to improve.

2.2 Perspectives of Development of Technical Education

2.2.1 Perspective Plan for Technical Education

In formulating a perspective plan for technical education, an orchestrated increase in our efforts and inputs have to be built into the 8th Five Year Plan and beyond. Clearly, the perspectives of development of technical education should also mesh and match with the national development goals. Taking into account the national perspectives and social relevance, the NPE has emphasised the need for reorganising the

by the turn of the century through the induction of improved technologies, supply of adequate technical and managerial manpower to the services sector as well as to the unorganised sectors, promotion of continuing education and distance learning, computerisation, entrepreneurship development, strengthening of the community polytechnics system as well as innovative research and development. Improving the efficiency and effectiveness at all levels is also essential.

2.2.2 Approach to Technical Education

A radical change in thinking is needed if technical education is to address itself to the changing pace of science and technology. Scientific and technological advances are so rapid and unpredictable that they preclude anyone from obtaining a knowledge of all that needs to be learnt in a fixed period. Three or four years are far too short to learn all aspects of any discipline. The pure lecture-home-work-quiz format existing today can no longer train the engineers and technologists of tomorrow, who have to take on the challenges of the future. Engineering is a problem-solving profession. The aim of technical education must therefore be to prepare the students for a professionally productive life. Any valid approach to technical education must encourage development of motivation and skills for continuous independent learning. Technical education of tomorrow must train professionals who have an inter-disciplinary approach to problem-solving. After all, all the real problems in society are inter-disciplinary. The technical education system has to be re-designed and re-organised to produce a substantial percentage of self-propelled individuals who would be able to grow into any new area and make their contributions.

2.2.3 Problems of obsolescence and poor standards

Measures taken during the 7th Plan for improving the quality and standards of technical education and for strengthening its infra-structural aspects will require considerable re-enforcement in the coming years. The present state of obsolescence of technical education institutions needs urgent attention. Immediate action for their modernisation and an organisational mechanism for ensuring continuing upgradation are necessary if we are to stay internationally competitive at least in select areas. Modernisation cannot be undertaken as an occasional exercise, but has to be a continuous process. The task of modernisation cannot be limited to removal of obsolescence of infrastructure alone,

systems, examination system etc.

2.2.4 Management of the system

The management of the technical education system will need special attention in the coming years. Since technical education is essentially an investment and forms a crucial input for national development, it should no longer be treated as just a part of general education. As with other sectors of professional education such as health and agriculture, technical education should be organised, managed and administered separately from general education.

Increased professionalism on the part of managers of technical education in the areas of administration, planning, decision-making and organisational development has become vital. The decision making systems will have to be sensitised to respect the consultative processes not only in word, but also in spirit. The AICTE has to keep these points in mind in its efforts to coordinate and promote technical education.

The State being the implementing agency for most technical education programmes, the State Directorates have a variety of academic, professional and managerial roles to play. The State Boards of Technical Education need to be reorganised and vested with statutory powers in order to be more effective. The Directorates should have organs dealing with manpower assessment, planning, coordination, controlling, monitoring and evaluation of programmes. Reorganisation of the Directorates to enable them to perform these professional functions effectively should be undertaken as a matter of priority.

2.3 Objectives of the 8th Plan

Taking into account the present scenario, the situation in the year 1989-90, and the perspectives of development of technical education vis-a-vis the national development goals, we feel that while consolidating and strengthening the on-going programmes and the new schemes based on the NPE, the 8th Plan in respect of technical education should concentrate on:

- (i) Improvement of quality and standards at all levels.
- (ii) Upgradation of infrastructural facilities.
- (iii) Establishment of effective linkages with developmental sectors, national laboratories, industry and other

institutions/bodies.

- (iv) Technology watch and assessment of manpower in crucial areas.
- (v) Measures to prevent brain drain.
- (vi) Promotion of research and development.
- (vii) Steps to ensure cost effectiveness.
- (viii) Special programmes for SC/ST, women and the handicapped
- (ix) Entrepreneurship development.
- (x) Continuing education and retraining programmes.

3.0 TASKS FOR THE EIGHTH PLAN

3.1 Improvement of quality and standards

3.1.1 Curricula and course structure: As already mentioned in Section 2.2.2 a change is needed in our approach to technical education. A more broad-based flexible system of technical education is required to enable a better response to the unspecified demands of the future. Courses should be offered in suitable modules with the credit system and provision for multi-point entry.

Perhaps the first need is to bring about a total change in the laboratory work prescribed in the curricula of courses, which is presently confined to re-inforcement of theoretical concepts, verification of theorems/laws, calibration of instruments etc. This has to be changed to develop creative, innovative, inventive, experimental and problem-solving abilities by introducing problem/process-oriented laboratory exercises. Use of competitions, contests and projects relating to solution of real-life problems and institution of a system of awards, recognition and other incentives are some ways of encouraging creativity and innovation in experimental work. Curricula should be reviewed on a continuing basis to cope with technological changes and manpower needs. Adequate support should be provided to strengthen the work of curriculum development. The culture of seminars by students and faculty should become part of the technical education system.

Technical education has 'science' as its base, and it is necessary to take stock of the quality of science education being imparted in schools and colleges that finally feed students to engineering institutions. We have to start shaping our future engineers and technologists in schools rather than in engineering colleges.

