

REPORT, IIT REVIEW COMMITTEE, 1986

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MEMBERSHIP OF THE COMMITTEE

CHAIRMAN

Nayudamma, Y.* Chairman, Centre for Development Alternatives
CLRI Campus, Adyar, Madras.

VICE-CHAIRMAN

Bhaya, Hiten. Member, Planning Commission, New Delhi.

MEMBERS

Rao, C.N.R. Bangalore.	Director, Indian Institute of Science,
Amin, Nanubhai	Chairman, Jyoti Limited, Baroda.
Kalyanakrishnan, J.A.	Chief Secretary, Government of Uttar Pradesh, Lucknow.
Padmanabhan, M.S.	10, Appu Street, Mylapore, Madras.
Narain, Jagdish	Secretary, Association of Indian Universities, New Delhi.
Singh, Man Mohan	till 7.12.1984 Financial Adviser of the
Parkash, Mrs. Priya	from 8.12.84 Ministry of Human Resource to 18.2.85 Development
Narayanan, L.S.	since 18.2.1985 on Ex-officio basis.

MEMBER-SECRETARY

Vedantham, S. Deputy Educational Adviser (T), Ministry of
Human Resource Development, Government of
India, New Delhi.

* killed in the Kanishka Air-crash on 23.6.85

THE REMIT OF THE COMMITTEE

Subject: Appointment of reviewing Committee to review the working of the Indian Institutes of Technology at Kharagpur, Bombay, Madras, Kanpur and Delhi.

The Visitor of the Indian Institutes of Technology at Kharagpur, Bombay, Madras, Kanpur and Delhi in accordance with Sub-Section 9 of the Institutes of Technology Act empowering him to appoint a Committee to review the work and progress of the IITs has appointed a Reviewing Committee for all the five IITs with the following terms of reference:

- (a) to review the present progress of the Institutes of Technology in fulfilment of its broad objectives as a centre of advanced studies and research in science, engineering and technology.
- (b) to examine how far the Institutes have interacted with other technical Institutes with particular reference to courses of study, programmes of research and faculty development.
- (c) to assess the overall impact of the Institutes on the training of high grade engineers for the technological development of the country.
- (d) to recommend the lines along which the five Institutes should be further developed for advanced studies and research taking into account the developments that have taken place or projected at the other Institutes of Technology and the Indian Institute of Science, and
- (e) To report on any other aspects that are relevant to overall functioning of the Institutes.

Sd/- (S. Vedantham) Deputy Educational Adviser (Tech.) Government of India

No. F. 10-9/82-T.6 Dated: 11-5-1983

GLOSSARY OF ABBREVIATIONS

AICTE	All India Council of Technical Education
AIU	Association of Indian Universities
BHEL	Bharat Heavy Electricals Limited
BOG	Board of Governors
B.Tech.	Bachelor of Technology
CSIR	Council of Scientific & Industrial Research
CSIC	Centre for Scientific & Industrial Consultancy
CAD	Computer Aided Design
CAI	Computer Aided Instruction
CAM	Computer Assisted Manufacture
CEA	Central Electricity Authority
CMI	Computer Managed Instruction
CPRI	Central Power Research Institute
DST	Department of Science & Technology
DGTD	Directorate General of Technical Department
DOE	Department of Electronics
FIP	Faculty Improvement Programme
FINEP	Brazil's Studies & Projects Funding Agency
GATE	Graduate Aptitude Test in Engineering
GRS	General Research Scheme
HAL	Hindustan Aeronautics Limited
HVDC	High Voltage Direct Current
IIT	Indian Institute of Technology
IITs	Indian Institutes of Technology
IISc	Indian Institute of Science
JEE	Joint Entrance Examination
INPI	National Institute of Industrial Projects of Brazil
LSI	Large Scale Integrated
M. H. D.	Magneto-Hydro-Dynamics
M.Tech.	Master of Technology
MIT	Massachusetts Institute of Technology
NAI	Centres set up in Brazil for Linkages with Industry
NIFFTE	National Institute of Foundry & Forged Technology
NIT	Nuclei for Technological Innovation set up in the Universities in Brazil
NITIE	National Institute of Training in Industrial Engineering
NTH	Norwegian Technical Institute.
NTPC	National Thermal Power Corporation
OTEC	Ocean Thermal Energy Conversion
PG	Postgraduate
Ph. D.	Doctor of Philosophy
PWD	Public Works Department
OIP	Quality Improvement Programme
REC	Regional Engineering College
R&D;	Research & Development
SACC	Scientific Advisory Committee to the Cabinet
SC	Scheduled Castes
SERC	Science & Engineering Research Council
SINTEF	Foundation of Scientific & Industrial Research
SPR	Science Policy Resolution
ST	Scheduled Tribes
S&T;	Science & Technology
SWOT	Strengths-Weaknesses-Opportunities-Threats
TPS	Technology Policy Statement
TTTP	Technical Teacher Training Programme
UG	Undergraduate
UGC	University Grants Commission
VLSI	Very Large Scale Integrated

PREFACE

The duty and privilege of presenting this Report has fallen to my sad lot after the sudden and tragic death of the Chairman of our Committee, Dr. Y Nayudamma, in the Kanishka air crash. The schedule of work was further upset by the change of assignment of some of the Committee members, including myself. But the tentative recommendations of the Committee were made available to the government some time ago when it became clear that the preparation of the full report would take time and that the Government would find it useful to have the gist of our findings in the context of the Seventh Plan exercises and the formulation of the New Education Policy. In the main, our conclusions were guided by the experience and vision of Dr. Nayudamma whilst he was still with us. All the members of the Committee and I consider this report as a small homage to Dr. Nayudamma in many ways.

Looking back on the 25 years' working of the IITs it can be said without any reservation that they amply fulfilled the specific goals set for them by bringing to life five national institutes of advanced technological learning of international standards and producing over 27,000 high-grade engineers who have not only strengthened our own industrial base but also earned appreciation elsewhere. The IITs, however, cannot afford to rest on their laurels. That the expectations from these institutes of excellence are high, was evident from the concern expressed by an segments of the community who met the Committee- the Industry, the Government, the Alumni, the Students, the Faculty and many others.

Over these years there have been continuous and significant changes in the realm of science and technology as well as in the economic scene- internationally and nationally. More is to come and at a faster rate. The IITs have to set their sights to new targets. We could not but help notice several mismatches developing during this period, between the IITs and their environment which need to be corrected in the coming years.

First, the demand from the industry for engineer-scientist- if one may so distinguish the products from the IIT system-was less than that for the conventional engineer-managers. This has resulted in two inter- related distortions, namely, the efflux of IIT graduates abroad and the relative unattractiveness of the post-graduate programmes for the top decile of the IIT graduates. This situation will change as Indian industry is compelled to enhance its design and development capabilities in order to become internationally competitive according to the national policy demands. A strong link must be forged between the industry and the IITs on one hand and the IITs and the scientific institutions on the other, immediately.

Second, despite the general expectation that all national institutions will contribute specifically to the development of our predominantly rural economy, an ambivalent attitude seems to persist in the IITs in this regard, based perhaps on the commonly held belief that technology was relevant only to large-scale manufacturing industry. Whilst this may be true in the case of developed countries where industry has the dominant share in the national income and the basic necessities are available to the entire population, our situation is substantially different. It is clear that given the right orientation, high technology not only can but must contribute to improving living conditions, to making traditional vocations more efficient and to imparting knowledge, in our countryside.

Lastly, there was the natural problem of ageing-obsolence of equipment and facilities, obsolete administrative practices and more importantly the threat of falling behind in knowledge and losing in organisational vitality.

Our suggestions are based on these perceptions and intended to enable the IITs fulfil their potential role in the more dynamic and innovative stage of economic development India is destined to enter by the turn of the century. The recommendations cover both academia and the governance of these institutions. Except for the problem of funding and a few amendments to the Act which concern the government most of the changes are within the competence of the Boards of the IITs and their Senates. If this Review reinforces the introspective process in the IITs leading to the desired direction of change it will have served its purpose largely. The IITs have a future brighter than their past and we are confident that they will so shape it.

In Chapter 8 we have acknowledged the support we received from various individuals and institutions which made this Review possible. It remains for me to acknowledge the contribution of my learned colleagues in the Committee, specially the enormous work put in by our Member-Secretary Shri S. Vedantham of the Ministry of Human Resource Development.

31st December 1986 HITEN BHAYA (Vice-Chairman)

PREAMBLE

◆ 1.1 Brief History of the Review Committee

The Indian Institutes of Technology (IITs) five of them in all-are located at Kharagpur, Bombay, Madras, Kanpur and Delhi. They are governed by a common IIT Act. Under Section 9(2) of the Act, the President of India, in his capacity as the Visitor of the IITs, is empowered to appoint one or more persons to review the work and progress of these Institutes.

◆ 1.2 Appointment of the Review Committee

The IITs have completed nearly a quarter of a century of existence. The President of India, in his capacity as the Visitor, appointed this Committee, to review the work and progress of these Institutes all together and recommend the lines on which they should develop in the future.

◆ 1.3 Distinctive Features

The distinctive feature of this Review Committee is that the present one is a single Committee for all the IITs unlike the earlier Review Committees. We did not, therefore, make any specific recommendations for each IIT, as our terms of reference are for IITs as a whole. However, we have taken into consideration presentations made by each IIT and a number of large groups of academic and other interests from each IIT. The total recommendations, therefore, are to be looked upon as recommendations for the development of the five IITs as a whole.

While we examined the IITs as a whole in all their facets, there were a number of other Committees which looked into one or other feature only but in great depth and sometimes, laterally with other Institutions and Colleges. Since the last review made between 1971-1973, many changes have taken place. Still more are likely in the years to come in the socioeconomic climate and technological needs of the country. The IITs have to respond to these changes effectively, in the larger and long term interests of the country.

◆ 1.4 Terms of Reference

The terms of reference given to us have a wide range of academic review and such related matters as finance and its management, governance of the IIT system, management structure and other relevant support systems, needed to enable the IITs to perform their functions in accordance with their charter.

◆ 1.5 Methodology: Collection, Study and Analysis of Reports/Opinions

At the first meeting of the Committee we discussed the terms of reference to see whether these require any modification or expansion. In this meeting we had also invited the

Education Secretary and other officers from the then Ministry of Education to interact with us. In the second meeting, we discussed the tasks involved. Several ways and means were also discussed to collect data/information from the IITs. The question of interaction with institutions/organisations/individuals and user Industry and other user groups connected with the functioning of IITs was also discussed at length.

Before visiting these IITs we had familiarised ourselves with the background material on the basis of reports and documents presented earlier by several other committees mentioned below:

Development of Higher Technical Shri N.R.Sarkar Institutions in India (1948) passed by the Parliament Indian Institute of Technology under the chairmanship of Act (1956) Reports of the last Review Committees

- IIT Kharagpur (1973)	Shri G. Pande
- IIT Bombay (1972)	Dr. H.N. Sethna
- IIT Madras (1971)	Prof. P.L. Bhatnagar
- IIT Kanpur (1973)	Dr. S. Bhagavantam
- IIT Delhi (1973)	Shri M.R. Chopra

In addition to the above, we also studied the reports of the following special committees;

Committee on	Chairman
Equipment (1976)	Shri P.Sahai
Foreign Technical Assistance (1980)	Prof. Y.Nayudamma
Postgraduate Education and Research (1980)	Prof. Y.Nayudamma
Reviewing of Centres of Advanced Studies in IITs (1981)	Dr. M.G.K Menon

Apart from these reports, we also perused the following documents prepared/circulated by the Member-Secretary during the course of conducting review:

- Visitor's orders on the report of the previous Review Committees.
- Series of Study Papers prepared by the Member-Secretary based on the material received from various sources focussing on one or other important issues pertaining to IITs.
- Strengths-Weaknesses-Opportunities-Threats (SWOT) Analysis. These were prepared by each IIT and circulated to us which helped us to identify a number of issues that deserve to be looked into.

- Information received from each IIT giving status position on (a), (b) and (c) of the terms of reference. - IITs' response to the questionnaire framed by us on special aspects.
- IITs' response to clarifications requested from them.
- Statistical information on basic data received from each IIT.

To elicit opinion/views of those who may have at some time or the other some interface or impact with the IITs, a set of issues were spelt out in the form of questionnaires and mailed to those individuals/ organisations in India and abroad to whom each such questionnaire pertained. Individuals addressed abroad were mainly Alumni of the IITs and the Experts who had helped the IITs in their early stages of development. The public at large were also requested through national Newspapers to express their views about the role of the IITs. A number of responses were received. These responses were studied, analysed, summarised and circulated to members.

We spent two days in each IIT and held detailed discussions with different representative groups. The programme of the visit to the IITs was structured well in advance and was widely advertised within and outside the IIT campus.

During the visits the structure of discussion in each IIT covered invariably representatives coming from the following groups:

- IIT Council Members-past and present
- Chairmen of Boards-past and present
- Board Members-past and present
- Directors-past and present
- Deans--past and present
- Industrialists and Businessmen
- Senate
- Faculty Groups
- Representatives of Students and Research Scholars including SC/ST students
- Representatives of Alumni Associations
- Representatives of Employees Association (including Faculty Association, Technical Staff, Non-academic Staff and SC/ST Employees)
- Representatives of the Regional Committees of the AICTE, Apprenticeship Boards and other Technical Institutions in each region
- Mess employees

- Individual memorialists and those who responded to the advertisement made through the press

1.6 Limitations of our Report

- In this report we confine ourselves to the terms of reference which is mainly an "academic review" of the IITs and such relevant issues pertaining to academic matters. Other issues which do not have a close relevance to academic activities yet brought before us by Associations/Unions etc. we're not taken up for review and comments.

- We mainly examined issues on the basis of written or oral evidences presented before us. We had on no occasion doubted the presentation or checked their veracity.

- A number of studies such as migration of students abroad or development of publication indices of research staff could not be carried out by the Committee and our conclusions are based on our overall understanding of these issues, though towards the end of our tasks, we received a report from Association of Indian Universities on some of these aspects.

- Similarly, the plan provisions needed by the IITs for development in Seventh Five Year Plan is again based not on our detailed study but on global understanding of the problems in the IITs, as presented by the respective IITs.

- Generally speaking, our report is the result of deliberations on the advice received by us on issues that we raised with many in the field both within and outside the IIT system.

-We also drew our conclusions on some issues through the reports submitted by other expert committees such as the Postgraduate Committee Report, Menon Committee Report on assessment of Centres.

PERFORMANCE REVIEW

2.1 The Establishment of the IITs

The IITs were set up by an Act of Parliament with a specific declaration that these are our "Institutes of National Importance," They were conceived to act as leaders in technology innovation, train the necessary manpower and promote generally the state-of-art of Technology in the country. Their role was to enhance the country's techno-economic strength and technological self-reliance. Our terms of reference enjoined upon us to critically evaluate the extent to which the IITs achieved this objective and suggest future lines of development.

We examined the recommendations contained in the interim report of the Sarkar Committee, which can be regarded as the origin of the IITs. It envisaged establishment of these institutions to meet the anticipated requirements of the post-war (1939-45) industrial development in respect of higher technical personnel. The report of the Sarkar Committee clearly points out that these higher technical institutions now known as IITs, were expected to be the centres of excellence like the Massachusetts Institute of Technology, USA, and at the same time evolve and conduct programmes relevant to meet the anticipated requirements of the country.

In our view, these goals are valid even today. It is, however, necessary within these goals, from time to time to specify priorities with which IITs should be concerned. At the early stage of their establishment the IITs emphasised training of manpower particularly at the undergraduate level to match the standards of quality elsewhere in the world as their goal. Some of the IIT faculty still feel that they need not proceed any further and, their goals are solely confined to teaching and research programmes. However, this view is not shared by many who see the need for adding other dimensions to their activities. We noted that the early visionaries anticipated clearly that IITs should remain selective, be financed adequately, and from time to time, have their priorities spelt out within the overall direction of growth that was envisioned and anticipated. In doing so whatever was necessary, be it manpower training or research output, or biasing their research to the needs of the industry, or application of Science and Technology to rural situations, all were well within the scope and goals of the IITs originally set.

At the time of establishment of the IITs there were a number of well-established engineering colleges and universities. India had a record of good Technical Education system and some of the institutions like Roorkee University, Bengal Engineering College, Jadavpur University, Banaras Hindu University, Poona Engineering College, Guindy Engineering College and the Indian Institute of Science, to name a few, enjoyed a high reputation. Still a deliberate decision was taken at that time not to adopt any one of these existing institutions as an IIT, but to establish IITs, de-novo. This single important decision seems to have been based on the premise that the new IITs needed to develop their own specific culture for promoting excellence. We feel that this basic premise continue to be valid even today.