At higher levels, a new institutional approach needs to be introduced to provide education in science comparable in quality with what the IITs do in engineering. Such an institutional structure should be linked to the higher institutions of learning such as TIFR, IISc, IITs etc. drawing upon the human and material resources of these institutions to ensure that the quality of education provided remains high.

Some of the emerging areas, though science-based, are heavily technology oriented. Examples are: computer science, opto-electronics, operations research, laser technology etc. For these areas there is urgent need to train scientists/technologists who can handle the twin responsibilities of scientific research and innovative application. The traditional framework of engineering programme is inappropriate for this purpose and a separate stream has to be developed. These courses should be introduced only in selected institutions having adequate infrastructural facilities. Such courses which are already existing should be restructured to make them more application oriented.

Major changes are about to take place in India in the area of manufacturing engineering. Engineering design and product development are areas on which we need to concentrate. The current de-emphasis on capability for design of products and systems must be removed by a well thought-out strategy including re-design of the engineering curricula to ensure that engineering and industrial design skills are properly developed among the students.

Professional manpower needs for human settlements for the next few decades require to be assessed properly and education oriented to support them. Steps should be taken to establish suitable curricula in existing institutions and also open habitat schools, if necessary.

3.1.2 Admission of students: Admission to technical education programmes at diploma, undergraduate and postgraduate levels must be based only on merit and motivation. Selection of students should be through carefully designed entrance tests. While these tests could be conducted State-wise for admission to diploma level institutions, there should be a common national test for admission to all degree programmes and another common national test for admission to all post-graduate programmes.

3.1.3 Faculty and staff development: Next to the student body, the faculty is the most important factor in assuring the success of any engineering education programme. Technical competence, scientific understanding, creative ability and humanistic wisdom are essential for teachers of engineering and technology. To quote from Grinter Report on Evaluation of Engineering Education in the United States: "Distinguished faculties are far more

details of curricula or magnificence of facilities".

Engineering faculty face a formidable task in that they have multiple roles to perform: teaching, research, development of learning resource material, extension work, and managing the institution. It is crucial that they must keep themselves abreast of emerging technologies. What is even more important is that they must perform a leadership role in investigating new technologies and recommending their application.

Recruitment to teaching positions should be strictly on merit by open competition and on all-India basis. Appropriate screening techniques and recruitment procedures should be adopted to ensure selection of persons of the highest calibre. Educational institutions, engineering profession, industry and Government should jointly develop a variety of programmes designed to enhance the development of engineering faculty members as practicing engineers through the effective use of study leave, summer training, consulting and research opportunities.

Technical teacher training and re-training programmes play a vital role in improving standards of teaching and curricula. Coordinated teacher training programmes should be organised at the national level for both polytechnic and engineering college teachers. Tools of educational technology are eminently suited for teacher training.

A rigorous 'staff appraisal scheme' to assess the teacher annually in the area of teaching, laboratory work, research, extension work, institutional management etc. should be introduced in every institution. Staff appraisal records should be looked into at every stage of promotion. Teachers should also be asked to evaluate themselves through self-assessment schemes. To ensure sustained high-quality performance, appointments to senior positions (i.e. professors and heads of institutions) should be on contract basis for five years, renewable after assessment.

The non-teaching technical supporting staff has a direct bearing on the technical education process. Apart from assisting in laboratory experimentation and workshop practice, they are primarily responsible for the maintenance of laboratory equipment, instruments etc. Training needs of this category of personnel deserve immediate attention to ensure optimum and effective utilisation of resources for instruction.

3.1.4 Accreditation: Continuous evaluation of institutions as also their total performance in respect of programmes is essential for maintenance of standards. This will also enable

capability to launch new programmes and projects, and consolidate the existing programmes. Granting autonomy to selected institutions and departments on the basis of track records will go a long way in upgrading academic standards.

For the success of accreditation and assessment, it is important to ensure that referable standards are developed for the sub-sectors of science, engineering, management, architecture, etc. and detailed norms of physical facilities, teaching infrastructure, teacher-student ratio, teacher competencies, curricula, and expenditure per student etc. are laid down. This task has to be undertaken as a matter of urgency by the National Accreditation Board proposed to be set up under the aegis of the new statutory AICTE. Audit of all existing institutions and their quality grading should be completed well before the start of the Eighth Plan.

3.2 Upgradation of infrastructural facilities

Coordinated and concerted efforts are to be made to upgrade the infrastructural facilities in technical education institutions. Routine needs of institutions such as availability of basic equipment, chemicals and consumables, power supply, water supply, seminar and conference facilities etc. should be looked into in greater detail with specific programmes drawn out for providing them.

The programmes of the Ministry of Human Resource Development and the UGC in respect of 'modernisation and removal of obsolescence', 'thrust areas' etc. should be further strengthened and coordinated. Computer facilities should be considerably enhanced. Mechanisms should be evolved so that large computer systems are linked to educational and research institutions through appropriate telecommunication facilities. Computer network should be provided through regional computers as well as enhanced availability of PCs. Developments in the field of educational technology have made available a variety of audio-visual aids and reprographic facilities which could make the instructional process more effective. Adequate support should be given to institutions to organise audio-visual and reprographic services.