The IIT Act provides for periodical review. IIT Kharagpur which was the first one to be established was reviewed for the first time in 1959 by a Committee under the chairmanship of Sir Willis Jackson. All the IITs were reviewed by separate and independent Review Committees during 1971-73. Ours is the first common Review Committee set up to look into

the entire IIT structure as a whole rather than each IIT independently. Such a unique opportunity gave us the freedom to examine the paths adopted by each of the IITs, their success stories and their areas of weakness. We were asked to evaluate the existing position and indicate directions of growth of the IIT system. The purpose of this Review Committee is, therefore, different from the earlier ones, in that, we were not to go specifically through the work of each IIT, let alone each department or centre in every IIT. Ours is a comprehensive academic review of the IIT system as a whole. The result of our review is expected to serve as an input for directions in which IITs should grow.

IITs have gained, over a number of years, a reputation as institutions of excellence in India. Many in this country and many from abroad were of the clear opinion that these are the best institutions in the country and needed further support for promoting their work. Such a success came about because, as a policy, support was continuously given by the Government of India providing them more liberal (liberal under the circumstances, though IITs have felt that the plan funds are small and larger input was necessary to make the infrastructure adequate and contemporary) funds in a favoured manner. We noted that it was a deliberate policy from the time of setting up of them to treat the IITs as "special" and to fund them liberally with higher expectation of excellence in their achievement, performance and commitment to the Nation. IITs met the expectation by evolving a unique system by which they got the best of Indian students for their undergraduate courses. The IITs were able to review periodically their courses of study and method of evaluation with a view to bring out the best from the students who could pursue studies at their own pace. At the same time the IITs were also able to introduce modern concepts in technology as and when they evolved without a long lapse of time. IITs got the best of faculty and most of the IITs were reasonably equipped. It follows that it is no longer possible to have more such institutions financed on such a scale so liberally. Therefore, it is desirable wherever possible to finance other technical institutions that are doing good work, through Technical Education Plan Schemes.

2.2 Contribution and Impact of IITs

Our remit requires us to review the present progress of the Institutes of Technology in fulfilment of their broad objectives as centres of advanced studies and research in Science, Engineering and Technology; to examine how far the Institutes have interacted with other Technical Institutes with particular reference to courses of study, programmes of research and faculty development and to assess the overall impact of the Institutes on the training of high grade engineers for the technological development of the country. We noted that the strength of the IITs is known by the quality and calibre of their undergraduate students, who are acknowledged, as well-trained and accepted easily, by most in India and abroad. A major reason for this success is the selection of students through a rigorous competitive process which is popular among the students in India. The total output of all undergraduates from all IITs upto 1984 comes to 26,677 (Table 2.2A and Figure 2.2(I)). Quantitatively as well as qualitatively, IITs' contribution to the requirement of technical manpower has been significant.

The employers of engineering graduates in India are of the opinion that the detailed programme of B.Tech. generally meets the needs of the industry. The students who went abroad have also done extremely well. Experts from abroad have very favourably commented on the analytical capabilities of the IIT graduates. IIT alumni abroad have said that after the type of training and academic exposures they have received, the challenges posed to them in

the newer institutions are relatively simple to meet. Consequently, the reputation of IITs at home and abroad appears to be well-established. This is no mean achievement in the course of two decades and credit is due to IITs on this score.

The IITs have also contributed their share in upgrading the quality of Engineering Education in the country, through QIP (Quality Improvement Programme) and FIP (Faculty Improvement Programme) (Tables 2.2B, 2.2C and Figures 2.2(II), 2.2(III)).

A number of faculty of our Technical Institutions have received intensive programme of training including exposure to the techniques of modern teaching methods. Some of them are trained, as a part of these programmes, for their Ph.D., while some others are given training in the development and planning of the laboratories. All these programmes are carried out by the IITs within their own resources.

IITs have also helped laboratory planning in selected engineering institutions under the Institutional Network scheme since 1970, by planning their core facilities (Table 2.2D).

IITs have helped these institutions in drawing up relevant laboratory manuals, and generally improved experiments in the laboratory. Such efforts of the IITs cannot be measured specifically in terms of graduates and postgraduates. But they all go to enhance qualitatively the general level of engineering education in the country. We feel, therefore, that merely dividing the total cost incurred by an IIT by the number of graduates or postgraduates produced, without taking into account such valuable extension work done by them is fallacious, because the extra amount so spent is judiciously used by them also to enhance the quality of training imparted by other institutions. IITs have interacted well with other technical institutions with specific reference to their courses of study, and programmes of faculty development.

Their research activities have increased manifold. There are a number of centres of research where identified S&T; areas are being developed. If these centres of excellence were not established, the country would have been far less prepared for self-reliance than it is today. This is one of the strengths they have achieved during the last few years. It is to these institutions which many industries in the country now approach, though in a limited manner, for solutions to their problems. It is to these institutions that many S&T; Departments have approached for expertise and sponsored research. It is again these institutions that conduct a large number of postgraduate programmes. We would, therefore, like to record that IITs have well fulfilled some of their major objectives such as development of first-rate B.Tech graduates, up gradation of engineering education in the country, contribution to research programmes and undertaking a leadership role which was envisaged for them.

2.3 Shortfalls

The very achievements of the IITs raised expectations in many quarters for greater commitment and better results in some areas. It should be recognised that if there are shortfalls in performance of these institutions, these have to be viewed against the perception of higher expectations and not necessarily in the context of what was achievable within the given resources and the environment in which the IITs functioned. Attention has to be paid in the coming years to cover these lacunae.

(a) Their undergraduate programmes have tended to become stereotyped although when they started, there was a great deal of flexibility. Departments in the IITs now increasingly work in water-tight compartments. They are the main operational units on the academic side. They are the ones who should constantly review their academic programmes, requirements of their laboratory and courses and generally promote the academic progress of the pupils. If the IITs' courses become increasingly rigid, they will cease to reflect a true response to live problems. There is a felt need to have greater flexibility in the course structure such as would permit the students to take a number of elective courses (especially in the last two years) thereby enriching both variety and depth of the output of their students. Such flexibility is essential if an IIT graduate is to be aware of and alive to the changing situation in the technological scene.

The way the practicals are conducted in the IITs is another source of disappointment, in that they are becoming stereotyped verification of data and not experimentation. At present, they do not encourage young minds exploring or enquiring into the process or even arouse their curiosity. The student, thus, is becoming more and more a technician arranging experiments to demonstrate and not becoming a young scientist imbued with a zeal for discovery. It is far more important at this stage to sharpen this edge of curiosity if the students are to grow into scientists and technologists of the future-the purpose for which the IITs were established.

(b) The total research output of IITs and the quality of research carried out have not reached the levels expected of them. Even the number of professional awards, earned by the IIT faculty in recognition of their research work is getting fewer and fewer. This is in contrast to the earlier years when IIT faculties were recognised as leaders of research. A number of the alumni who migrated abroad have stated that an important reason for their going abroad is the realisation, even as they were in their undergraduate courses, of the fact that while their teachers produce a large number of research papers, they are not well known; their teachers are not recognised research leaders and their papers are not quoted internationally as often as it should be. There is truth in this, and the level of research needs to be considerably raised.

(c) IITs in the earlier years were well known for experimental research. Over the last few years their emphasis on experimental research has dwindled. There seems to be a tendency to avoid experimental work and instead take up a number of routine projects which are statistically more impressive. It would have made a difference if, for example, they had taken up a few projects on instrumentation, and used their infrastructure to develop a number of scientific and technical instruments. It is important that design and fabrication of sophisticated instruments either as a part of Master's projects or Ph.D programmes, is given priority over routine items.

(d) Though these are Institutes of Technology there are relatively few doctorates in technology. Ph.Ds are awarded equally in science-based and engineering-based subjects but few have earned a doctorate in technology. The number of students taking up a research project or projects in applied technology either for their thesis or for project work are very few. Achievement of high degree of technological competence and self-reliance implied the presence in the system of adequate number of doctorate level persons in technology. This is conspicuous by its absence amongst the IIT graduates.

(e) Their contact with the industry is few and far between. Neither are they able to advise the industry how their technologies can be improved in a cost effective manner nor are they able to provide any technological break-through for adoption by the industry. Indian industry uses

the facilities in the IITs peripherally either for testing or for measurement or for few simple projects of not great consequence. There is no substantial technological fallout from the projects undertaken by the IITs or from the results flowing from their research. The IITs have to make a significant departure from the present state and make distinct contributions to our national R&D; scene.

(f) The IIT faculties as a community appeared to have an ambivalent attitude to the application of Science and Technology in rural areas. Some even felt that it could not be their area of concern as they had very little to contribute. Application of Science and Technology solutions to rural problems can be as exciting as they are in an industrial situation or in pure research area, and the results could benefit far greater number of people. It is important that IITs must increase their sensitivity to the problem of their environment and relate their activities more and more to indigenous problems with a view to obtain solutions through the application of technology.

(g) The cream of the IIT graduates are not available for service in the country. Many take up jobs in developed countries, and even those who remain do not take up challenging engineering and technological jobs, but prefer to go for managerial positions, where higher monetary rewards are available but jobs which bear no relation to their basic IIT training. This is a more complex problem to which IITs may at best can find only partial solutions.

(h) Some IIT students were also expected to be entrepreneurs and job generators but there are not many of them. A conscious move to encourage entrepreneurship and prepare undergraduates for it, is part of the IITs' future task.

(i) It has been sensed that the training imparted and examples provided by the IIT system are such that almost all students develop an ambition to go abroad. Teachers invariably prefer spending their sabbatical leave abroad in preference to better opportunities and challenging jobs in the industry in India or in other engineering colleges or in other R&D; sectors. Even in their syllabi, examples and illustrations are rarely related to Indian situations. Thus, the IIT value system does not motivate the students to be committed to work in the country which has invested so much on their training.

(j) Lastly, a number of organisational lacunae are noticeable which need attention, such as:

-Absence of clear-cut personnel policies and a disproportionate number of non-academic supporting staff.

-Absence of any system of training and retraining of the employees.

-Raising non-plan expenditure.

-Administration appears to be one of the weakest links in terms of structure and regulations. Most of the people who are in administration including the Deans are not trained or have experience in management. In the circumstances, the administrative system tends to be one of crisis management and the administrative apparatus is perceived more as an over-riding hindrance than a supportive subsystem to the mainstream of academic activities.

-Even though their B.Tech. programme is considered to be good, not many of the graduates join the M.Tech. programmes nor aspire to faculty positions. Qualitatively the output of their

M.Tech. programmes, according to the IITs themselves, is not as good as that of their B.Tech. programmes.

-Dependence on budgetary support is absolute and there is little attempt to reduce it by exploring avenues of income-raising for the Institutes.

- The meetings of the Boards of Governors are more devoted to routine administrative matters rather than on academic affairs. According to the IITs, the representatives of the State Governments are confined to the State perspective rather than being concerned with the problems of the IIT.

- Despite the fact that an IIT is supposed to have a decentralized type of management, in practice they work in a bureaucratic pyramidal structure. Consequently, they have lost flexibility and the ability to take quick decisions which is the essence of a cluster type management with decentralized responsibility. This is reflected in their Statutes which concentrate power at a few points rather than disperse it; even though the Boards are empowered to amend their Statutes according to their needs.

These issues have been discussed in subsequent Chapters at appropriate places.

2.4 External Factors

The shortcomings mentioned cannot, however, be faulted solely on IITs. For example, when one says that IITs were to train its graduates as scientist-engineers to take over positions of responsibility in R&D; organisations and in High-technology areas it is implied that their optimal use cannot be in areas of routine engineering problems of the Indian Industry. Yet employment opportunities are more in these areas than the former. The fault lies in the state of the art of R&D; in our industries.

Industries in India were developed under colonial conditions. The development of the products, the process, the design and fabrication of the equipment were all done abroad. Even the erection of plant and machinery was done by foreign technicians. In these circumstances the role of an Indian engineer was confined to the maintenance of plants and operation of the production schedules. Engineering careers, therefore, were neither intellectually challenging nor financially rewarding. True, since independence we have witnessed a spectacular growth of industries, but their basic characteristics have undergone very little change. They operate under an umbrella of protection with imported process know-how and machinery. Much progress in fabrication and building of equipment and machinery has, of course, been achieved in recent times. But there is relatively little work done in the design of plant and machinery and the development of process know-how. This is evident from the fact that since independence, Indian industry entered into more than 6000 foreign collaboration agreements. They cover import of not only product, process know-how, and machinery but even trademarks and brand names.

Very little investment is made by industry in meaningful Research and Development. Systematic efforts are rarely made to digest and indigenise the imported technology. India often goes for repetitive import of technology and depends on foreign collaboration for even updating technology. The normal tendency is to look to the collaborators for the solution of even simple problems. This chronic dependence of industry on foreign collaboration has

inhibited the growth of Indian know-how, design and consultancy capabilities, depriving Indian engineers of the excitement and thrill of participating creatively in the industrial development of the country. On the other hand, a virtual ban on import of capital and consumer goods and the operations of industrial licensing system practically eliminated competition and with it eliminated the need to innovate and experiment.

It is not strange, therefore, that in such industrial situation the curriculum and instruction in the IITs tend to become theoretical, conceptual and esoteric and of less relevance to the contemporary local scene. It generates special pulls both on the teachers and the taught. In this situation a teacher in an IIT is encouraged to publish his scientific results in a foreign journal, look forward to an invitation to international seminars or even obtain teaching assignments in foreign institutions. No wonder an IIT teacher finds in such a situation, careers abroad professionally more satisfying and financially more rewarding. Therefore, the industrial development policy followed so far has willy-nilly created an ethos where a foreign audience is always present before an IIT; and in the choice of problems they try to tackle ones that are esoteric and nearer to problems in advanced countries than to the realities of India. The remedy, therefore, does not solely lie within the IIT system.

Apart from the lack of stimulation in the external environment, internally, the IITs having completed 25 years face the problem of ageing. There is an abatement of enthusiasm in keeping abreast of the modern technology, and a creeping reluctance to face up to the challenges of the country. It affects their efficiency and creativity.

The absence of a national coordinated manpower policy is another external handicap. Manpower is trained still in an adhoc fashion and there is no central manpower informatics which could relate manpower development to specific quantified technology needs. There is no agency to suggest mid-course corrections, if deficiencies are noticed in the manpower development.

The working atmosphere in the IITs also gets affected by external political considerations. There are thus a number of internal and external factors which detract from the optimal functioning of the IITs. These are our best institutions of excellence. They need support both by way of policies and finance in order to enable them to match their performance to the expectations of the country. Our terms of reference require us to suggest the lines on which the five Institutes of Technology should be developed. This is being dealt with in the next few Chapters of this report taking into cognisance the perceptions outlined above.

SUMMARY

The Indian Institutes of Technology were established with the objective which is best described in the words of the late Prime Minister Pandit Jawaharlal Nehru- "to provide scientists and technologists of the highest calibre who would engage in research, design and development to help building the nation towards self- reliance in her technological needs". There is a more elaborate statement of objectives in the Sarkar Committee Report and in the statutory charter of the IITs. These are comprehensive and hold good even today though it may be necessary to re-emphasise some, to remove ambivalence in some others and to set the priorities more clearly to meet the changing needs. (Para 2.1)

The IITs were set up inspite of the recognition that some colleges of engineering had "attained a quality with age". IITs have completed nearly a quarter of a century of existence. This is the first time that a single common committee was appointed to review all the IITs together. They have acquired a degree of excellence in their facilities and faculty with the help of industrialised countries and as liberal a funding as was possible by the central government. The IITs have evolved an exclusive system of attracting good calibre students. They also evolved sound systems pertaining to courses of study and evaluation and oriented towards helping students to learn at their pace, choosing a load and picking electives with flexibility in the choice of subject. Their performance is evaluated not by chance achievements in a single examination but continuously through varied methods. (Para 2.1)

These measures have enabled the IITs to produce B.Tech. engineers of excellent quality comparable to the best in the world. (Para 2.2)

During the last decade, the IITs have also contributed to the up gradation of engineering education in the country. Considerable investment and effort has gone in to increase of research activities, developing some centres of advanced research to give technological leadership and diversifying and expanding post-graduate engineering education. (Para 2.2)

One cannot, however, overlook the fact that output from the IITs may not have been commensurate with the inputs and expectations. One can question the degree of impact of IITs on national, industrial, economic and social development, on their attaining excellence and leadership in research and education and in motivating the students and teachers to be pioneers and job-generators. Of late, there are indications that the undergraduate programmes themselves tend to be less flexible than originally envisaged. Experimental research and design and fabrication of sophisticated instruments are on the decline. IITs do not seem to be able to motivate the students and teachers sufficiently in regard to their commitment to the nation to give their best and to achieve excellence. (Para 2.3)

In fairness to the IITs, their performance audit should take into account the internal and external environmental factors, obsolescence in institutes set up two to three decades ago, and lack of coordinated manpower and technology policies posing challenges that hinder efficiency and productivity. (Para 2.4)

GOALS AND OBJECTIVES

◆ 3.1 A General Charter

The Goals and Objectives were derived from the Sarkar Committee Report referred to earlier and embodied in the IIT Act. Two subsequent documents, namely the Science Policy Resolution (1958) and the Technology Policy Statement (1983) provide a sharper focus against which the Goals and Objectives of these Institutions could be reviewed.