With the vast amount of published literature and the newer methods of information retrieval, the role of library in the teaching-learning process has become very important. To get maximum benefit from this resource, it is essential that the efficiency of the library services should be improved. With modern networking facilities through computers and satellite communication, we should formulate a long-term plan for increasing the access to world literature in most of our technical education institutions.

The role of resource centres in the instructional process is very significant. Such centres can help individualise the instructional process and make it more student oriented. Remedial instruction to weaker students becomes easier through a variety of instructional alternatives, which the students could choose according to their level and background. Learning resource centres also offer facilities to the teacher to design his instructional strategies around the material and equipment available, and to prepare his own instructional material and aids. Learning resource centres should be established in as many institutions as possible.

There is acute shortage of hostels in technical education institutions. In the vast majority of institutions, hostels for girls are non-existent with the result that most of the girls who do get admission do not take it. This is too serious a matter, which should receive special attention. Lack of adequate facilities for sports, recreation, cultural activities etc. continue to plague many institutions.

Shortage of residential accommodation for faculty is a major handicap in recruiting competent faculty even to our premier institutions. Urgent steps should be taken to provide adequate residential accommodation for teachers. If for any reason it is not possible/feasible to build new quarters/flats, alternative arrangements such as leasing to estate developers should be explored.

3.3 Linkage with industry, national laboratories, developmental sectors and other institutions/bodies

The new NPE points out the need for a networking

system between technical education on the one hand and industry, R&D organisations and other sectors with complimentary characteristics on the other. This will become possible only if a process of polarisation is initiated. If the country with its limited resources wants to become a global leader in technical manpower development in the 21st century, there has to be a recognition of the fact that polarisation and networking will have to be ushered in. This is also necessary to promote relevance and optimisation of benefits in the field of technical education.

3.3.1 Linkages with industry: Institution-industry collaboration has been the theme of numerous studies, discussions, seminars and conferences. Dialogues between industry and academia have been taking place, but it is not clear if both sides do an effective job of communicating. Promotion of industry-institution interaction through apprenticeship opportunities, consultancy and sponsored research, continuing education programmes for industry personnel, 'adjunct professorship' in institutions for willing and capable personnel from industry, 'residency' for institutional faculty in industry, involvement of industry in the development of curricula and courses etc. is an important goal to be pursued vigorously. For this purpose, organisational mechanisms such as industrial liaison boards, industry-institution cells, industrial foundation etc. will have to be set up and properly supported for effective functioning. Eminent educationists/academicians should be put on the Boards of Directors of Industrial undertakings and leaders in industry should be placed on the Boards and advisory bodies of educational institutions. The question of collecting 'education cess' or tax from industry to share the cost of technical education and giving tax exemption for contributions made by industry for the development of technical education should receive serious consideration.

3.3.2 Linkages with national laboratories: In many areas of science and particularly in engineering a new system of links between technical education institutions and national laboratories needs to be forged. By national laboratories we mean those institutions that work under agencies such as CSIR, defence, space, and atomic energy

Many of these institutions have received substantial support since Independence, and the time has come for them to plough part of that input back into the education system by such joint ventures. The organisation of the national laboratories permits them to undertake major projects of a kind that are difficult to undertake in most universities and technical education institutions. The facilities available and the expertise built up can promote excellence in research. On the other hand, these laboratories do not have easy access to the bright young talent that many universities still attract, but cannot utilise because of lack of exposure, opportunity or facilities.

With the rapid advancement and new developments in science and technology, several inter-disciplinary and new areas are emerging which need a different kind of training set up than is available in our existing educational institutions. For example, some of the major national laboratories such as BARC, NAL, NCL, NPL and DMRL should train students at the postgraduate and Ph.D levels in chosen areas of advanced technology. Areas such as advanced materials science and technology, parallel computing, robotics and automation need expertise to be built up through careful planning in the educational system. Mobility and exchange of faculty between academic institutions, national laboratories and industrial establishments should be encouraged to prevent inbreeding. To facilitate such free mobility and exchange of personnel, the existing rules and regulations regarding inter-departmental deputations etc. should be modified and liberalised.

3.3.3 Linkages with developmental sectors: Technical education institutions having the potential and capability to undertake problem-oriented and application-oriented programmes should be facilitated to interact directly with developmental sectors such as industry, energy, irrigation, agriculture, and health with a view to solving, to the extent possible, the problems of the latter. Developmental projects and industrial expansion should be linked up with the induction of competent engineers and technologists into the establishments. The AICTE and others concerned should liaise effectively with national agencies such as the Planning Commission, Department of Industrial Development, Department of Rural Development, Department of Economic Affairs

etc. to give the necessary policy support for such interaction. Since technical education is essentially developmental investment, plan allocations for technical education should be commensurate with the developmental outlays of the user departments.

Rather than promoting more and more management education programmes to the special needs of business and industry - which form only 10% of the total organised sector - we should consider reorienting our management education and training facilities to meet the requirements of the hitherto neglected, but vital areas of organised sector such as transport, power, communication, health, education and irrigation. Management education and training facilities should be geared also to train and upgrade all those involved in productive enterprises in the non-organised sector such as agriculture, handloom and animal husbandry, which are a significant and critical part of our national economy.

3.3.4 Linkages with vocational education and craftsmen training, and networking between institutions: Technical education has to be viewed in its entirety, and not separately for craftsmen, technicians, engineers, designers and researchers. Technical education has to be related to the total needs of the industry and the economic and technological development of the country. For that very reason, an integrated approach to the design and development of these programmes comprehensively is called for. Integration at least in the curricular aspects of technical, management, technician, vocational and craftsmen education and training should be attempted.

The present scheme of networking higher technological institutions such as the IITs with the less developed institutions for the development of laboratories, collaborative research, training of faculty, etc. has yielded useful results. This scheme should be further strengthened and extended to more institutions including polytechnics.

3.3.5 Linkages with professional bodies: Several professional bodies are doing significant work in technical manpower development, but they generally work independently and in isolation.

There is need to coordinate their activities. They should be involved in a big way in assessing the need for continuing education and in planning and organising continuing education programmes. These professional bodies can also help in manpower assessment and in providing avenues for horizontal and vertical growth for the professionals.

3.4 Technology watch and assessment of manpower needs

In the absence of adequate information on manpower requirements, it will be difficult to anticipate areas of growth in the field of science and technology and plan for technical manpower development. A proper manpower information system is at present not available.

Forecasting of manpower, especially in the emerging areas, is a priority requirement. There will be some difficulty in making realistic projections of technical manpower requirements in the absence of reliable projections of the growth and development expected. We will do well to engineer mechanisms that would ensure that manpower planning is related to the needs of the economy and not merely dependent on social pressures. Manpower planning has to be attempted both at the macro and micro-level.

The recent establishment of Technology Information Forecasting and Assessment Council (TIFAC) is an important development - as its objectives include the evaluation of existing technology, preparation of technology forecast reports, and estimation of the nature and quantum of likely demands of goods and services in future.

It will be necessary to couple the technology forecasting system with the system for manpower forecasting and planning; both will gain from such coupling. A realistic assessment of technology and its implementation is not possible without consideration of the manpower substance. Nor can manpower forecasting have any particular value unless it takes into account the technologies of the future and their implications.

The technical education system will have to develop a reasonably clear picture of the skill profiles of the future. For this purpose a National Directory of Occupations and Job Titles held by the wage-earning/self-employed persons in organised, unorganised, service, rural, infrastructure and other sectors and sub-sectors may be prepared, identifying the general/professional/vocational education and duration requirements for all such positions. The absence of such a Directory has caused some difficulty in identifying a variety of need-based courses and fixing intake levels. Such a Directory could be used as the basis for developing educational and training programmes for meeting the manpower requirements from time to time and also to identify jobs which can be de-linked from the requirement of degrees and diplomas. This work may be entrusted to the National Technical Manpower Information System (NTMIS), which should interact with TIFAC and also with the National Testing Service (NTS).

All new courses and educational programmes would have to be based on well-established manpower needs. Within the approved annual intake capacity, each institution should increase the supply of technical manpower by improving the efficiency and effectiveness of educational processes. Shifts in the intake capacities between disciplines may be effected to cater to the emerging manpower needs.

One limitation to the use of manpower prediction in India is that inter-State mobility may be inhibited owing to cultural differences (in language, food habits and life styles) and the "sons of the soil" philosophy. This situation leads to imbalances in engineering manpower in the States. In some States there are serious shortages of certain kinds of engineering personnel, while in others there is a surplus of engineers in the same speciality. The NPE has stated that "in higher education in general, and in technical education in particular, steps will be taken to facilitate inter-regional mobility by providing equal access to every Indian of requisite merit regardless of his origins". The need to revive a national Indian Engineering Personnel Service (IEPS) should be considered.

3.5 Measures to prevent 'brain drain'

'Brain drain' is usually associated with the emigration of highly qualified scientists and technologists to other - usually advanced - countries. There is also 'brain drain' of other types, of S&T personnel taking up other professions, usually administrative and allied services, and management (after MBA), and thus lost to the profession for which they are trained at very high cost. Many of the trained women cannot pursue their profession due to various reasons. The problem is sufficiently serious.

There have been many attempts to enquire into the reasons for the migration of talent out of the country. Apart from the attraction of better academic and economic opportunities and a higher standard of living in advanced countries, one is able to identify many contributing factors, big and small, from the Indian side. Anyone seriously interested in scientific research always aims for the very best opportunities, particularly when one is young. In India, the infrastructure, facilities, instruments, etc. for scientific research, particularly in experimental sciences, do not measure up to those available abroad. Young people are quite aware of this fact and give this an important reason for their migration. Opportunities for quality jobs for talented scientists too are very limited in India. Among the other causes which encourage our young people to go abroad are lack of adequate recognition for merit and achievements (in terms of awards, promotions, assignment of new responsibilities, etc.), administrative and managerial red-tapism needing the active scientist to waste time and effort just to chase papers or to get approvals, difficulties in establishing contacts with peers and international developments, meagre opportunities for intellectual stimulation, an insensitive, outmoded and unresponsive management system not geared to dealing with science and scientists.

Much effort has been made to persuade those who have preferred to settle down abroad to return. They include the scheme of 'Scientists Pool', creation of supernumerary posts, special facilities to import equipment for those returning from abroad, establishment of new scientific departments in emerging areas, and so on. Many

governmental and non-governmental delegations have toured many foreign countries to meet such people and encourage them to return, offering them opportunities as attractive as possible. But, by and large the success achieved has not been encouraging.