The IITs were established on the basis of the recommendations of the Sarkar Committee Report. In addition to the Sarkar Committee report, the IIT Act and Statutes of the IITs indicate the lines along which IITs should develop. According to these documents IITs are expected:

-to be higher technical institutions on the lines of the Massachusetts Institute of Technology- better known as MIT;

-to provide for instruction and research in some branches of Engineering and Technology, Science and Arts for the advancement of learning and dissemination of knowledge in specific branches.

The two broad objectives which emerge from the above line of development are:

- The advancement of knowledge through education and research, in both Pure and Applied Science, in Engineering, Social Science and Humanities; and

- service to the community and nation (which we refer to as Extension activity) through the use of their resources both intellectual and material, particularly through Continuing Education for professionals working in Industry.

The Science Policy Resolution (SPR) of the Government of India (1958) is a basic document of relevance to the IITs. The SPR resolves:

-to foster, promote and sustain scientific research in all its aspects-pure, applied and educational; -to ensure adequate supply of research scientists of highest quality;

-to recognise the work of research scientists as an important component of the strength of the nation;

-to encourage programmes for the training of scientific and technical personnel to fulfil the country's needs in science and education, agriculture and industry, and defence;

-to encourage dissemination and discovery of knowledge in an atmosphere of scientific freedom.

IITs also constitute a major source for research-scientists of high calibre; they also are expected to serve the people of India and provide the country with benefits of application of

their discovery and knowledge and as such are entitled to academic freedom and research support as implied in the SPR.

The Science Policy Resolution (SPR) directly contributed to an impressive scientific and technical manpower formation and its success prompted the Government to evolve a statement of Technology Policy. The Technology Policy Statement (TPS) states that technological advances are influencing life styles as well as societal expectation. Much in the same manner as IITs are part of the successful implementation of the SPR, they now have a greater responsibility for fulfilling the relevant goals of the Technology Policy Statement as well. As Institutes of Technology, their charter, is to resonate the expectations spelt out in the Technology Policy Statement.

The Technology Policy Statement (1983) affirms, interalia, that:

- technology must relate to our people's aspirations and to our local needs;
- technology covers both manufacturing and servicing sectors.

The Statement affirms that the base for this consists of trained manpower, which IITs are charged to develop. It envisages special attention to the promotion of newly emerging and frontier areas and encourages research in these areas.

IITs have a specific role to implement these avowed objectives of the Technology Policy Statement within their general charter of education, research and extension.

Such goals require that IITs must

- excel in all aspects of academic activity and produce a high quality science-based engineering student;
- survive on specialization; work increasingly in frontline areas that transcend disciplines;
- have a perception and a value system appropriate to the pursuit of high science and high engineering science to meet the critically evaluated needs of the society in terms of products and processes using indigenous resources in close collaboration with manufacturing and service sectors;
- programme into their activities the emerging technological needs with a futuristic outlook;
- accept extension and public service as a third dimension to their role in addition to education and research;
- attain a stature that enables them to provide leadership with credibility. They should be the "think-tanks" for higher technological education and research;
- Aim at preparing more of "creative engineers", "innovative thinkers" and "engineer entrepreneurs";
- develop a special nexus with rural development mainly by way of involvement in technology-based solutions for problems in rural areas;

- maintain and foster interactive linkages with leading technological institutions and centres of research in India and abroad.

Education

The purpose of the educational programmes in the IITs should be:

-to develop in each student mastery of fundamentals, versatility of mind, motivation for learning, intellectual discipline and self-reliance which provide the best foundation for continuing professional achievement;

- to provide a liberal as well as a professional education so that each student acquires a respect for moral values, a sense of their duties as a citizen, a feeling for taste and style, and a better human understanding. All these are required for leadership;

- to send forth men and women of the highest professional competence with a breadth of learning and a character to deal constructively with issues, and problems anticipated in the next decade relevant to the programmes of development of our country.

Research and Scholarship

IITs must seek through their research activities to create an atmosphere of intellectual excitement, a climate of inquiry and innovation in which a student develops a consuming interest for understanding issues of his own volition.

Extension

As INDIAN Institutes of Technology, they must recognise their inherent obligation to serve students and alumni, the profession of engineering, the world of scholarship, the nation and the society at large. IITs should thus seek to serve the community directly through their human resources and through the use of their facilities, wherever there is a need, to which they can respond easily. These objectives are derived from the original goals and not construed de- novo.

The Report of the Committee on Post Graduate Engineering Education lays stress on the thrust areas such as Fibre Optics, Micro- electronics, Materials Science, Reliability Engineering, Robotics, Ocean Engineering, Computer Science etc. IITs have a significant role to build a superstructure in the form of Postgraduate Programmes in such thrust areas that go to influence the quality of Undergraduate Curriculum. In order to develop such a curriculum they need to interact and develop linkages with their surroundings specially with the manufacturing and service sectors.

During our discussions several questions arose while spelling out goals of IITs, such as:

- should not the IITs mainly concentrate on forging links with organised industrial sector for import and diversification of its technology?

- should IITs commit their resources for developing appropriate rural technology for mass impact?
- should not the Institutes strive for an optimal blend of a limited number of objectives in order that they do not spread their resources thinly?

We are clear in our minds that the Technology Policy Statement and the Science Policy Resolution demand a conscious integrated approach covering technology assessment, technology acquisition, absorption, utilization and diffusion. This responsibility cannot be solely placed on the IITs. But, IITs cannot escape participation in one or more aspects of Technology development along with others. Technology policy studies may be initiated in one or more IITs to enable them to have a proper appraisal of modern technologies, and arrive at an assessment of their relevance to the needs of our society. Such studies will help orient research and curriculum to produce engineers alive to the needs of the nation. IITs then would no longer be accused of training people according to the needs of the developed nations.

3.2 Specific Goals

Within the overall goals outlined some specific goals need to be spelt out. It is obvious that IITs must continue to engage in manpower development but their students must be different and special. An IIT student must be an agent of change of Technology practice in the country, and initiate a new working culture in our industry, with a view to increase productivity and bring to industry the capability to innovate. Some IIT graduates should, therefore, become entrepreneurs themselves for starting new science-based, technology oriented industries. They are thus to be so trained by the IITs as to build into their value system a sense of responsibility to the country and a desire to do great things for the society. Their perception must not preclude Hi-Tech. as an important tool to solve ground level problems.

IITs must continue to interact more closely with other technology institutions and become the lead-centres of Technical Teacher Training. Faculty in the IITs must become visible agents of change, as natural partners, for upgrading standards of Technical Education, research in general, and specifically development of newer laboratories and newer programmes in the technical institutions in the region where they are located.

Some of the IITs, who have locational advantages, can involve themselves in the tasks related to the development of R&D; in the industry by means of supplying competent technical manpower and by offering laboratory solutions to the problems faced by the industry. Their method of instruction should be innovative and qualitatively different. For instance, Micro-electronics may be taught in other colleges as an educational programme, but IITs who have research excellence in their proximity, on the other hand, would bring in a practical bias and illustrate a number of case studies relevant to their curricula. Their functions of teaching, research and extension would be perceived as an integrated block and not as separate identities. Without such integration, a teacher cannot develop the personality of the taught in a wholesome fashion, relating what is taught to actual experience. The teacher's experience in extension activity will improve the quality of his research, in turn improving his teaching content. The students will then see him as a leader in research whose work is relevant. Some of the alumni settled abroad while responding to our questionnaire mentioned that a major cause of their migration abroad is the absence of academic and research leaders in the IITs.

They find that the leaders mentioned in reputed forums are Professors working in institutions abroad, but not the Professors of the IITs. It is this excitement to be able to work as students of these international leaders soon after their graduation that lures them to migrate abroad, referred to as "brain-drain". Only by attaining such status and international reputation that the faculty in the IIT can motivate many of these brilliant students to stay back and work with them.

As the Information Age is ushering in, thanks to the technological advancements in the areas of Microelectronics, Materials Engineering and Bio-technology etc. the country will look towards IITs to be lead-agents for promoting training, research support and technology development in many such thrust areas. The goals of an IIT, therefore, must specifically include helping such changes happen in this country in a programmed manner and faster. It is for each IIT to decide on what priority areas they need to emphasise, from time to time and plan for them.

Extension activities will make their programmes realistic, their research work more relevant and they will acquire expertise enough to act as consultants to a consultant. Such orientation alone will enable IITs to become an important link between Technology and Development.

To summarise:

The Indian Institutes of Technology

Academically

- strive to be relevant and excellent;
- engage themselves in teaching, training, research, publication and extension work of relevance;
- remain within the optimum size in order to be effective;
- Concentrate in selected areas of technology which can help remove impediments facing the country's goal of self- reliance;
- Produce job generators i.e. engineer entrepreneurs;
- produce creative and innovative engineers;
- become consultant to consultants;
- engage in trans-disciplinary education and research;
- make pioneering effort especially in frontier areas of technology;
- inculcate the desired perception and value system in their students both by personal example and by precept.

Organisationally

- function in a decentralized way;
- earn more and depend less on budgetary support from the State;
- sharpen the cutting edge of knowledge from time to time; and for which
 - * Survive on specialisation and intellectual elitism;
 - * Attempt to be cost-effective in all their endeavours; * prepare for and assume a leadership role in Technical Teacher Training.

These are indicated to illustrate a number of objectives that IITs can have, although, from time to time they will emphasise one or the other objective, relevant at the time.

3.3 Implementation

Our recommendations are all related to the achievement of these goals. We would like to emphasise at this stage, that all the effort that has gone into shaping these views supported by a number of people, within the IIT system, within the country as well as a number of experts and alumni abroad, will not bear fruit, unless these recommendations are examined, and decisions are announced. Equally important is to act on such decisions quickly and effectively. During our visits to IITs, many have doubted whether there is effective machinery available for implementing such decisions. We are very clear that the changes which we are suggesting are in tune within the policies and the needs of our time and these can be implemented if there is a clearly enunciated policy backed by the Government. It is also necessary to translate their backing by providing qualified and competent manpower for implementation. Wherever the Government is committed, implementation becomes easier. If recommendations are acted upon changes will be clear and visible in five years' time.

We gather that currently the management of IIT desk in the Ministry is clubbed with other duties, and there is hardly any time to nurture and extend the support necessary from Government to these institutions e.g. in the Council of IITs, to deal with the issues arising in the Parliament. It is essential that the Ministry of Human Resource Development should deal with IITs as the sole concern of a wholtime officer without any other major load added to him. To be effective, he must be at a sufficiently senior level. He should be backed with qualified staff who could initiate in the next few years an effective mechanism for implementation. We would emphasise that this aspect be taken into account while examining our recommendations.

The second important aspect for successful implementation of the suggestions made by us, is specific policy support of the Government of India, e.g.

- association of IITs with Policy Planning agencies of the Government like Department of Electronics for import of electronic equipment, DGTD with regard to technology import and development etc., energy conservation, and other areas of S&T; work (4.5.3);

- encouraging industry by way of tax concessions for their contribution to establish meaningful linkages with the IITs (4.5.2);
- freeing them from bureaucratic interferences, ensuring autonomy and demanding accountability (6.1.1);
- encouraging measures necessary to create situations where IIT alumni remain engaged within the country in challenging tasks (4.8.5);
- engaging IITs in the selective thrust areas of development (4.9.1);
- considering them as focal points and think-tanks in the matter of framing Technical Education Policy at graduate levels and beyond (3.2);
- National Pension Scheme for faculty for easy mobility into industry and R&D; organisations (4.9.5);
- support for entrepreneurship effort of faculty and for those successful in efforts for indigenous technology development (4.4.6 and 4.9.1);
- external support to the IIT management for enforcing higher standards of achievement and reward merit in both faculty and other employees (4.9.2);
- supporting IITs to establish and enforce separation policy for faculty, based on objective assessment and giving the political backing as necessary in this regard (4.9.2);
- helping IITs to remain high in their standards even if it means modifying some Government policies in the sphere of reservations or industrial relations (4.5.2 and 4.8.4);
- Central Plan provisions for removal of obsolescence (5. 1. 1);
- faculty housing and provision for modern computers for the IITs (5.1.1);

SUMMARY

Technological manpower production is admittedly the basic function of the IITs. The product has to be excellent in quality, relevant to the technological needs of the country, motivated to give of its best and have a commitment to the country. (Para 3.1)

The goals and tasks of these institutes in their process of development have to relate continuously to:

- Significant and notable changes that are taking place in the socioeconomic development of the country; and
- Rapidly exploding universe of knowledge in science and technology. (Para 3.1)

To preserve IITs' character as institutes of national importance and to maintain their leadership and pacesetter function in technological education, research and extension and to be able to produce the kind of technological manpower set out above, their goals must be:

- to excel in teaching, research and in all aspects of academic activity and produce a high quality science-based engineering student;
- to survive on specialisation, work increasingly in front line areas that transcend disciplines;
- to have a perception and a value system appropriate to the pursuit of high engineering science to meet the critically evaluated needs of the society;
- to programme into their activities emerging technological needs with a futuristic outlook;
- to accept extension and public service as a third dimension to their role in addition to education and research;
- to attain a stature that enables them to provide leadership with credibility. They should be the "think-tank" for higher technological education;
- to aim at preparing more of creative engineers, innovative thinkers and engineer entrepreneurs
- to develop a special nexus with rural development mainly by way of involvement in technology-based solutions for problems in rural areas;
- to maintain and foster interactive linkages with leading technological institutions and centres of research in India and abroad. (Para 3.2)

It is against this broad conceptual background that the recommendations of this Committee are based. It is expected that if the recommendations are accepted and acted upon, changes will be clear and visible in five years' time. (Para 3.3)

ACADEMIA

4.1 Programmes: General

4.1.1 Current Programmes

IITs are offering undergraduate programmes leading to B.Tech. Degree and Master's Degree in Science and Technology since their inception.

As compared to many Engineering Colleges, IITs have a favourable teacher-pupil ratio, averaging 1:8 for undergraduate courses and 1:4 at postgraduate levels. A teacher in an IIT has a normal teaching load of 8-10 hours per week. Every teacher including the senior-most in a Department has to have one lecture course of three to four hours duration per week. The work load expected of a teacher is fixed as 20 hours of lectures and lecture equivalent. All other assignments such as administrative responsibilities, hours spent on library, on practical work, on research etc. are converted into total work load.

IITs have the advantage of a continuous internal evaluation system that is well thought of in academic circles. IITs also have a periodical examination system, which some consider as a strait-jacket system, taking away the joy and pleasure of a learning process. The periodical system of assessment of students although rated by many as innovative, does tend to be highly evaluation-oriented rather than knowledge-oriented and it seems that their students are preparing for examinations all the time. But the resilient nature of the IIT system does permit review and change all these defects by themselves. Some IITs, as a result, reduce their class strength, and in some classes teachers are given freedom to decide their own system of evaluation. But generally speaking, all the IITs adopt letter grades like A, B, C, D and E instead of percentage marks, to measure the performance of a student. Opinions are divided on the use of letter grades; some favoured the use of more letter grades with each letter representing a finer range of marks. There are, however, courses amenable to evaluation purely on the basis of pass or fail. The salutary feature is their being aware of various methodologies of evaluation and their ability to correct for themselves.

4.1.2 Continuation of Existing Programmes

IITs must continue their B.Tech. Programmes because

(i) Evidence indicates clearly that they have evolved a commendable undergraduate system comprising merit-oriented entrance examination for selection of students; a good teaching and training programme and a sound evaluation system. The system has produced excellent technically-oriented manpower. B.Tech. graduates of IITs have earned uniformly good reports both within and outside the country.

The undergraduate system should not, therefore, be dismantled but improved upon to reach still higher levels of excellence.

(ii) Undergraduate education in institutions like IITs where there are dominant postgraduate and research activities, offers to students an exposure to the best of faculty and facilities. This prepares them well to face newer technological changes.

Faculty also benefits by this opportunity to teach from basic levels young students who are both intelligent and inquisitive.

However, some changes in these programmes can be made to utilise fully the better class of faculty, and students that are available to IITs:

- Instead of offering same common programmes/courses, as offered in any engineering college, IITs should make efforts to design and offer courses in newer areas. To what extent specialisation and trans-disciplinary courses are to be introduced at the first degree level has to be considered by each IIT.

- Help transfer of some of the well-developed B.Tech. Programmes to other engineering colleges.

- Start has already been made in a couple of IITs in designing integrated M.Tech. programmes. The quality of and response to such courses needs to be carefully watched before expanding the programmes.

- Methods of imparting instructions need improvement. Use of electronics media, flexible options to students to select subjects of study; self-study techniques-are some areas needing detailed examination, planning, and successful implementation.

- The country's requirement of engineering manpower at the first degree level can be categorised into two distinct types. One may be termed Engineer-Scientists and the other Engineer-Managers.