It will take a long time to make conditions in India comparable to those obtaining in countries like USA. It would be in the fitness of things to set it as one of our major goals. In the meantime any step to induce our best talent to remain in the country and to attract back those who are abroad should receive immediate attention. All out measures should be adopted to initiate a counter-movement of 'brain gain'. Our suggestions are:

- The Scientists Pool in CSIR has to be made more attractive by offering better remuneration according to merit and by providing proper placement at the right institution.
- A favourable work environment will induce many to return and stay on. For this, they should be assured of: (i) stimulating work and opportunities, (ii) their ready acceptance in the local system, (iii) opportunities to go abroad for conferences and contacts periodically (e.g. sabbaticals and summer visits), and (iv) reasonable salaries, benefits and perks without upsetting the balance with the local scientists.
- International collaboration programmes should be more effectively utilised to enable our scientists and technologists to undertake useful collaborative projects of mutual interest and enable them to use some of the best research facilities in the world.
- International programmes should also enable our young scientists to get short duration training in the world's best research institutions and laboratories. Assured opportunities for such training in leading institutions abroad and employment in India thereafter may minimise the loss of young talent to foreign countries at Ph.D and post-doctoral levels.
- Concrete steps should be taken to enhance the mobility of scientists and technologists paying due attention to such matters as accommodation, financial compensation, children's education, etc.

- Attention should be paid to channelizing trained youth within the country for national development.
- Each IIT, university and national laboratory should maintain a register of students and young researchers who go abroad for higher studies or training and maintain their career record on year to year basis to the extent possible. If properly done, a sense of belonging can be established through this linkage. Our missions abroad should also keep a record of scientists and engineers of Indian origin and be in close contact with them.
- Migration of engineering graduates to non-engineering professions can be checked if career guidance activities are taken up as a part of the placement function. Much of the "brain drain" to foreign lands, to other professions, and as a result of mismatching of actual abilities and the jobs taken up by students take place because they do not have the benefit of proper career counselling. The placement function should therefore include career counselling and rendering of help to the students to set out career goals and to chalk out or plan out their careers.
- Opportunities of employment, especially on part-time basis, must be made available for well-trained women scientists and engineers.

3.6 Promotion of research

There is urgent need for spreading the culture of research on a much wider basis in technical education institutions and universities. While the peaks of excellence are to be nurtured, the general research capability in the country should also be built up to put to use the widely available talent in academic institutions. Major national facilities required for carrying out research should be increasingly set up in educational institutions which, in turn, should improve their own administrative procedures to avoid unnecessary delays and bureaucratic hurdles in the speedy implementation of research programmes. Centralised agencies and Ministries have also to see that their procedures for dealing with educational and research institutions are further simplified to ensure that the autonomy required for pursuing research in such institutions is introduced immediately. Some of them have initiated action

along these lines and major facilities are being installed in the educational institutions, thus providing access to these infrastructures to wider cross-sections of the academic community and more importantly, to the student community on the campus. But much more needs to be done for technical education institutions.

Efforts should be made to see how the expertise available in our technical education institutions can be geared towards solving the problems of our economic and industrial sectors. Challenging, mission-oriented projects should be assigned to these institutions in order to give better focus to their R&D efforts.

The UGC has evolved some methods by which selected departments or groups in universities are given special assistance or support to promote their research programmes. This is a laudable step, but we would like to recommend that the concept be extended to promoting centres of excellence around individuals or small groups of scientists and engineers instead of the whole department or institution. This will enable scientists and engineers with a proven record of achievement and bright ideas for future research to get the modest support that will make it easier for them to undertake projects involving higher scientific risks as well as high potential rewards. Such centres should be encouraged in technical education institutions.

When resources are scarce, it is advisable to allocate them on the basis of priorities rather than something-for-everybody basis. It is increasingly clear that if priorities are not determined systematically and explicitly, they will continue to be determined intuitively, often in response to expedience, and demands of special interest groups. Problem-oriented research projects of national importance may be identified in consultation with industry and national agencies and institutions encouraged to develop specialised research abilities in selected areas for undertaking such identified projects of national importance. Judicious allocation of specific responsibilities amongst the different institutions for industry-oriented R&D has to be prepared and adequate support provided for carrying out the tasks.

A National Board for Science and Engineering Research should be set up solely for funding fundamental research. This Board should be autonomous just as the National Science Foundation (NSF) in the USA.

Multi-disciplinary, trans-disciplinary and trans-organisational research with emphasis on design and development should be encouraged at all levels. Academic institutions engaged in post-graduate teaching and research should have properly screened and pre-evaluated research programmes.

A greater S&T involvement at the State level is essential if research is to percolate down to the State level institutions. For this purpose, the State Councils for Science and Technology as well as their Departments of Science and Technology have to be activated.

3.7 Steps to ensure cost-effectiveness

Since technical education is expensive and financial resources are limited, it is necessary to take concrete steps to ensure cost-effectiveness.

There is some duplication of investment even in technical education institutions located close to each other. Each of these institutions requires similar and often expensive laboratory equipment and library facilities. A careful scrutiny reveals that many of the facilities are also not being optimally utilised. Many of the instruments are not maintained well and some have been non-functional for a long period.

There is a case for a thorough examination of the technical education set up for achieving optimal use of resources and for getting maximum returns on the investment.