- The need for the former is felt in design, development and research areas; and in teaching. In fact, such persons will be more attuned to acquire further in-depth knowledge by continuing postgraduate and doctoral courses. IITs programmes have been oriented more towards this category.

- Engineer-Managers, on the other hand, are needed to formulate and implement plans for growth; to develop organisation and systems; to evolve methods of forecasting and so on. A number of IIT graduates have acquitted themselves creditably in these areas of management including marketing, entrepreneurship. Such supplementary skills have often been acquired subsequent to leaving IITs. IITs may consider supporting them, by offering critical courses in these areas. IITs' good image as "producers of excellent manpower" rests more with this group of engineers who have joined industry rather than those in research & development areas-although the latter was to be the unique products of the IITs.

- IITs ought not to feel satisfied that their graduates have done well in production, maintenance, construction and similar shop floor functions in operating industries. The graduates of other engineering colleges are equally well equipped to play this part and the requirements of engineering manpower for such functions will largely have to come from the engineering colleges.

- IITs must also continue their postgraduate programmes/courses leading to M.Tech. and Ph.Ds. The one to one ratio between UG and PG decided upon earlier must be attained and maintained.

- Unfortunately M.Tech. graduates have not made the same excellent impact as B.Tech. graduates. Most of them are first degree graduates from other colleges and only a few are graduates of IITs. Better selection through GATE (Graduate Aptitude Test in Engineering); closer interaction with user industries in selecting students and subjects; better course materials-will, it is hoped, bring about the desired change. This issue has been discussed further in Para 4.8.2.

A number of issues were raised by some of the witnesses such as, reduction of duration of undergraduate programme from five to four years and M.Tech. programme from two years to three semesters. Duration will necessarily vary from time to time depending upon the quality of input available from the schools and at entry level. We feel that such matters should be watched carefully by the Council of Indian Institutes of Technology and they should take appropriate decisions from time to time.

4.1.3 Student Population in UG and PG

Neither the Sarkar Committee nor the IIT Act laid down precisely the relative emphasis between UG and PG programmes. However, in 1974, based on the recommendations of the previous Review Committees, the Visitor issued orders directing IITs to try to achieve a one-to-one ratio between the undergraduate and postgraduate student population. Table 4.1.3 gives the student strength in UG and PG IIT-wise and year-wise from 1974. While IIT Madras kept close to this norm from 1974 onwards, Delhi & Bombay have achieved it later; Kanpur is static at about 1.5:1 and Kharagpur slid back to 2:1 after having made some move towards this norm.

We noticed that (except in IIT Kharagpur) a significant number of students are taking PG programmes in pure science/humanities as distinct from technology, constituting almost one-third of PG population. All IITs have sophisticated facilities and good faculty in pure science to serve as supporting structure for technology teaching, and it is good that these are being well utilized.

A number of views in this regard were presented to us. Our perception is as follows:

-The best of students at undergraduate level must be encouraged to continue in the IITs for postgraduate education and, therefore, IITs must nurture in sufficient strength both undergraduate and postgraduate programmes.

-Equal emphasis on postgraduate and undergraduate courses is more desirable than concentration on either one. The advances of technology are such that require interdisciplinary approaches for the solutions of real world problems. Co-existence of both types of programmes is likely to increase problem-solving capabilities.

-Through postgraduate programmes IITs can assimilate the latest knowledge and such new knowledge can be passed on to undergraduate curricula. Even for formulating model curricula for the technical education system, programmes at both levels are necessary.

- Undergraduate programmes should continue to give instructions in various scientific and engineering disciplines so that the students have the necessary background. Promoting more and more inter-disciplinary courses at this level at the cost of the core courses will not be desirable.

- There must be an equal emphasis on first degree and on postgraduate courses because without good undergraduate students one cannot have good postgraduate programmes. The quality of students admitted by IITs for postgraduate programmes from other engineering colleges have not proved to be upto the mark. A vigorous postgraduate research school has a stimulating effect on the undergraduate programmes and, therefore, it is necessary to continue programmes at both the levels.

- Staff and research facilities available in these institutions have been developed over the years to cater for both postgraduate and undergraduate programmes with equal emphasis.

We recommend that student strength of undergraduate and postgraduate courses should be aimed to be maintained at 1:1 ratio.

4.1.4 Optimum Size of an IIT

The resources and management structure of the IITs were modelled as for a small University. Over 25 years and more, the system has now come to a point of strain and perhaps even a break-down. IITs conduct currently a number of programmes such as undergraduate courses, postgraduate courses, research programmes, QIP, FIP, consultancy etc. far beyond what was visualized at the time of their establishment. Though, this is a natural growth, it is time to consider whether the already strained system can be loaded further and, if so, what is the limit of expansion. For this purpose, it is necessary to examine the facilities available in each IIT, such as limited power supply, water supply, computer facilities, control and information systems, problems of accommodation and other infrastructural constraints. A general lay-out of the campus of each IIT can be seen in Figs. 4.1.4 (I,II, III, IV and V). There has been a tremendous increase in their M.Tech. programmes from 6-8 per IIT to over 40-50 per IIT now. Similar expansion has taken place in other fields too. These courses may well be essential, as some of these programmes are in emerging areas of technology or areas of relevance to our industrial needs. IIT system itself should constantly look into whether some of these fields can merge with others so that an IIT does not grow beyond its optimum size. The key indicators can be expressed in several ways such as number of students or teachers or courses etc. They are all inter-related ultimately to the student population which determines the overall staff strength, and also related to the number of programmes IITs conduct. Having taken into account several factors we feel that in order that each IIT can function efficiently it should have an optimum size of about 2500 students. Within this framework it is possible for them to work efficiently and also achieve maximum results. This has become now more relevant and urgent because of the scarce resources available and the high investment needed for the pursuit of high-technology with which IITs are concerned.

4.1.5 Any More New IITs?

In view of the limit on the total student-population we have recommended for each IIT, a natural question that arises is, whether we need to establish more IITs. We are aware that the rush for admission to the undergraduate courses for IITs is heavy. Currently not more than

1200 students are taken into the IIT system even though over 70,000 students appear every year at the Joint Entrance Examination (JEE) for admission to their B.Tech. programmes. The JEE standards are high and demand hard work and high motivation and provide stiff competition among the best of candidates. This is a testimony to the high rating given by candidates for gaining admission to a B.Tech. programme in IIT. The IIT degree is prestigious and is commonly perceived as a valuable aid for good career opportunities both at home and abroad.

Naturally the question arises as to why more IITs should not be established. We have considered this issue.

Historically, the IITs are the result of a major experiment in international collaboration inducting the experience and expertise of leading nations in the world providing us their proven methods of development of high grade engineering manpower. There is little scope or necessity for proliferating this pattern at this stage of our development.

We also did not have any concrete evidence regarding specific manpower requirements that may justify the need to expand the number of undergraduates trained in India as Engineer-Scientists. Therefore, we do not feel that there is any ground either to start new IITs or to expand the number of seats at undergraduate or at postgraduate levels in the IITs.

IIT as a unique system does not make undergraduate education its ultimate end. The logic of the IIT system derives from its involvement in PG and research work and manpower training to keep pace with technological growth. The cost of undergraduate education in the IIT system is bound to be substantially higher. The argument for establishing more IITs cannot be based on the demands for good quality training at undergraduate level but has to consider the totality of benefits and outputs including the PG and Research level, the manpower needs to be met and the investments involved. We are of the view that the existing five IITs provide an adequate base for meeting the foreseeable needs of highly qualified trained and equipped "Engineer- Scientists" and that there is no urgent need to establish more IITs for the next decade or so.

We are also aware that there are a number of first rate technical institutions in this country both as university technical institutions as well as Regional Engineering Colleges who have done excellent work, in the sphere of providing good quality technical manpower with their limited resources. It is more advantageous to help such excellent institutions by additional funding to build up their resources and augment their capabilities.

4.1.6 IITs as Pace Setters

We noted that (except in the case of IIT Kharagpur) the establishment of IITs was helped by assistance from first-rate institutions abroad. With coming of age it should be now possible for the IITs to be the focal points of assistance to other Indian technical institutions in several ways and for projecting the pattern of their programmes in the Indian Technical Education scene. In any educational system, it is essential to have a national yardstick against which the performance of other institutions could be measured. IITs provide this standard. It is also their duty that IITs should now assist other technical institutions in their development, through the Institutional Net-Work Programme and Faculty Development Programme. It is vital for the IITs in the context of heavy demand on their resources such as buildings, space,

equipment to pass on their developed programmes to other institutions. Starting new B.Tech. programmes in inter- disciplinary/multi-disciplinary fields and in frontier areas would require additional financial and other human resources. We are taking these into account while recommending the additional Plan Provisions for the IITs (Para 5.1.2).

4.2 B.Tech. Programmes

4.2.1 Aims

The development of technical personnel at higher levels in India has been traditionally in the institutions like engineering colleges and in the IITs, and these products absorbed in the industry with or without suitable practical training programme. As mentioned earlier the category of technical personnel required at higher level is of two different types; the first are those to be developed as engineer- managers. For their development they must have besides an understanding of the basic sciences and principles of engineering, the ability to lead people, formulate and implement plans and to organise production. Critics of IITs often find fault with the IIT system to the effect that IIT products do not fit the role of engineer-managers in industry. The aim perceived by the IITs when they developed their programmes, was to produce another category of engineering personnel best described as Engineer-Scientists. This training of engineer- scientist belongs specially to the domain of an IIT. Engineer- scientists are expected to be mostly employed in research, design and development and in teaching. This is the basis which distinguishes the IIT training from the training given by many engineering colleges. Engineer-scientists must not only have a very sound background of basic and engineering sciences but they must possess the ability to apply this knowledge to a specific situation. For historic reasons and because of the nature of our industrial development, no systematic effort has been made to identify the tasks of Engineer-Managers as distinct from Engineer-Scientists. This contributes to the fact that a large number of IIT engineering graduates take up jobs which have little to do with their engineering-background. The malady lies in the inability of Indian industry to absorb the type of engineers produced by the IITs in appropriate research, development, design or academic positions so far. Nevertheless, the IITs should continue to produce manpower requirement of engineer-scientists through their B.Tech. programmes as the Indian technological scene is rapidly changing and will need such products in the near future.

4.2.2 Greater Flexibility Needed

The IITs appear to have lost the flexibility in their programmes, which they initially had by virtue of their measure of freedom to formulate programmes and conduct examinations and assessments which they enjoy even now. For example, a student in Chemical Engineering passes out but wants to have some knowledge about computers; he may have already done a course in Computer Science i.e. basic language course. If he could be allowed the facility of staying on say for three months to do a few more allied courses he would be better equipped for his chosen speciality. Right now what happens is that he does not pass out but drops deliberately in order to do some other courses. IITs need to allow such candidates the facility for 'adding on' to the course and take another degree. In fact they also need facilities of transfer of students at least from one IIT to another IIT, carrying the credits already earned to their advantage. They also need to have the freedom within the same IIT to add on credits in relevant subjects and graduate finally in a discipline of their choice. IITs may also use their flexibility to offer courses with credits, on payment through their evening and summer

programmes to students from other engineering colleges so that they can accumulate credits and eventually obtain a degree of an IIT on that basis. The academic programme of both graduate and undergraduate students should be broad-based around three core requirements i.e. (i) General Requirements; (ii) Institute Requirements and (iii) Departmental Requirements.

These requirements should, however, be flexible to allow each student in collaboration with an identified faculty adviser to whom the student should be attached, to develop an individual programme in response to his interest and ability. IITs should use their autonomy to achieve the required degree of flexibility to suit the requirements of a student as long as their core requirements are fulfilled. It is in this way that their programmes could be seen as different from a usual engineering college programmes.

IITs also will have to respond to several changes to the development taking place outside the IIT system. In some areas it may be beyond the capacity of IITs to initiate changes but they can do so in such areas where the student's theoretical concepts need sharpening. IITs will appreciate that courses and curricula which allow open ended teaching initiate intellectual curiosity in the minds of all involved and eventually facilitate changes in society in general. Awareness of scientific development as well as changes happening in the society are two important criteria to bear in mind.

During our visits we felt that undergraduate programmes in the IITs thought of international standard tend more towards 'training' than 'education'. As a result, students become excellent in analysis but poor in synthesis and in current awareness. This is perhaps due to the rigid examination system and the inability of teachers to remain up-to-date. To rectify this:

- At least a percentage, say 20% of the programme content should deal with current open-ended problems.

- More use should be made of term papers and projects in place of traditional examinations.

- A small number of students who are academically oriented and brilliant should be picked up for special development. Regular teaching programmes may be unsuited to their talents. Such students should be attached to the best of teachers for tutoring in advanced topics and training for academic research.

- Similarly, there will be always in a large class some slow- pace learners who need to be tutored specially for coming up to the prescribed level of competence.

All these are possible if IITs make imaginative use of their academic freedom and flexibility. A number of choices of electives are available on paper but in reality few are actually available. In short, B.Tech. level programmes in the IITs should aim at flexibility and actual availability of wide choice of electives to suit individual talents as far as possible.

The success of the B.Tech. programme of IIT is no doubt attributable to the quality, the standard maintained and the inter-disciplinary approach even at the undergraduate level. The system should make not only a bright student brighter but even a not-so-a-bright student equally bright. It should take full advantage of the initiative and interest of the students. Since the IITs are in a position to keep abreast of the developments taking place in the world of fast moving technology, they should advantageously introduce modern concepts available

elsewhere such as Lasers, Holography, Fibre Optics, Quantum Optics, Micro Processors, Information Technology, Computer Graphics etc.

4.2.3 Creative Programmes

We did notice however that some of the IITs have incorporated a number of ideas in their formulation of graduate programmes in one way or another. This is commendable as IITs were expected to be developing experimental programmes. For example, IIT Kanpur has recognised the need for incorporating a substantial dose of basic sciences and humanities in the engineering curriculum in accordance with their objective of developing a science-based engineering as their strength. Similarly, IIT Bombay has developed innovative programmes taking into account the changes occurring in industry around them. These are essential and welcome changes. More of such innovative effort is needed in all the IITs.

4.2.4 Science-based Engineering Curriculum

We noted that main thrust of the IITs is to develop a scientist- engineer and, therefore, IITs have been emphasising a science-based engineering curriculum. From the point of view of a practical engineer it could be said that an orientation to practical application is a 'must' for teaching in an Institute of Technology. Application of technology demands good knowledge in Science (Physics, Mechanics, Thermodynamics, Fluid Mechanics and Materials etc.). The training of a practical engineer on the other hand would need Mathematics only as a tool and not as the basic knowledge for understanding physically a problem. Introducing too much of Mathematics and Science may erode their training for coping with practical situations. Too often the students solve with ease complicated mathematical problems and evolve solutions, but when they attempt to apply the concept of, say Bernoulli's theorem or First Law of Thermodynamics, it may be a disaster. There is a need to balance Mathematics and Science in engineering subjects, It is necessary, therefore, that IITs should constantly examine this need in order to develop a properly balanced curriculum which will equip science-based engineers adequately. When the IITs started there was an initial dichotomy between concept-oriented courses on the one hand and practice-oriented courses on the other. It still persists in some of the IITs. Over the years the importance originally given to science and engineering science is perhaps whittled down. Engineers coming out of the IITs, because of their exposure to new ideas whether in basic sciences or engineering sciences, are equipped to think for themselves and successfully establish a working relationship between the sophisticated and the advanced on the one hand and the traditional and the well-tried on the other. While science is essentially open- ended, engineering is essentially mission-oriented. It is this confrontation between the two-convention and creativity-in the curriculum of an IIT which brings forth the best in the talented students. It is very important that these institutes should continue with their emphasis on engineering science, analysis, design and software development.

Currently, the IITs conduct a four year B.Tech. programme and one of the IITs was of the view that the five year B.Tech. programme is superior to the four year programme and that they should be permitted to admit students after 11th class standard. We could not agree with this, in view of the National Education Policy which identifies 10+2 as the higher secondary stage from which University Education starts. There will be no 11th class students if this National Policy is implemented.

4.3 M. Tech. Programmes

4.3.1 Aims

IITs offer a number of programmes leading to the award of M.Tech. degree. Complete details are available in Table 4.3.1 A. These programmes are now of three semesters duration and students get a monthly scholarship of Rs. 1000/- if they are admitted after selection through the Graduate Aptitude Test in Engineering (GATE).

M.Tech. constitutes an important segment of a variety of courses offered by the IITs. We, therefore, made a study of their design against the objectives that these programmes must serve. Our examination reveals:-

-M.Tech. programmes are generally unable to attract students of better quality.

- Has it something to do with the course contents of M.Tech. programmes or lack of job opportunities to compensate for the time and effort spent in acquiring this additional qualification?

- Should they be more diversified or should they serve narrow specialisations or should the approach be inter- disciplinary/multi-disciplinary?

-The number of postgraduate courses offered in IITs have increased in the recent years. In many cases, they have a common core curricula consisting of 70% of the total curricula, the remaining 30% catering to a specialised curriculum. Thus, with a little rearrangement of pertinent curriculum a number of M.Tech. courses are offered. No effective evaluation has been made as to how far these programmes serve the present day needs of the industry or the requirements of research.

- Some postgraduate courses in the IITs confine themselves narrowly to their fields of specialisation. They seem to have become sketchy in content, and more science-based than technology-oriented.

- Some argued that IITs should be chartered solely as postgraduate institutions that will make them more responsible to effectively formulate quality programmes of relevance at Master's level.

- The quality of postgraduate programmes in the IITs are adversely affected by the calibre of present students intake. The limited market for those who get M.Tech. training is both a cause and an effect of this vicious circle. Most employers prefer and pay better an IIT B.Tech. graduate than an M.Tech. So these courses do not have any added market value and it is mostly a non-IIT B.Tech. wishing to have a degree from an IIT who joins the graduate programme without any special aim or plan to serve any specific needs. The stipend helps him to bide time till he gets an employment. Therefore, it is perhaps worthwhile to restrict M.Tech. Programmes as far as possible only to those who are sponsored by the users. It will be more meaningful and practical if topics for dissertation for M.Tech. projects are undertaken and monitored jointly with the user-industry.

- While there may be a need for class-room instruction lectures at the undergraduate level, the need for such teaching at the postgraduate level should be minimal. Therefore, once a B.Tech. graduate enters a postgraduate programme there should be free and open lectures on specified selected topics, so that many can attend and benefit from them. There should be no heavy formal course work. It should be open to a graduate student, with the approval of his adviser, to take credit for a number of lectures essential for him including such special foundation courses necessary to prepare the student. In addition, laboratory work can be made compulsory and the Institute can ensure that core requirements for fulfilling the postgraduate degree are fulfilled.

- Currently teachers teach isolated topics at postgraduate level and not a whole subject matter, thereby a student is likely to lose the perspective of his programme. This aspect is to be taken care of in devising a wholesome integrated programme. M.Tech. programmes can, for instance, be made the compulsory course component of an overall research programme leading to the Ph.D. degree whereby the course alone earns credits leading to an M. Tech. degree, but the student remains a registered research candidate for Ph.D degree. Thus M.Tech. can be viewed not as an end-on course but as a preparation for a career in research. It can then be an affirmation that a student, in order to be able to pursue research, has qualified by attainment of knowledge at M.Tech. level in topics related to his research area.

- M.Tech. by course work as opposed to M.Tech. by research is a useful part of a comprehensive training for technical teaching. In the earlier years the then Ministry of Education conducted the Technical Teachers' Training Programme, where apart from training one as a teacher, he was also provided an indepth knowledge by a course at the M.Tech. level.

- There is a view that IIT graduates (B.Tech., M.Tech. or Ph.D.) who wish to become entrepreneurs be given a tailored programme relevant to their needs and with broad technical inputs to enable them become a Hi-Tech. entrepreneur and a job generator rather than a job-seeker.

- Since industry values and pays for shop floor experiences more than higher academic qualifications, some suggest that M.Tech. should be predominantly offered on part-time basis as Continuing Education programme to those working in the industry.

- Projects undertaken in the M.Tech. courses should generally support our industrial development. For this purpose, projects must be identified by industry. Industry should come forward with problems that can be set as an M.Tech. project. Industry then can utilise highly qualified talent outside their shops, and give an opportunity to IIT students for exposure to industrial practices.

- There is some reluctance on the part of the research scholars and faculty members to work on industry-oriented problems. This may be due to their perception that theoretical and analytical work gives them a greater and surer academic recognition compared to their efforts in development of products indigenously. IITs should correct such perceptions and place equal emphasis on relevance to Indian needs.

We felt that there are several such aspects of the M.Tech. programmes which have to be looked into carefully by the IIT system themselves. The problems of postgraduate education has been exhaustively dealt with in the report of the Postgraduate Committee and suggestions

made. Most of these solutions are valid for adoption by the IITs. However, it must be emphasised that M.Tech. is essential for the preparation of a technical teacher, who, must have depth of specialisation at least in one aspect of the broad discipline to enhance his teaching abilities. Without that depth, teaching in engineering college cannot be effective. Therefore, M.Tech. is an essential ingredient of teacher-preparation for engineering education.

A reference was made regarding increasing the duration of the M.Tech. programme from three semesters to four semesters of two years duration. Following the Postgraduate Committee's recommendations the duration of the programme has been reduced recently from two years to three semesters. We, recommend that this reduced duration of programme should be continued. The Council of Indian Institutes of Technology may, if necessary, look into this problem afresh at a later date.

Table 4.3.1 B gives IIT-wise sanctioned intake, actual intake and postgraduates produced for the years 1977-83. It is a matter of concern for us that even though IITs have 11,000 seats available, only 6,000 seats are utilised leading to a high wastage. This matter has to be examined by the Council seriously in order to ensure optimal utilisation of resources.

The Indian Industries have to upgrade their capability to absorb technology and equip themselves to attain higher standards of technology in their operations. They can no longer remain traditional. Sooner rather than later our industry has to have trained manpower who can influence and help our industry in the absorption of emerging technology and enable our industry to scale-up their technology competence. With the information age already in, and micro-processor techniques being adopted practically in all spheres of industry, traditional industries will have to be modernised; and a key resource for such a modernisation is M.Tech. personnel. Similarly, the main source of recruitment in our R&D; organisations is M.Tech. personnel and IITs must cater to the manpower needs of R&D; organisations. Their training must enable them to meet this objective as well.

4.3.2 M.Tech. as a Minimum Recruitment Qualification

The report of the Review Committee on Postgraduate Education & Research in Engineering & Technology (June 1980) has dealt with the need to realise in greater measure not only the relevance but the necessity for postgraduate engineering qualification in certain types of jobs. We quote from their findings and recommendations:

"It is necessary to recognise publicly and to publicise more widely that in today's world postgraduate studies at Master's degree level are a normal part of basic engineering education. The unreasonably restrictive conception that a Bachelor's degree is sufficient preparation for most engineering work should not be perpetuated. It is a sad situation that today of the total S&T; manpower employed in the public sector R&D; organisations in the country, only 2% are Ph.Ds. and 12% MEs/M.Techs. in engineering. in the private sector these figures are 1 % and 9% respectively.

A sustained national programme should be launched to stimulate more widespread understanding among employers of the nature and importance of the engineering dimension and of the potential benefits to them from employing postgraduate engineers in a wide range of activities. Employing organisations should review their salary and career structures for

engineers to ensure that they adequately reflect a value for postgraduate engineers contributions.

It should be made mandatory to prescribe postgraduate degree as the minimum qualification for recruitment to many positions in the engineering profession in industry, R&D; Organisations, Electricity Boards, PWDs, P&T;, Railways, etc.

It is high time to do away with the present policy and practice of regulating graduate engineers at the lowest levels (single point entry) to many services. As an incentive and mark of recognition, it should be mandatory to give not less than two extra increments whenever postgraduate degree holders are recruited. A suitable number of advance increments should also be given to doctorate degree holders."

We cannot add to this. We fully endorse these recommendations.

4.4 Research & Development Activities

4.4.1 Directions of Research

Research in a Higher Educational Institution is an important facet of work. It is inconceivable to have a good technical educational institution sustaining itself solely on the basis of teaching programmes. Research is an important and vital component of the surroundings of the undergraduate student.

A condition-precedent for the self-reliant economy we aim at is that we have competent people in R&D; activity to keep us abreast of the world's development. IITs have to cater to this need by working on the frontiers of knowledge and at a level of international competence. An inquisitive mind thrives in an atmosphere where a number of similar scholars are working on topics of challenge requiring a trans-disciplinary culture, research for many of them is a life-line. The student too, in such an environment learns more than what he is taught, by his observation, by his walking around the laboratories and by proximity to his research-teachers.

There are some basic differences in the nature of research, in Science and Technology. Research in Science tends to become autonomous and can be pursued in relative isolation within the bounds of a discipline and, therefore, it does not require direct linkages with other institutions and organisations. On the other hand, research in Technology involves interaction between several disciplines and needs effective linkages between Academia, Industry and other organisations. Research in Sciences is visible in the IITs, but it is high time to develop institutional arrangements to meet the needs of research in Technology.

We are convinced that in an IIT both scientists and technologists are necessary and should be encouraged but it is necessary to recognise the distinction between Science & Technology in the matter of award of a Ph.D. by an IIT. Traditionally such advance degrees are awarded on the basis of an original contribution to the field or an addition to the body of knowledge in that field. In the case of technologist, this must be judged more by the Technology evolved, work of a candidate exhibiting the quality of his practice of engineering, his ability in creating something new, rather than to explore why and how something works. To guide such students the IIT teachers must maintain their proficiency as engineers; they must continue to

practise engineering; they must continue to be involved in design and creation of new machinery, new systems and the like. They must keep abreast of their field of expertise through active practice and not concentrate on the number of publication. IITs do have a special responsibility in progressing technology development.

The primary purpose of research in an IIT should be to advance knowledge and enrich educational programmes. Instruction and Research are inter-dependent, and both may suffer when dealt with separately. These functions are, therefore, to be regarded as integrated and interwoven in the entire academic and administrative structure of the IITs.

Many in their evidence to us pointed out that research productivity in the IITs now is much lower than what is expected. Due to shortage of time, we could not get a study made on the citation impact of the work done by the individuals and selected departments of five IITs for the year 1973-83. We gathered that foreign journals take about six months to come to India. Publication of a paper takes a year and the paper so published has a lag in time of two to three years behind the latest work in the forefront of technologies. Even when our scientists genuinely find a solution to a problem somebody else abroad may beat him in publishing. It is very important that IIT system should have access to all published literature. They must be helped to have such an access, They can also be helped by financial support for research workers to go abroad for international conferences where they can meet a number of persons and be informed of the latest work in his field. A number of international conferences can be held in the IITs which also will give them an opportunity for interaction. Academic research in the IITs, requires restructuring and given positive and effective encouragement. Currently the junior faculty has difficulty in getting research scholars. It will be desirable to restrict the number of institute scholars that a teacher can have and encourage more research scholars under sponsorship programmes.

We feel that it is now necessary to identify strategic emerging areas of research and make plans to acquire highly trained manpower for various tasks and missions. Once these areas are identified by a competent national body such as the Science Advisory Committee to the Prime Minister of India, IITs may depute some of them abroad under a well prepared scheme of training. These scholars are to be expected to return to work in the IITs in these emerging areas. The Council of IITs can specifically indicate an earmarked budget for promoting development of research work in emerging areas.

There is also a problem of methodology for evaluating the progress of research activities. In case of basic research the fund of knowledge generated may be measured by publication in international literature in the area of work either in the form of new theories or new processes or new technologies. But in the case of user-oriented research or development programme cost-benefit analysis of the research may be a useful criterion e.g.

- (i) The amount of foreign exchange saved;
- (ii) The number of patents/discoveries;
- (iii) Generation of funds.

There are yardsticks developed for selection and evaluation of technological research reports. An example is given at Table 4.4.1.

For this purpose, IITs must have an effective channel of delivery of Technology from IITs to various industries. We have suggested (Para 4.4.4) the setting up of an Industrial Foundation in each IIT as a channel.

As regards selection of topics for R&D;, we suggest two broad criteria;

- (i) Basic research in emerging areas of Science and Technology and a certain amount of exploratory/open-ended research in other frontier areas and
- (ii) Developmental work in selected areas where attainment of a high order of excellence will be the goal.

IITs need both basic and applied research. Development of concepts and some fundamental research are essential for building up a department or a unit. Only a limited number of students and staff are, however, competent to do this type of work. They should be encouraged because these investigations are often the "seed-corn" from which new commercially valuable developments may emerge. Research investigations on specific products should not, however, be regarded as intellectually inferior, because acceptable solutions to many problems demand originality, sound techniques and a knowledge of current scientific and technological ideas. 'Pure' and 'Applied' research are synergistic and both are essential for an IIT.

4.4.2 Strengthening Research

Research work pursued by the IITs did not appear to have so far, an effective imprint, on the national scene. We examined this matter in depth. IITs at present have a large number of sponsored projects. Usually the sponsoring agencies are Government departments such as Department of Electronics, Department of Defence Research, and Department of Science & Technology etc. The current value of projects for each IIT is estimated to be of the order of Rs. five crores. It was, however, disheartening to note that very few research projects are sponsored by the industry (public or private sectors) although there are a number of industrial consultancy assignments. There is a need for IITs to take an initiative in this matter. If they had developed a distinct R&D; centre there might have been a healthy cross flow between industry and IITs. Currently, industry is able to import turnkey projects. Such turnkey solutions 'Prevent other organisations such as the IITs to act as their consultants, do their own research to solve industrial problems and deliver to them a turnkey product. This obviously the IITs cannot do. IITs can offer only a research solution to some problems. Beyond that there is a long innovative chain. It starts from basic research typically in an organisation like the IIT, goes through applied research in the R&D; sector of the industry, enabling the industry to formulate prototypes and then lead on to production. IITs can thus be only the first link in the, innovation- chain. IITs cannot be expected to set up pilot plants. Therefore, when one examines the capabilities, involvement and success of IITs in solution of problems in the Indian Industrial scene, it is necessary to remember that their success is conditioned by the strength of other members of the chain of innovation. IITs cannot be faulted for the absence of strong R&D; within the industry. Industrial climate in the country should be such that it creates a demand for utilising national capabilities like the IIT system. Government can even consider tax incentive for such research activity sponsored by the industry.

IITs own faculty evaluation too must recognise relevant research activities.

There is, as mentioned before, considerable emphasis on consultancy work. We felt such work should be awarded by Industry to the IITs on an institutional basis rather than to individual faculty members even though it is the reputation of an individual faculty which often attracts such clients. The remuneration allowed by the Institute to the faculty should, however, be such as to retain interest in such work.

4.4.3 Research Interaction

Industry now prefers to go for an international collaboration rather than encourage an IIT to solve their problems. For the IIT faculty, likewise, publication in foreign journals, visits to international seminars, teaching assignments in foreign institutions and career abroad appear to be more attractive than challenges and exciting opportunities available locally. Basically, this is a problem of attitudes. There is urgent need for developing a healthy and viable relationship between the responsibilities of the faculty to their primary tasks of Teaching and Research for which they are paid and their consultancy engagements which brings them extra income. The importance of R&D; within a technical institution towards a long term developmental plan of Technology has been emphasised in a report of the Working Party on Engineering Research in Britain (1979) by Lord Baker. After noting that the relations between research workers and academic institutions and industry in UK are not close enough, they have strongly recommended that the postgraduate work in the technical institutions should shift from basic Scientific Research work towards Engineering Research; and they have defined Engineering Research in the following terms:

"Engineering research should be considered as the combination of new scientific discovery with the practical design and development-of a real product or process of proven, or potentially likely, utility. Involvement by industry is essential at all stages of research, development and design, whether it be done in the physics or materials laboratory as basic research or in an engineering laboratory or drawing office for product design and development."

This shift in emphasis from Basic Scientific Research towards Engineering Research is taking place in many countries. The IITs must make a quick start in this direction.

The IIT faculty engages Research Scholars on payment in projects or in consultancy work. The scholars are required to interact in the projects actively, as, the projects are to be completed within a time schedule. If this time frame is changed, either the services of a specific scholar is not available or if the project is completed early the scholar is without any work and thus without scholarship finance. Such an arrangement is unsatisfactory and affects the completion of projects on time. When a consultancy is earned by the Institute it should be possible to remunerate a scholar even beyond his term if engaged on work of academic relevance to the institute. If payments are made on this basis a number of competent persons in the campus will be available for work with various projects received by the IIT.

4.4.4 Industrial Foundation-A Suggestion

Some of the preceding analysis point to an urgent need for a permanent unit linking the IITs and their research nucleus with Industry and their problems. Such a link can well be an Industrial Foundation. We suggest setting up of one such Foundation in every IIT. The Centre for Scientific and Industrial Consultancy of the Indian Institute of Science, Bangalore (CSIC)

is available as a model for the IITs. The lack of strong Industry-IIT linkage has led to the present situation where:

- The faculty, in general, have no industrial experience or exposure;
- There is no provision for continuing education in the IITs for practising engineers to update their technology competence;
- State-of-art in the industry prevents flow between organised research in the IITs and evolution of Industrial R&D;
- There is no link person available in most of the departments of the IITs; 3 -some of the IITs feel constrained to accept contracts with time bound results.

The remedy to this situation lies in each IIT having a professional unit like the proposed Industrial Foundation working on commercial lines. It is equally necessary simultaneously to ease the chronic dependence of our industry on foreign collaboration and reward the Industry for sending their problems to IITs and other Indian academic bodies.