In order to ensure optimal use of resources, at least at the level of higher technological institutes, each institute should be required to concentrate its efforts to produce technical manpower in certain specialised fields, identified on the basis of existing strengths. Even at the level of the second tier of engineering institutions, attempts must be made to identify broad areas or fields in which they should concentrate their efforts.

The advantage of concentrating efforts in a limited number of fields in the higher technological institutes is that, each institution,

within the available resources, could build up and maintain properly the most sophisticated and modern laboratory facilities in these fields, could build up and update the library facilities and subscribe to most of the important technical journals in the fields concerned and thus have the best of facilities in the world for training of manpower in a number of specialised fields. Such institutions would emerge to become the national brain-trusts in the chosen areas.

Courses and programmes which are out-dated and stereotyped should be gradually wound up at least at the post-graduate level. Wherever possible they should be redesigned to include, relevant, emerging areas. Introduction of programmes and courses in conventional areas should be permitted only in exceptional cases. Neighbouring academic and research institutions should be encouraged not only to conduct joint programmes, but also to share facilities.

We should seriously consider whether the cost of providing trained manpower in certain highly specialised areas should not be borne by the interested agencies and industries.

Several avenues are available for multiple usage of infrastructural facilities existing in technical education institutions. They include part-time evening courses, continuing education programmes, consultancy and testing services, and so on. Institutions should be given the freedom to utilise all these avenues. This will permit optimum utilisation of the available facilities and also help institutions to generate 'resources', which can be used for further infrastructural development. Institutions should be encouraged to offer a variety of programmes at different levels and through different forms involving a large number of students. Wherever necessary, institutions should be asked to increase their intake to the formal courses to the extent of 10 to 15% so that the same infrastructure can train more people with marginal inputs.

To ensure cost-effectiveness, it is important to emphasise the role of non-monetary inputs such as: better planning, advanced technologies and practices, better systems of supervision and administration, monitoring and evaluation, and above all dedicated efforts by teachers, students and educational administrators.

3.8 Special programmes for SC/ST, women and physically handicapped

As mentioned in the NPE, appropriate formal and non-formal programmes of technical education will be devised for the benefit of women, the economically and socially weaker sections, and the physically handicapped.

About 15% of our population comprises Scheduled Castes (SC) and 7½% Scheduled Tribes (ST). In spite of the various concessions, incentives and relaxations extended to them, the enrolment of SC/ST students in degree level institutions is less than 5% and in diploma level institutions less than 9%. SC/ST students deserve all encouragement, but forcing institutions to enrol unprepared students has played havoc - socially, psychologically and professionally - on such students. The only sensible solution to this problem appears to be to identify as many talented and bright SC/ST students as possible at school stage and organise special coaching classes to prepare them to compete with other students for admission to professional courses in engineering and technology on their own merit. The scheme for organising such coaching classes in the Central Schools, Navodaya Vidyalayas and other identified institutions should be worked out and implemented in collaboration with the NCERT and the Kendriya Vidyalaya Sangathan.

The enrolment of girls in technical education institutions at degree level is only 12%, while that at diploma level institutions it is about 17%. One of the most inhibiting factors preventing girls from joining courses in engineering and technology is the fact that the vast majority of engineering colleges and polytechnics in the country do not have girls hostels at all. Even prestigious institutions such as the IITs, IIMs and RECs do not have adequate residential accommodation for girl students. This situation should be remedied by making adequate provisions for girls hostels in the development plans of the institutions. Needless to add that special incentives such as scholarships, freeships, stipends etc. should be provided to attract deserving girl students to professional courses. It may also be useful to organise guidance seminars for girl students at the +2 stage of the school to motivate them and to give them insights into the various branches of engineering

and technology. Efforts are also necessary to see that technically trained women can continue in their profession. Special arrangements may be necessary for this to happen.

Most advanced countries take special care of their handicapped people. In India, they are often left to the mercy of an uncaring society. Even though the national sample survey conducted during the 1981 census lists the number of physically handicapped people in the country at 12 million, it is estimated that the figure today will be nearer 80 million or about 10% of the population. Most of them are intelligent young people capable of being trained for productive work. Unfortunately, facilities for technical education and training of the handicapped are so meagre in the country that they can as well be considered as non-existent.

The tasks related to the special programmes discussed above are not only challenging, but also difficult. A variety of training programmes will have to be designed. Teachers for training the handicapped will have to be trained. Special equipment and facilities will be required for imparting training to the handicapped. The Ministries of Human Resource Development, Labour and Welfare will have to formulate a major scheme for this purpose and implement it with a mission-oriented approach. Initially efforts should be made to introduce training programmes for the handicapped in as many existing institutions as possible.

3.9 Entrepreneurship development

The growing problem of un-employment and under-employment among engineering graduates and technician diplomates has become a matter of serious concern. It is imperative that we should explore new avenues to lead students in large numbers towards self-employment and entrepreneurship.

An entrepreneur is a person who initiates an economic activity and manages the same successfully. The myth that entrepreneurs are born is no more valid, because it has been proved that entrepreneurs can be developed through scientific methods and training. Entrepreneurship development programmes aim at motivating, developing, and counselling potential entrepreneurs to establish their own enterprises and develop their entrepreneurial skills, knowledge and competencies. Entrepreneurship development

thus encompasses efforts to develop entrepreneurs, new enterprises and human resources.