Models such as the Stanford Research Institute (SRI) or Illinois Institute of Technology Research Institute at Chicago will also work in an IIT. Both these institutions are connected with their universities by common Boards. Among the developing countries Brazil which has remarkable industrial progress has successful institutional linkages established between S&T; and Industry which may be worth studying. IITs too can have Industrial Foundation under the same Board of Governors with the Director of the IIT as the link. The Foundation should obtain a large number of sponsored research and consultancy development projects and obtain funds not only to pay for the cost of the projects but their over-heads plus a little profit. The Foundation should employ people only on commercial considerations. They should assess capabilities available and existing in their Institutes and bring out an Information Brochure on what their Institutes can do. The technical resources available for them are the 'Brains' of the Institute supported by the infrastructure. The Foundation should monitor and implement their project work on a strict time schedule, and, for this purpose rules and procedures are to be evolved specifically to suit their own needs and must not have the rigidity of government departmental practices which are by and large followed by the IITs.

The Foundation among other things may encourage Science and Technology Parks in the vicinity of the IIT for entrepreneurship development. The time spent by faculty on pursuing solutions for Industrial research problems on R&D; and on other sponsored research must be counted for faculty assessment and reward.

The Foundation should also examine the relevance of IIT's M.Tech. programmes, specifically whether their M.Tech. graduates are being absorbed in the Indian Industry and advise the Senate suitably. It should use modern and sophisticated public relations and marketing techniques.

The Foundation should be allowed to retain the excess of their earnings over expenditure and have the freedom to use it gainfully although this will technically form part of the accounts of an IIT. Industry contributing to the R&D; or any other programmes through the Industrial Foundation should be eligible for appropriate tax exemption. The Foundation should be free

to raise its own capital on the basis of its capability. The Foundation must ensure that teachers and others assigned to a project are able to devote time to the project in hand and keep a watch on their ability and capacity to deliver results on schedule.

An important drawback pointed out by the industry is lack of time- sense on the part of the IIT in respect of projects sponsored by them. Similarly another problem noticed is the inordinate delay involved in the execution of a project because a particular faculty member is either away on deputation or for other reasons including loss of his interest after initial support of the project. When the Foundation is set-up, all projects and consultancy are to be Institution-based. It is important that the IIT must identify at least two leaders to be in-charge of a project so that if one has to leave, the other will take care of the progress of the work. The Foundation must also associate an industrial nominee with the project right through. It would be the responsibility of the Foundation to ensure that teachers and others involved in the project are not allowed to leave the IIT on any ground without their prior clearance.

Briefly, the Industrial Foundation shall be a corporate body created by the respective Boards of Governors and located in the respective IITs. It will

- engage in research relevant to industry, bid for R&D; projects from the industry both public sector and private sector or from the Government departments;
- build up a lasting and meaningful cooperation between the IIT concerned and R&D; organisations in Industry;
- be the half-way house, to bring together the research groups or individual researchers with industry or other clients;
- act as a clearing house for consultancy services, both for immediate and long-range problem of industry;
- also assist Continuing Education programmes (Para 4.5.4).

We further suggest that:

- work done for the industry through Industrial Foundation or otherwise recognised should be taken into account for faculty assessment;
- there must be an enabling clause in the charter of the Industrial Foundation for promoting company in an emerging area if their assessment is that such promotion will further enhance industry-IIT linkage,
- liberal provision should be made by the Industrial Foundation to reward financially deserving individuals.

The Statutes of the IIT must be amended where necessary to enable the Foundation to be independent in respect of their finances and regulations and rules under the overall supervision of the Board. It will be open to them to secure funds from individual organisations, industries, R&D; organisations etc. and defray legitimate expenditure for further activities. Their management should be governed by a governing body whose Chairman will be the Director of the Institute on ex-officio basis. Their management will also

include representation from the Board of Governors, the Council of IITs, the faculty and other interested groups as well as representation of the concerned industries. The Foundation will work in accordance with the rules framed from time to time and on the guidelines generally indicated by the Council of IITs. Their rules will, however, have to be approved, modified or repealed by the respective Board of Governors. The foundation can formulate its own agenda for work, publish annual report, and such pamphlets necessary to attract investment from the industry etc., appoint an auditor to examine their accounts, prepare annual reports and accounts for the perusal of the Board. The Council of Indian Institutes of Technology will generally provide guidance for enhancing the capabilities of these Foundations in all the IITs.

The Industrial Foundation must undertake to publish for use by the industry:

- A Research Report giving information on research results in the IIT;
- A Progress Report for R&D; work undertaken by the Foundation;
- A Teaching Bulletin.

The Industrial Foundation can lay down its own norms of work and decide payments to all workers including their own staff e.g. those who are currently appointed under projects. The Foundation must focus its work to the development of indigenous technology so as to attract more and more industrial investment with them. The Foundation will also act as an organisation advising the DGT and DOE particularly on import of technology. They must also study the possibilities of collaboration with other agencies for Technology Development in India.

4.4.5 Other Supportive Actions

There are a number of other measures required to bring R&D; in the industry and IITs closer and more meaningful. For example, IITs/Foundation should get grants from DST and others to do work of an exploratory nature in the areas of emerging technology because these areas will not be funded by the industry.

At present consultancy contracts in the IITs tend to be stereotyped, or routine testing and quality inspection. But a number of faculty members in IIT are interested to do such type of work for the extra income they bring in though it may not contribute anything towards basic research or development work. Projects will be meaningful with user-orientation if they are sponsored by industries, and routed through the proposed Industrial Foundation.

4.4.6 Promoting Faculty Entrepreneurship

IITs could better train their students to become entrepreneurs and job-generators if some of the IIT faculty themselves become entrepreneurs. A number of persons spoke about the type of partnership between industry and institution as in Route 128 or in Stanford in the USA. In Route 128 such a relationship between the companies and the universities has been successful largely because of the close relationship that exists between the leaders of industry and the university faculty. A good percentage of the companies in these locations were started with the MIT professors or are owned by them partly or fully. Similarly, steps should be taken by

the IITs to encourage transliteration of their research results into an industry. We hope the proposed Industrial Foundation will prove to be such a vehicle. The intimate IIT-industry closeness visualised is one of the kind that sparked the success of the Silicon Valley. If an industry supported by say an IIT alumni or by a teacher or by a client gains from the IITs' know-how, it is then probable that these industries willingly will give a share of their funds to IITs later. There should be constant encouragement for such activities by the Industrial Foundation in each IIT. They must encourage a faculty who successfully conducts applied R&D; to start an industry. Such teachers may be encouraged to utilise their sabbatical leave or extraordinary leave for this purpose and could be allowed even while on sabbatical leave to use facilities in the IIT to develop or refine their product further. This type of freedom and access to facilities in the IITs is one that will spark development of new Hi-Tech. industries.

Science or Technology Parks can be given a small area of land in the proximity of an IIT and the use of IIT facilities in the development stage. In between, IIT staff so occupied should be allowed to maintain their faculty privileges so that they need not feel insecure whilst venturing out on a new industry. We would even suggest that faculty members be permitted to attend to such work even on a part-time basis and their salary in the IIT determined on a part-time basis. The present rules and regulations need substantial modifications. We note that similar provisions exist in the CSIR for their research workers to take sabbatical leave for three years while their emoluments and status in the CSIR laboratory are protected. We would recommend that similar provisions be available in the IITs.

4.4.7 Resources for Research Work

Sponsored Projects: Problems

The IITs currently obtain Plan assistance from several government departments who sponsor specific projects with the IITs, while such sponsorship has been of help to them it has also left behind problems with the IITs. Usually a sponsoring authority identifies a Project Investigator in the IIT, who develops a project, works out the cost and finalises project details. The plan assistance received from the IIT is based on the assumption that necessary infrastructure is available in the IIT and it is profitable for the funding agency to utilise existing resources in an IIT instead of investing on their own. In actual practice the sponsored project forces IIT to recruit more personnel such as scientific staff, technical personnel, workshop and non-faculty staff whose appointments are made out of the project funds and to be terminated at the end of the project. When project authorities cease to fund the project at the completion of the task, the IIT concerned is on the look-out for similar projects, where the staff already recruited can be further employed, thus transferring the liability of further employment of these personnel on a project-to-project basis. So far as these employees are concerned, they remain stationary in an IIT for a number of years though their employment changes as employees of one project after another. Hopes are thus built that by such a process they are being permanently absorbed as employees of the IIT. Most of them believe that at the end of a project or a number of projects so sequentially arranged for further continuous employment in the IIT, they will be permanently absorbed specially because at that late stage they no longer can compete successfully for employment in the outside market. The assumption behind all such projects is that on completion of the project these employees must automatically move out with a view to better their career opportunities and to further the progress of the project results possibly in the employment of the project authorities. In practice, however, this kind of project funding has left more problems with the IITs. Some of

these personnel are likely to remain in the IITs for a number of years. Because they are not regarded as staff employed by the IIT, they do not enjoy the same privileges as other staff of the Institute. No IIT can afford to absorb such a large number of staff as institution staff either, although one or another IIT in the past absorbed some staff complicating their problems further. On the other hand the authorities sponsoring projects are not able to give additional resources. Their's is a simple contractual stand that they fund for the duration of the project and the rest is the headache of the IIT. The sponsoring authorities do not cover the cost of additional infrastructure needed to be provided by the IIT such as housing etc. for the project staff. It is this unrealistic type of funding of projects that has created a number of problems.

IITs are not able to carry out the sponsored project for lack of these funds even though they have the scientific capability. The sponsoring agencies should be asked to finance as overhead atleast 30% of the project grant. A start should be made immediately with government departments and public sector agencies.

Relevant Research

There is one significant issue raised often concerning IITs' autonomy and "relevance to society". This question is pertinent to the funding needs of the IITs and the objectives of the IITs as there is considerable ambivalence amongst the academics on this issue.

Some in the IITs and some outside have questioned whether it is correct for the IITs to apply their energies on all problems relating to the economic needs of the society which require inputs of applied research for their solution. In Chapter 3 of this report dealing with the goals and objectives we have clearly stated that IITs must generally apply themselves also to the problems faced by the society in sectors other than industry and evolve technological solutions thereof. There may be occasions however when the academic community of an IIT can have conscientious objection to deal with problems not appealing to their values. At that stage, it will be a matter for appropriate decision by the Senate of an IIT. But, when they consciously choose to apply their energies in certain selected areas relevant to societal needs, they are entitled to adequate resource support for that purpose. They must then fully engage themselves without let-up. In such a context, the autonomy of the IITs must be interpreted as a tool to pursue an ideal viz. "service to society". The IITs derive their right to autonomy, by their dedication to pursuit of knowledge. To the extent the IITs discharge their intellectual and public obligations effectively; they will earn the esteem of the society, and their autonomy will and can never be easily eroded. This is not by any means an easy task quick of achievement, but this is a line along which the IITs must move without reservations.

Some Reservations

We should, however, record some reservations and apprehensions shared by academicians regarding sponsored research. Many of them see a conflict between the essential openness and freedom of academia and the proprietary interest of the industry. There is also a fear of political interference through Government-funded research. Some concern exists that such research projects may suppress the independence of research-scientists and that the priorities of the IITs may be disturbed. While accepting the need to safeguard the fundamental feature of the academic life in the IITs, we would, however, emphasise that the experience of several leading academic institutions all over the world demonstrates that it is possible to develop

linkages which are mutually satisfactory and that the basic goals and performance of academic pursuits are in no way jeopardised.

We would also add that the IITs, who are essentially universities in the field of Engineering and Technology, should be academic research centres where ideas are freely pursued in such disciplines with which the IITs are concerned. If the IITs are to carry out mission-oriented research only, there is a danger that our country may miss building up leadership in Technology. The IITs should be free to develop areas other than mission-oriented research. The freedom to pursue research work in frontier areas or in existing fields of choice by academics should not be lost sight of, in our emphasis on dedicated mission-oriented research for which funds are more easily available. A proper balance between these two aspects of research has to be kept at all times, by the Academic Advisory Committee of the Council (Para 6.1.2).

We consider that hereafter the proposed Industrial Foundation (Para 4.4.4) will deal with project funding in its totality. While accepting a project, like any other commercial body the Foundation authorities should realistically assess the likely cost of undertaking a project, cost of the personnel (including housing, resident facilities etc. for them), cost to maintain such project personnel between projects etc. and bid for the total amount. They should not accept a project unless at least all their costs are covered. They should also seek more and more assistance for their programmes under Science & Engineering Research Council (SERC) and General Research Scheme (GRS) of the Department of Science and Technology. Training some of their existing staff at appropriate higher level of functioning in newer areas will be of help. The Foundation should also bid for many of the projects being sponsored by Departments of Defence Research, Science and Technology, Energy, Environment and other Government departments like Indian Meteorological Department etc. and use resources at their disposal.

4.4.8 Development of Thrust Areas

During our visits to the IITs, the academics presented to us plans for development of specific thrust areas of research and graduate programmes for inclusion in the Seventh Five Year Plan. The academics of IITs are enthusiastic and excited about these programmes in the areas of importance in the S&T; sector and in the areas crucial for development of our country as indicated in our National Plan (1985- 90). IITs may not and need not get major funding specifically from the Ministry of Human Resource Development or any other single source for the thrust areas as they are obtaining so far. It will be salutary on the part of an IIT to be able to bid and compete for these funds either individually or severally for separate provisions made in S&T; plan in each sector so that the authorities concerned would be able to judge the quality of the programmes being undertaken and be able to recognise more specifically that their enthusiasm is matched with competence, preparedness and ability to deliver. We feel that these plan funds must be earned by IITs on merit.

4.4.9 Industry-Research-Education Nexus

IITs have to participate in the development of Technology as well as its application in production. The first need is to extend the base of Technology Research nationally. There are some excellent educational institutions and excellent centres of research in the country in the university system and the CSIR chain of national laboratories. There is a need for a greater

mobility between these systems and it is necessary for all concerned to provide incentives and encourage such mobility. There is a need for some of the leading Indian Universities and IITs to exchange personnel. Such exchange of techniques and skills from IITs can benefit other institutions and vice-versa.

We felt that IITs interaction in this regard with R&D; establishments like CSIR, Defence Laboratories and Public sector units of industries are not adequate. There are no institutional arrangements for strengthening the movement between these agencies or for continuous dialogue between the institutions and industries. A lot more needs to be done in this direction. The culture of working in isolation is common to institutions and industries in our country. But the IITs should at least take the initiative to break this insularity.

Elsewhere in the world, one is witnessing a direct coupling of industry with universities e.g. in the modern field of Molecular Biology. Even though in the foreign countries the universities are afraid that their open ended quest for knowledge might suffer in the process they are encouraging such coupling. Even in our country there is example of such fruitful collaboration e.g. the development of HVDC transmission by BHEL/NTPC/CEA/CIPRI and IISc Bangalore. One cannot predict the outcome of such integration, but it is very clear that spectacular developments in the field of Molecular Biology are taking place at an incredible speed because of this. In India too it is high time we have some open ended research in our IITs at least in the areas identified as national priorities specifically as there are identified S&T; components of our national development.

4.4.10 Relating R&D; to the Spatial Environment

One often hears the IITs being criticised as elitist institutions unable to interact with their own environment and with other technical institutions. On the other hand, IITs contend rather forcefully that in order that they remain excellent they need special inputs and challenging tasks within their own domain. We realise that the consequence of excellence is elitism. As long as special favours are given to IIT as inputs to promote high quality research and extension work elitism cannot be resented. It is only when all in the IIT system are favoured in all matters as a matter of routine, regardless of whether they contribute to excellence or not, that there is a resentment. We feel, therefore, that IITs should scout for, talented people who could integrate excellence with their commitments to social responsibilities.

An average person in an institution of excellence should be far above an average person elsewhere in terms of his attitudes and leadership role. It is good to recognise that while Science is International, Technology in which the IITs are engaged, has strong national parameters. Therefore, the IITs have to relate their programmes and work to national surrounding.

IITs need to shed their hesitancy to involve themselves in national perspectives and technological development of our country. As Indian Institutes of Technology their charter is to act as the technological "brain banks" for the country. Therefore, they should concentrate more and more on the extension aspect of their three basic roles viz. Education, Research and Extension. Extension is but a natural corollary to their roles of Education and Research.

We feel that as institutions of national importance their work should respond to national problems which need scientific and technological solutions. The infrastructure available in

these campuses both human and material have been provided out of scarce national resources, and it is a legitimate expectation that the IITs should be seen to be involved in public service in some meaningful way.

The triad of Education, Research and Extension is an accepted concept in many educational disciplines. It is not completely a new idea, e.g. in Social Sciences, the extension concept is practised in the area of planning and social welfare; in Natural sciences in the field of testing laboratories and Geotechnical exploration; in Medical sciences in the hospitals. Therefore, in engineering sciences too extension is a concept of integrating it with industry, technology development and specialised production. We observe that the University Grants Commission has accepted extension activity as an important dimension of the University life. Consequently, many universities have opened Centres of Development Studies, Policy Studies and Rural Development with a view to bring an inter-disciplinary approach to solutions of social problems. It has been the experience in all these disciplines that extension activities make education relevant to the needs of the people; higher education is then seen as useful to the society. For intellectual refuelling IIT teaching staff do go abroad. Similarly, for their perception of the social needs the teaching staff should turn to their surroundings. This will also help us to innovate in our own way rather than live on borrowed ideas all the time.

We do not wish to leave an impression that the IITs are not at present involved with problems of relevance to this country. We know that some of the centres in the IIT do work with other departments for solutions that will bring relief to the public. For example, we know the Atmospheric Sciences Centre in an IIT is involved in a very major way with the development of numerical forecasting methods utilising super computer facility based at the National Informatics Centre, which aims at providing forecasting data of real importance to Indian Agriculture. That Centre would use INSAT to convey data derived from numerical forecasting to local groups at district level who will make relevant interpretation as to what it means in agricultural terms for the farmers of a district. We take this particular example to illustrate those efforts in the application of Science and Technology to rural problems does not necessarily mean living in rural areas, or working at a very low level of technology or generating employment situations. High science and high technology can be applied in a meaningful way relevant to the rural society. We noted that another IIT has attempted a rural project but some of the work they have taken up could as well have been done by an agency outside the IIT. While the application of Science and Technology to problem relating to our rural situation should be the legitimate concern of the IIT, further implementation can be left to other agencies.

Problems of rural relevance are generally seen now as separate from the technological scene but they should be seen equally as areas of application of engineering and science. The century old traditional technologies, on which the bulk of our people depend for survival, have become increasingly inadequate in the context of rising expectations, growing population and depleting resources. It may be that rural problems appear quite mundane but they are certainly not trivial. These problems demand the same vigour, sophistication, subtlety and creativity as is generally associated with the technologies of the industrialised countries. In choosing their curriculum or research work, IITs should give special attention to technologies related to alternative resources of energy such as wind-mills, mini-hydro's and grassfires. Rural development is only an illustration of our concern for the relevance of the IIT's to their spatial environment.

4.5 Linkages with Industry

4.5.1 Industry-IIT Linkages

Academic world and industry together hold the key to Technology development in many of the core areas of our economy. The survival and renewal capability of industry depends on the induction of improved technology. When IITs and industry work together, both are benefitted; the IITs gain an insight into the problems of the industry thus providing a base for their research and education.

We met a large number of representatives from the industry and also had a detailed memorandum from the Association of Indian Engineering Industry. The industry have felt that:

- IITs do not conform to a time bound programme. There are delays in the execution of sponsored assignments;
- IITs do not like linking specific tasks to their financial implications and they do not like reviews of progress of their work by the industry;
- The projects sponsored by the IITs are academic in nature and there is reluctance to take up practical design problems;
- Documentation of the procedure and research methodology is not given due importance by the IITs;
- In some cases continuity is lacking as problems are given as projects to M.Tech. Students who leave the institutes before the project is completed;
- IITs consider industry as a funding agency rather than as a partner;
- IIT faculty's visits to the industry are infrequent.

On the other hand, IITs complain that:

- Industry goes for indiscriminate import of foreign technology;
- Industry is reluctant to promote research in new directions;
- Industry uses IIT merely for testing their products rather than give substantial problems for research;
- Industry does not allow faculty to collaborate within the industry.

We feel that it is necessary to make clear what IITs can and cannot do and similarly what industry can and cannot do. Firstly, it is obvious that IITs may not produce and design products comparable in every respect to those of foreign/multi-national companies. Therefore, industry should not insist on IITs to give solutions which will give results identical to a foreign product of solution. IITs can, however, design and analyse their results.

Secondly, when a project is given to an IIT it should be understood by the industry that such projects are essentially joint projects. This requires industry to sponsor one of their engineers to make use of the facilities that are available, technical/analytical and intellectual. There should be a constant monitoring of the time schedule and this can be better achieved if industry sends a representative to work on the project with IIT. When the project is completed, the trained person so deputed can then take up the results of the efforts at the IIT for further development by the industry. IIT can thus be seen working in collaboration to draw a product specification, and help industry in product development. The rest of the know-how which exists in industry can be utilised by the industry for developing the product fully. This is how we perceive IIT-Industry linkage in actual practice.

We also observe that not many IIT graduates now take up R&D; in industry as a career because R&D; in India does not as such provide a future for them. If the collaboration between IIT and Industry takes place in the manner suggested further meaningful participation between Industry and the IITs will grow and eventually help develop a strong base for industrial R&D.;

We would also suggest that each IIT (or IITs together) survey the country industry-wise as to the technology in use and technology that can be made available indigenously. They can then indicate clearly to the industry what IITs can do and suggest areas in which industry can ask for their help. Consultancy work through the proposed Industrial Foundation to individual teachers may provide the vital link. The more the teachers participate in industrial consultancy the more will in turn their research output become a relevant input to the industry. In the process, the trained manpower in the IITs will be geared to solve problems of today and tomorrow thus establishing a cycle of innovation and enlarging their horizon of knowledge and interest.

4.5.2 Specific Recommendations to Promote Linkages

During our visits and through written evidences it was suggested to us that IITs should be involved with specially structured High-Technology industry such as Hindustan Aeronautical Limited, Indian Space Research Organisation etc. Views are also received by us that there should be:

- Review of incentives in the taxation policy in order that industries who commit finances for development in an IIT get tax benefits;
- Adjunct Professors be appointed in the IITs from industry;
- Prominent industrialists are regularly invited to address the students of the IITs with a view to bring both students and industry together;
- Joint guides for supervision of projects of M.Tech. Students;
- A link person between each relevant faculty group and the industry;
- A speedier purchase procedure in the IIT for industrial R&D; problems;
- Compulsory sabbatical arrangements for IIT Professors to go to industry;

- Enough housing to the people from industry.

We agree with these views. All except the first one of these points are within the ambit of the IIT system to implement as they deem useful. Appointments to adjunct professors should be made to practitioners in the industry who have developed high level of expertise in the fields of specific significance and importance to the IIT, and those who have a deep commitment to teaching and research. An Adjunct Professor's responsibilities will include but not limited to teaching and conducting/supervising research. Faculty members should maintain a close rapport with the industries both in the public sector and private sector and be required to spend one of the sabbaticals in the industry as well as their summer vacations in an industry of relevance. This will expose them to the working of the industry and building a close relationship with those in the industry. IITs should also involve increasingly industry in the development of the curricula on a regular and a continuing basis. The syllabus for postgraduate programmes should be reviewed and updated at least once in two years.

The industry too should refer live problems to IITs and these could serve as projects for M.Tech. and Doctoral students. In order to ensure continued interest of the industry, it is better if they bear the entire costs of these projects. Senior professionals from industry should be involved more and more as visiting faculty and handle lecture classes. IITs must be compelled to generate their own resources in collaboration with industry. The contributions made by the industry in any developmental plan of the IIT can be made eligible by the Government for tax deduction at 133%.

4.5.3 IITs' Association with Technology Surveys and Policy

Making/Regulating Bodies

As visualized in the Technology Policy Statement (1983) we must involve the corporate R&D; external R&D; and the academic institutions like IITs in the creation of new technologies and absorption of best of the imported technology. It is essential to associate institutes like IITs right from the initial stage of the absorption of the imported technology. Arrangements should be made to associate experts in the IITs with a view to utilise infrastructure and manpower of the IITs in order to develop our own need-based technology. The usual plea by the commercial houses is that the technology developed in an IIT is not a proven one and could not be given serious consideration. We suggest that for this purpose, in the Industrial Foundation (Para 4.4.4) there must be provision for a seed money given by the industry to do testing for relevance and taking it up to the pilot plant stage.

It has been noticed that IITs complain that they are not associated at the time when licences are granted to the industry by the licensing organisations like Directorate General of Technical Development (DGTD) and Department of Electronics (DOE). We recommend that IITs be associated with government departments like the DGTD, the DOE who control the import of Technology. They should also have opportunity to interact with bodies like SACC (Scientific Advisory Committee to Cabinet) and other policy planning bodies.

IITs also must conduct surveys, industry by industry. For example, one of the IITs can take up the area of textile industry and their technical survey can indicate the processes that are being used, the technology being used, the equipment being used, the problems that are coming up, the solutions which are indigenously available and the contributions of research

and consultancy that can be promoted in an IIT. Similarly they should also survey the progress of import substitution in specific industrial sectors.

There are models available elsewhere in the world specifically linking the University system with the Industry. A write-up of how such a linkage works in Brazil is available in Table 4.5.3.

Another model, which appears to have earned wide international recognition is that of SINTEF (Foundation of Scientific & Industrial Research), located at NTH (Norwegian Technical Institute), Trondheim, in Norway. The SINTEF is an independent and autonomous group, with the aim of promoting close ties between NTH, Norwegian Industry and Research Organisations. Their work is controlled by an independent Board of Directors, with a full-time Managing Director, to look after its day-to-day work and consists of representatives of NTH, SINTEF and Industry. A detailed report about SINTEF is available from the Industrial Tribology Machine Dynamics and, Maintenance Engineering Centre of IIT Delhi.

4.5.4 Strengthening Continuing Education

The Indian Institutes of Technology are special institutions deliberately funded for being well equipped, with the best of faculty, laboratories, and workshop and teaching facilities. It is expected that these facilities be fully used for training a larger section of the technical personnel. IITs must use their freedom to develop a variety of courses in the newer areas of technology thereby providing training of more manpower, utilising more of their existing facilities. They can conduct evening classes for working engineers from the industry on a flexible basis. IITs should be able to design Industrially-oriented courses where necessary, to meet the specific needs of the industry. They should formulate in addition to the evening classes, short-term refresher courses, seminars, workshops as a part of total system for continuing education in the country. This will also bring IITs closer to Industry. Their continuing education programme should also include provisions for the benefit of the teachers in the engineering colleges and persons working in R&D; establishments. Continuing education for engineers from industry could have great emphasis on engineering and innovation using modern equipment's, Computer Aided Design, Computer Aided Engineering and Computer Aided Manufacture. Their short term courses which are already popular with the industry should be enhanced to arouse greater interest within the industry in certain topics directly related to the needs of the industry.

We noted that some of the IITs have R&D; news letters mailed to a number of people in the industry and let the industry know their continuing education programme plan for next six months. They also invite suggestions from the industry. They identify programmes for the industry through Industry-institute collaborative committee and depending upon the suggestions modulates their programmes and their M.Tech. Projects. It is necessary that these programmes are made financially self-sufficient. In fact institutions like MIT after which IITs have modelled themselves, pay from the funds of continuing education programmes, 15% of their cost to the MIT for using the facilities.

Indian industry, because of its late starting, has varying levels of sophisticated and traditional technologies. In recent years not only has there been a phenomenal growth of new knowledge in Science and Technology per-se but the time frame required to translate these ideas into new industrial processes and products has been drastically shortened. This has given rise to a

complex situation in all industries across the board. This is a challenge and calls for a suitable response. IITs can play a significant role in this context leading to a two way benefit for the industry as well as IITs. With this in mind IITs could design courses in what might be called New Basics particularly suitable and meant for the middle level personnel from the industry. Such a course may include:

- Programming use of computers especially a micro-processor based system;
- Systems analysis, sub-systems optimisation etc.; -heat transfer, low temperature techniques, energy sources;
- Pollution and its control;
- Inventory control, material management, and cost benefit analysis;
- Management techniques and job training/retraining programme for employees.

The basic idea is to provide a continuing education programme which will directly result in increasing the competence of work in the industry. Such a programme will require the faculty to visit the industries, look for the individuals who could act as their counter- parts for promoting and designing courses, needed by the industry. If these courses are organised properly efforts involved will pay more than the cost towards the IIT in the form of general acceptance by the industry. IITs too can increase their ability to perceive the problems of the industry and suggest solutions. As industry builds its confidence in the IITs, up gradation of their technology competence can be arranged by IITs and industry would be willing to pay for this expenditure.

We recognise that the continuing education programme can be undertaken by the IITs through various methods, such as short-term courses, workshops & seminars. In addition there could be classes in summer vacations and in the month of December. As' these programmes grow it is possible that they may like to conduct evening classes on regular basis. Suitable step should be evolved by the Council to organise continuing education programmes for evening classes. However, we do not recommend exceeding present faculty strength but the Council may consider suitably rewarding the teachers for continuing education programme in the evening classes should such a contingency arises.

4.6 Programmes-Courses-Subjects-Curricula

4.6.1 Available Programmes & Courses

- Undergraduate (UG) courses of four years (eight semesters) duration leading to first degree-B.Tech. are being offered in all IITs in basic engineering subjects like Civil, Mechanical & Electrical. In some IITs, they are being offered also in Metallurgy, Mining, Electronics, Chemical Engineering; and also, in some specialised fields like Textile Technology, Rubber Technology, Computer Science, Aeronautical Engineering, Naval Architecture, Agriculture Engineering, etc.
- Postgraduate (PG) programmes of 18 months (three semesters) duration leading to M.Tech. or M.S. are available in all IITs in a wide variety of technology subjects.

- Besides the above, PG courses leading to M.Sc. are also available in some IITs in Science subjects (viz.) Maths, Physics, Chemistry & Applied Geology. However, these are, either, two years duration for B.Sc. students, or five years duration in integrated courses for 10 + 2 candidates.

- Research facilities leading to Ph.D., and also facilities for Post-Doctoral research, are available in all IITs. The subjects can be in technology, or science, or humanities. However, the number of persons doing Ph.D. in technology subjects is not commensurate with the facilities available.

- Diploma courses generally in specialised subjects of technology or science are offered in some IITs. These are all of one year duration after Bachelor's degree in technology, or, Master's degree in science. However, gradually these courses are being discontinued. Short-term courses of few weeks, on industry-oriented subjects are conducted every now and then. No degree, diploma or certificate is given. Table 4.6.1 lists out programmes and courses, and also departments, in the five IITs. IIT Kharagpur which was the first to start, has the widest spectrum with a large number of courses & departments, while IIT Kanpur has the minimum.

4.6.2 Review of Programmes & Courses-Syllabi & Curricula

IITs are autonomous institutions with freedom to select programmes and courses and formulate the syllabi and 'curricula for the same. To maintain excellence and relevance of these courses, IITs periodically review and modify them. The diverse needs, views and concepts-some even, mutually contradictory-that are being considered, continuously by the IITs, are detailed below. This is a process which must necessarily continue in the IITs because no single answer is valid for all situations at all times or for all IITs. (a) Programmes/Courses in Newer Areas of Knowledge:

- Electronics & Solid State with their expanding impact on wider areas of activities like operations & control, communication, information processing, etc;

- Space and its attendant areas of development like rocketry, satellite, gravity-less processing etc;

- Bio-Science with its innumerable possibility to change the life-style and ecosystem;

- Extracting and processing hydrocarbons-cracking, synthesising and reforming their molecular structure;

- Newer materials like advanced ceramics heralding a new stone-age, exotic electronic materials etc.

These are limited illustrations of application of science and technology which will play an increasingly crucial role in our lives.

The programmes and courses in these areas of knowledge will prepare a manpower which would be able to absorb, assimilate, adopt and later develop further in these fields.

The programmes & courses can be:

- Research/PG programme or UG course or some electives in other UG courses to support in-depth programmes later in PG/Research.

- Department or Centre based.

- Single discipline, or, cross disciplinary type.

(b) Some subjects which already form part/section in some course or other, may need to develop for a sharp definitive focus as separate programmes or courses. It can be done either by splitting an existing course, or, by regrouping sections from a number of courses. Some illustrations are:

- Power, Control & Instruments, Electronic & Communication were split out of the Composite Electrical Engineering Course in an IIT.

- Petroleum Refining & Hydrocarbon Processing became a separate programme by regrouping sections from Fuel Technology, Organic Processing, etc.

- Solid State technology was formed as separate centre/programme by regrouping sections from Physics, Material Science, and Electronics.

(c) Some programmes at PG level (M.Tech.) have to be specially tailored to suit a particular industrial customer. For example, IIT Madras formulated programmes on Aircraft production at the request of HAL, and another one to meet the requirements of Fertiliser Corporation.

(d) A number of areas which have great impact on live-issues, are inter-disciplinary. Programmes and courses have to be organised for them. Aspects of such programmes e.g.

- The relative emphasis on these programmes/courses, in the UG and PG levels;

- Whether this should be organised by Centres of Studies, or, by Department specific for the subject, or, by a number of Departments coordinating among themselves;

- Technology is the result of high-grade inter-disciplinary effort. Therefore, from a student's point of view three aspects of the curriculum must be taken care of:

(i) Practical work be done in an industrial environment.

39 (ii) Design and project assigned work should be so designed as to enable the student to learn to become self-confident and, (iii) Seminar-sessions be allotted in which the student is trained to discuss orally about his problem using available presentation media.

(e) Formulating syllabi and curricula; Upgrading them to follow the advances in science & technology; updating them to be more appropriate and relevant to what is available in industries/fields in India through imports; making them to be more in tune with social attitude- are efforts which involve continuous resolution of conflicting concepts in order to arrive at a reasonable synthesis.