The National Science and Technology Entrepreneurship Development Board (NSTEDB) established under the Department of Science & Technology in 1982 has attempted several worthwhile schemes such as Entrepreneurship Development Programmes (EDPs), Entrepreneurship Awareness Camps (EACs), Science and Technology Entrepreneurs Park (STEP) and preparation of opportunity profiles. A number of institutions have been established in recent years by other agencies including State Governments in various parts of the country for training entrepreneurs. A review of their programmes indicates that the technical and management education system has not adequately responded to these programmes and taken advantage of them. Entrepreneurship education should be integrated with the formal system of technical education by introducing suitable modules.

Special entrepreneurship development programmes exclusively for S&T personnel are essential and should be implemented in close collaboration with NSTEDB, CSIR laboratories, Industrial Development Bank of India, Department of Industrial Development and such other agencies. Entrepreneurship awareness camps should be conducted in every engineering college and polytechnic. STEPs should be established in proximity to well-established technical education institutions to serve as centres for innovation, technology transfer, technology upgradation and for provision of services to present and potential entrepreneurs. Entrepreneurship as a subject of study should be introduced in all technical and management courses. We need to train more and more people to start their own industries and enterprises around identified technologies.

3.10 Continuing education and re-training programmes

Although there is a growing awareness for continuing education and re-training programmes in engineering and technology, the existing facilities are grossly inadequate. The programmes in operation today are generally replicas of the formal education programmes.

A major organisational change is needed if the scope of the continuing education tasks is to be addressed properly in the context of the rapidly changing technologies.

There is need to formalise re-training programmes for engineering and technology personnel engaged in all sectors and these should be made mandatory. Increasing use of modern communication devices like television, computer, satellites, etc. should be made in continuing education. Programmed learning packages have to be created and distance learning methodology employed to enable self-development and training of all scientific and technical personnel, who would care to - and need to - keep themselves updated. This calls for a definite strategy of creating knowledge base, developing resource material and offering modular packages of learning, which a mature scientist and technologist can avail of.

Continuing education must become a national culture and should form a recognised activity of all technical education institutions. In fact, much of the manpower requirements in emerging areas should be met by retraining technical personnel already in employment.

4.0 FINANCIAL ESTIMATES

Taking into account the present scenario, the perspectives of development upto the year 2005 A.D., and the tasks to be undertaken during 1990-95, it is estimated that the barest minimum financial outlay required for technical and management education during the 8th Plan will be Rs. 4739.10 crores (Central sector: Rs.3656.10 crores, State sector: Rs.1083.00 crores). Financial estimates in respect of each scheme are indicated below:

(Rs. in Lakhs)

Sl. No.	Name of the Scheme	Central sector		State sector	
		Seventh Plan outlay (approved)	Seventh Plan Expndt. Anticipated)	Proposed outlay Eighth Plan	Proposed outlay Eighth Plan
1	2	3	4	5	6
I. <u>DIRECTION & ADMINISTRATION</u>					
1.	National Technical Manpower Information System (NTMIS)	100	212	1000	-
2.	Re-organising, restructuring and strengthening AICTE, its Committees/Boards of Studies.	-	620	2500	-
3.	Grant of autonomy to selected institutions.	-	110	500	500
4.	Strengthening existing institutions and establishing new institutions for non-corporate and unorganised sectors.	-	120	1500	1500
II. <u>TRAINING</u>					
5.	Regional Engineering Colleges (RECs).	2000	5396	40000	6000
6.	Apprenticeship training.	400	1019	5000	600
7.	Central institutions:	800	3775	10000	-
	- Technical Teachers' Training Institutes (TTTIs)				

1	2	3	4	5	6
	- National Institute for Training in Industrial Engineering (NITIE).				
	- National Institute of Foundry and Forge Technology (NIFFT)				
	- School of Planning and Architecture (SPA)				
8.	UGC schemes	2800	5595	15000	-
9.	Advanced technician courses	300	178	1000	1000
10.	Re-structuring courses and programmes	-	130	200	1000
11.	Promoting technical education for women: setting up of residential polytechnics for women	-	440	10000	4000
12.	Training and technical education of the handicapped	-	110	1500	1500
III. RESEARCH					
13.	Indian Institutes of Technology (IITs)	2000	10048	25000	-
14.	Indian Institutes of Management (IIMs)	1500	3364	10000	-
15.	Development of P.G. courses	300	815	2000	500
16.	Development of management courses	100	151	1000	4000
17.	Institutional network	200	500	1500	3000
18.	International Centre for Science and Technology Education	600	111	1000	-
19.	Research and Development (R&D) in selected higher technical institutions	-	500	20000	5000
IV. ENGINEERING/TECHNICAL COLLEGES AND INSTITUTIONS					
20.	Community Polytechnics	950	1467	5000	5000
21.	Modernisation and removal of obsolescence	6000	20472	80000	10000

1	2	3	4	5	6
22.	Thrust areas of technical education:	2500	11395	35000	10000
	i) Creation of infrastructure in areas of emerging technology				
	ii) Strengthening of facilities in crucial areas of technology where weakness exists				
	iii) Programmes of new and improved technologies offering courses in specialised fields				
23.	Institution-industry interaction	-	370	1500	5 00
24.	Curriculum development	-	317	800	1500
25.	Continuing education including faculty and staff development	-	203	1500	3000
26.	(i) Special institutes for rural and appropriate technology	1350	90	2500	1000
	(ii) Experimental pilot projects for integrated rural development				

V. OTHER SCHEMES

27.	Indian Institute of Technology, Assam	-	1800	25000	-
28.	Longowal Institute of Engg. and Technology	-	400	600	-
29.	Educational Consultants India Ltd.	-	120	10	-
30.	New quality improvement programmes	100	-	-	-
31.	Completion of development schemes continuing from previous plans	-	-	-	15000

1	2	3	4	5	6
VI. NEW SCHEMES/PROGRAMMES					
32.	Strengthening State Directorates of Technical Education	-	-	-	2500
33.	New institutions under State sector	-	-	1	10000
34.	National Accreditation Board	-	20	500	100
35.	Technology watch	-	20	200	200
36.	Support to professional bodies	-	50	300	300
37.	Entrepreneurship development	-	25	500	300
38.	Projects for rural development by engineering colleges and other technical education institutions	-	-	300	300
39.	Development of technician education system	-	100	5 0000	2 0000
40.	Establishment of four Regional Libraries in science, engineering & technology	-	-	3200	-
41.	Promotion of excellence	-	-	10000	-
GRAND TOTAL:		22000	70043	365610	108300

5.0 C O N C L U S I O N

In this report, we have highlighted the important tasks for the 8th Plan. These include the following:

- (a) Improvement of quality and standards.
- (b) Upgradation of infrastructural facilities.
- (c) Linkages with industry, national laboratories, developmental sectors etc.
- (d) Technology watch and assessment of manpower needs.
- (e) Measures to prevent 'brain drain'.
- (f) Promotion of research.
- (g) Steps to ensure cost-effectiveness.
- (h) Special programmes for SC/ST, women and the physically handicapped.
- (i) Entrepreneurship development.
- (j) Continuing education and re-training programmes.

2. We have made certain priority recommendations. We feel that it is essential that these recommendations are adopted for execution in the 8th Plan. Otherwise, technical education in India will not be able to keep pace with the rapid industrial progress that is likely to occur in the future.

3. Training of highly skilled technical manpower and upgradation of the quality of existing institutions seem to be two of the main tasks that we face in the 8th Plan. It is, therefore, extremely important to revamp polytechnic education and improve the infrastructure of our engineering colleges. It is equally necessary to improve the facilities of our better institutions so that they are able to be competitive internationally. There is need for reorientation of management education and entrepreneurship education.

4. We have made recommendations with regard to special preogrammes in science education and programmes for the under-privileged.

5. We recommend the establishment of a separate body for funding research in engineering and technology. Outstanding individuals and groups working in scientific and technical institutions should be supported as units of excellence. At least four regional

science and engineering libraries should be established during the 8th Plan to ensure that teachers, research scholars and students have access to all the vital information.

6. The University Grants Commission has to receive higher funding towards support for engineering colleges and other technical institutions under its jurisdiction.

7. Taking all these aspects into consideration an outlay of Rs.4739 crores (Central sector: Rs.3656, State sector: Rs.1083 crores) has been proposed to implement the various recommendations. This is the basic minimum requirement to create conditions necessary for self-sustaining growth. It is imperative that we should invest atleast this much in technical & management education during the 8th Plan, not only to strengthen our scientific and technological base, but also to enhance our domestic technological capabilities and promote research and development in frontier areas of science and technology. Non-implementation of the recommendations and proposals made in this report will have very adverse effects on the development of technical manpower, which in turn will have serious consequences on the overall socio-economic development of the country.

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**Member-
Convener**

Terms of reference of the Working Group on Technical
& Management Education - Eighth Five Year Plan

1. To take stock of the position likely to be reached within the area by the end of 1989-90 both in relation to original programmes of Seventh Plan and the new initiatives under NPE-1986/Programmes of Action 1986 to identify problems and suggest effective remedial measures.
2. To suggest a feasible perspective development upto 2005 AD keeping in view the need for grass-root planning and to make the benefits of development programmes accessible to individual families of weaker sections of society viz. SCs/STs/women/handicapped/backward communities and to fully involve their interests in the drawing up of the development programmes.
3. To suggest measures for upgrading the standards, facilities and attainments of backward States/regions/districts.
4. To specify in clear terms the objectives of the programmes in this sector for the Eighth Plan.
5. To suggest measures for effective linkages between technical and management education and other development sectors including environment, health, industry, energy, agriculture, irrigation, S&T, mining, banking/business and commerce in the context of employment, self-employment and entrepreneurship activities.
6. To suggest innovative measures to improve the existing facilities for technical and management education, make it cost effective in terms of equipment, buildings etc., and introduce low-cost alternatives to achieve various specified goals and objectives of educational plans.
7. To consider evolution of an integrated system of commerce/business/management education involving IIMs/University Faculties of Management, Commerce Colleges etc.
8. To consider the extent of emigration of highly educated technical manpower and measures to retain/attract them including, inter-alia, proposals to make available courses more relevant to the emerging needs of various developmental sectors of economy in the country.
9. To consider such other matters as the Chairman considers relevant for the formulation of Eighth Five Year Plan.
10. To formulate proposals for the Eighth Five Year Plan (1990-95) in the light of the above perspective indicating priorities, policies and financial costs.