Some facets are:

- Should the syllabi have a greater scientific content emphasising on basic principles, demonstrating the applicability of these principles to live problems, with a view to stimulate an analytical and questioning mind with ability to synthesize; OR should they be close to live problems presented as case-studies and developed as project work?
- Even if the syllabi is science based, should it be of highly theory oriented with good mathematical treatment, but lacking in conceptual applications or in practical aspects at the cost of experiment and instrumentation?
- Should syllabi and curricula be such that at the end of UG course, student is well informed in any one broad-based engineering discipline: OR acquire proficiency in a comparatively narrower specialisation; OR get a generalised knowledge in a very widefield of inter-disciplinary character?
- Should upgrading aim to bring the programmes/courses to the forefront of technology which can then initiate, or act as catalyst for change in industrial processes and practical field work; OR should it be limited to updating in tune with technology imported and in current practice in the country in other words, only react the changes?
- Should electives be more in number and also available in semesters early in UG courses? (Presently they are less in number and are available in the last semester for all courses and last but one onwards, for some of the courses). The core/basic subjects take away most of the time in the early semesters and as such there is little or no room for electives. Are these 'core' subjects over-emphasised; OR they are the absolute minimal for a sound foundation?
- Should the electives in the PG programmes be restricted or channelised into groups, instead of being very open and wide, in order to ensure a better focus on to anyone area/field? If so, how restricted this scope should be-for example, should it be refrigerator, heat transfer, etc. OR thermal engineering?

Issues such as these will need continuous deliberations within the IIT system and should provide the basis for curriculum development activities because as stated earlier there cannot be solutions valid for all IITs at all times.

(f) Unit System with credits is in vogue

- To a limited extent, it has made education " Learner- oriented ". Student can find his own pace in the learning process with no feeling of failure or discredit. Faculty adviser gives guidance to select courses based on the characteristics and ability of incoming students.
- The system is liable to be misused by some " Credit-hungry" students. A carefully planned package deal which provides for adequate choice of electives may correct this situation.
- Mobility of students between IITs, and between disciplines is not very pronounced despite this credit system. This mobility is almost non-existence between IITs and other institutions.

(g) Research: Academic and Sponsored

A proper mix between the two has to be aimed at. The former should have a high academic content and be in pursuit of excellence; results should be published in reputed international journals to gain high citation index and thus international recognition for the institute.

The latter is invariably practical application-oriented and sponsored by some outside organisations. Here also, development is more important than applied research. These will perhaps have more visible impact in the Indian scene.

(h) A few departments have already outlived, or, likely to outlive their specificity. They need closing down, OR, they can be integrated with some other departments which are expanding; OR, acquire some sections from others and reform itself into newer departments.

Some examples:

Naval Architecture into Marine Technology

Aeronautical Engineering into Aero Space Engineering

(i) Courses and their Curricula should be innovative.

Some limited attempts have been made like:

- Integrated five years course leading to Masters in some technology subjects and most of science subjects.
- Streamed electives—a sequence of three related courses in the last three semesters enabling student to pick up knowledge in a sub-area outside his main engineering discipline.
- Part-time PG courses, was not successful though it would have been useful for working people. Instead, external registration and only one semester in the IIT rest outside are being tried.
- M.Tech. with thesis and non-thesis options—cannot be made available.

4.6.3 New Programmes

Table 4.6.3 gives IIT-wise the number of doctorates produced in the last ten years separately for Science and Engineering disciplines. These institutes have not produced many doctorates in Engineering and Technology. IIT Bombay and Kanpur have produced more or less on equal basis. IIT Delhi and Madras have produced more doctorates in engineering than in science. IIT Kharagpur has produced more doctorates in science than in engineering. It is important that IITs concerned with technology must concentrate more and more research work leading to the award of doctorate in Engineering & Technology subjects and in that context IITs have to take up new activities and prepare themselves for the type of technology needed to meet the challenge of 21st century. The Council of IITs should exercise its mind from time to time to encourage adding emerging areas, and shifting programmes in traditional areas towards inter-disciplinary ones in various subjects. We feel that new programmes (like Bio-sciences) may have to be introduced as interlocking/supporting ones to produce doctoral manpower to work on 'thrust areas' and 'leading edge' of technology.

Certain areas are already emerging as crucial in the Indian scene, viz.

* Micro-electronics and VLSI-Technology * Bio-technology * Energy Engineering * Atmospheric Sciences * Semi-conductor Physics * Ceramics * Fibre Optics * Seabed Mining * Ocean Engineering * Marine Instrumentation * Sophisticated Software development for Computer programmes * Bio-chemistry * Environment Engineering

These are only illustratives and not exhaustive.

VLSI is an emerging area, and India is going to have a silicon foundry. For each foundry a large number of people are required who will undertake design. It is important to reorient the electronic engineering education in this direction in all IITs. It is not merely sufficient that a few papers are published in this area, but as a corollary of advances that have taken place, one must treat VLSI advances as important for preparing electrical engineers for the twenty-first century. IITs should provide leadership in generating educational materials, preparation of teachers even for other engineering colleges in the reoriented Electronic Engineering courses. A large scale mounting-up of this programme is needed not only to formulate appropriate syllabus etc. but also in the context of challenges for developing text books, laboratory manuals and for faculty training.

The Department of Electronics, Government of India, while formulating their Seventh Five Year Plan set up a number of task forces. One such task force identifies that the lack of LSI/VLSI designers can be a major stumbling block for the country to enter into the micro-electronics era. At present, the country, hardly produces a handful of Ph.Ds. in LSI design and the country may be without a semblance of leadership in an area which requires a long gestation time. Recognising the crisis, the task force has recommended a decentralised design approach in IITs and leading universities. The adventure of realising design on silicon chips is to be initiated right from the undergraduate level with the printing of design in a semi-conductor foundry. The approach which is now widely adopted in Europe and USA, further has the potential to bring micro-electronics revolution within the grip of a wide sector of industry through a custom based design approach. The implementation of such a design approach requires a dedicated CAD facility, inter-disciplinary participation, automated testing facilities in the IITs with a provision for access to softwares through computer networking. This is a large area where IITs have to prepare themselves adequately and quickly. All over the world, VLSI design software have emerged from academic institutions through close tie-up with industries. Indian technological institutions like the IITs need to be structured to play the above role, and provide the technological leadership through their courses and curricula structures.

It is expected that even more than the micro-processor revolution in the form of computers, chips and their applications, Bio-technology will represent a new revolution in Technology. Basically Biology may become in the twentyfirst century what Physics and Chemistry are in this century. Bio-technology provides far more extensive technological revolution and that is why there is concentration in this area in the developed nations. There are now a number of Bio- technological-based new opportunities but three main areas of interest are:

- Fermentation technology from which new drugs and chemicals can be produced.
- Production of enzymes.

- Gene-splicing, as used for synthesising expensive natural products such as Interferon, Insulin and human endorphins used as pain killers. Gene-splicing has the potential to synthesise new substances which may substitute coal, oil and other raw materials.

Bio-technology is thought, sometimes erroneously, to refer to genetic engineering. While genetic engineering is the specific technique of transferring gene expression through laboratory conversion, Bio- technology involves converting discoveries in new biology into practical applications. These include a whole series of disciplines such as:

- bio-fuels
- nitrogen fixation
- fermentation
- plant hydrocarbons
- antibiotics
- vaccines
- bio-mass production
- microbial insecticides

It is important to realise that vast as the potential for development, vaster is the cost of specific infrastructure required to exploit this new field. Fermentation and enzyme technology or bio-catalysis has made greatest advances. Japan regards Bio-technology as the "best major technological revolution of this century".

The next century may be the "Age of Biology" as the last three decades were that of micro-electronics. IITs must prepare themselves adequately both by way of the manpower training, research programmes and research relevant in this area to meet India's emerging needs. IITs need a strong biology department which will interlock with the work in the areas of Bio-technology, Genetic engineering and Molecular-Biology. They should, therefore, develop programmes at doctoral, postgraduate and undergraduate levels, supporting each other in the form of courses, and programmes in this leading-edge of Technology.

Energy will be a major area where, as a nation, we have to invest a lot more in the next few years. Apart from better utilisation of available resources, a wide variety of natural resources, will have to be harnessed in a big way. The Indian Institutes of Technology are the leading institutions to suggest technological solutions to the effective conservation of energy in industry as well as in buildings. Apart from this wood and other bio-mass are major fuels used by millions of people. Fuel conversion and fuel substitution are important to widen the scope of their utilisation with better efficiencies. Similarly another area is Photovoltaic systems which have been rapidly developed in the recent years in Japan and the USA. It is necessary to develop indigenous capability in this field at the same high level and achieve cost-effective technologies. Also, the use of solar energy for power generation has considerable potential and should be pursued. A large part of the country has good winds which can be used for irrigation, power generation and to provide motive power. In addition,

it is also necessary to keep pace with the Research and Development work in emerging areas like OTEC and tidal energy, MHD and micro-hydels. All these will constitute important areas of advancement for IITs who may have to prepare themselves by formulating appropriate specialised degree courses or short-term training programmes.

Another area of special importance to our country is the Atmospheric Sciences specifically relating to climate variability studies and weather prediction. It will be necessary to strengthen activities relating to Atmospheric & Oceanic Studies concerned with all aspects related to numerical modelling in this important field, such as, development of appropriate physical parameterization, objective analysis of the data for regional models and other related problems such as development of coupled oceanatmospheric model. Groups and centres which have started work in emerging areas like atmospheric and oceanic sciences must strive for appropriate linkage with the university system.

4.6.4 More Experimental Work

Importance of laboratory work has been down-graded in the credit system. Three laboratory hours have been equated to one lecture hour and as such courses have moved more towards lectures.

IITs must provide their students "hands-on" experience both in setting up experiments and carrying them out. A number of suggestions were received by us in this regard:

- Experiments should be so designed as to illustrate fundamental principles and concepts without involving a series of detailed measurements. Similarly, a member of the staff should always be available to direct students in their private reading and enabling the students to design and exhibit what they learn.
- Ph.D. degree is now awarded usually for original academic research. In an Institute of Technology one would expect that more and more Ph.Ds. or equivalent degree will be awarded for say, the development of an instrument, for the first time in India. This is not happening significantly in the IITs.
- IITs should encourage designing of equipment and instrumentation and fabricating them or updating existing ones. Faculty must be assessed, for the development of fabrication of equipment in support of their own activities. While sophisticated equipment may not be fabricated, there is always some instrument that can be developed. This is possible particularly in the field of instrumentation and control systems, as, new devices are more communicative, versatile and intelligent. Efforts needed for developing instrumentation or designing equipment itself should find high score, in the IITs' reward system of evaluation.
- In the case of large equipment IITs can encourage a joint venture with similar research institutes or with industry, so that hardware can be developed later for the orientation needed by the user.
- The number of published papers is taken at present as an important index for evaluation as well as for the appointment of faculty. This should be given a lesser weightage than proven efforts in specific hardware development including R&D; for new processes, design technology etc.

- IITs can only provide an experimental role with regard to development of instrumentation. Modern technology and modern science have come to depend upon a good deal of instrumentation of various kinds, but Indian industry is not too keen to develop such equipment because of limited markets. In a few instances where they reproduce foreign designs, quality is not maintained. SERC of DST as a focal point could financially give projects to IITs for development of a variety of instrumentation. IITs should be encouraged to develop successful prototypes for being taken up for batch production through a pilot-plant specifically set up for this purpose.

Having considered all such views, we feel that doctorate degree may be offered on work relating to developmental projects, hardware, experimental work, instrumentation etc-areas in which the IITs faculty still seem to have an ambivalent attitude. We also feel that in the matter of instrumentation, a more function-oriented approach is necessary. The impact of microprocessor on all electronic instrumentation is overwhelming and dramatic. It is growing rapidly with the infusion of microcomputers in measurement and control. The present-day instruments are designed around innovative LSI memories and standardised bus oriented structures. Software engineering is an important ingredient in the instrument design.

Instruments are only one part, although a very important one in a complex and technologically fast moving industry where technology and product innovation must go hand in hand. IITs should provide leadership in the plan of development of instruments. There is a spurt of fresh activities in design of instruments in the world during the last few years. One of the important trends observed with respect to some instruments is that they are more intelligent, versatile, and can communicate with each other digitally. Virtual instrumentation is a new design-concept for instruments. Most of the technology development activities in the area of instrument usually consists of design, development and testing. The strategy for achieving self-reliance in the field of instruments implies basically the need for technology development. IITs are in a position to contribute to this, and one should encourage these Hi-Tech. efforts by award of a doctoral degree and other similar awards.

4.6.5 Emphasis on Inter-disciplinary Programmes

We are concerned about the need of IITs to shift into newer programmes that will become urgent both because of the quantum leap occurring in 'science and engineering' in general and because of the technological needs of the country in particular. Issues arise in this context such as:

- Is it necessary to have a single disciplinary courses or inter-disciplinary courses? Should a first degree holder in IIT be trained as a specialist or be a generalist?

Our observations- are as follows:

(a) Cross-disciplinary programmes though attractive have not been a resounding success even in USA, but today's engineering certainly needs a broad-based education. However, the advances of technology today are such as to require inter-disciplinary approach for the solution of real- world problems.

(b) As far as courses go, some inter-disciplinary studies are desirable in the case of an applied science course, which demands knowledge of the basic sciences and their application to industrial process.

(c) First degree courses should be based on single discipline and examples from other disciplines should be included only to demonstrate how knowledge and abilities in one discipline can be useful for solutions of problems in other disciplines. At a later stage of education cross and inter-disciplinary arrangements are useful in the form of seminars and colloquia.

- Cross-disciplinary courses should be offered for a first part of the total curriculum as an introduction to and, representing a broad view on Science and Technology.

-If the employers demand special skills, some of their sponsored candidates may be given single disciplinary courses ensuring that appropriate standards are maintained.

-Application of computers is more important than the study of computer science. For example IITs which have now a separate Computer Science Department should bring the use of computers into other disciplines.

-There should be some courses which have to be evolved in IITs that will require the institutes to work together. Some of the IITs possess the nucleus for such programmes e.g. bio- engineering/ technology.

We recommend that in the IITs, programmes should be shifted from the traditional areas towards inter-disciplinary ones like Materials Science, Energy System, Instrumentation etc. These should be normally offered as postgraduate programmes. Over the years separate undergraduate programmes in these areas be evolved, giving up the traditional areas. In the early stages, these postgraduate programmes of inter-disciplinary subjects can be based on elective course structure instead of starting a separate department/centre for it.



4.6.6 Developing Innovative Programmes

It becomes clear to us that IITs are the appropriate places where innovation in course-formulation, in better methods of admission and other similar academic matters can take place. For example, they could start a biology programme and integrate it with engineering eventually developing into a suitable bio-engineering programme. They could start intensive mathematics programme useful to higher technologies. They could start an integrated five year course leading to M.Tech. It is common practice in the European technical universities to have a five-year Diploma in Engineering (Dip. Engg.) with a fairly wide range of options given to students so that they can specialise in inter-disciplinary fields such as Bio-technology or Management with some engineering specialisation, various degrees of software and hardware combinations in the field of Computer Science. We feel that if any five-year integrated course leading to an M.Tech. degree in the IITs is to be instituted, then these should not be in the traditional disciplines of Electrical, Mechanical, Chemical Engineering and so on but in newer combinations. The present experiment at IIT Kanpur of an M.Tech. programme in Engineering Management, is a good example.

A number of existing B.Tech. programmes can easily be transformed into five-year M.Tech. programmes with greater inputs in Management subjects than has been possible in a four-year course. At the IIT Delhi, the Textile Technology Manufacturing optional of B.Tech. course and the proposed Production Engineering course in Mechanical Engineering Department could well be integrated with Management leading to a five-year M.Tech. degree. Apart from meeting the present day needs in the industry for management oriented technocrats, this would also help strengthening the Management faculty at the IITs. There is obviously a need in the country to develop strong Industrial Management Centres at the IITs, as a supplement to the Indian Institutes of Management where the training is more of a general nature.

Similarly new postgraduate courses may be developed based on project work alone. Similarly there is a need to develop Master's or Doctoral level of programme in Design Engineering. IITs could permit lateral entry to their undergraduate programmes instead of four-year programme for B.Tech. They can have three-year programme for 10 + 2 + 3 science graduates.

We recommend that innovative ideas should be attempted, such as starting of integrated five-year course leading to M.Tech. degree; and modular courses to give students greater flexibility in transfer between institutes and to change disciplines.

4.6.7 Teaching Methods, Teaching Aids & Evaluation

- Teaching methodology is in a continuous process of evaluation; educational psychologists have given insight as to how learning is accomplished. IITs have to get the best between different factors and concepts in teaching & evaluation practices. Some of these are:

* Lecture hours versus laboratory hours. What is the optimum?

* Contact hours in a week-Is 25 hours good enough or too high?

Change from "chalk & talk" pedagogy to more modern aids of audio-visual types and ultimately proceed towards computer- aided systems.

* Use extensively and effectively other means of imparting knowledge, like seminars & problem-solving sessions, project & field work; simulatory exercises & experiments where some amount of choosing and assembling of equipments has to be done by student, etc.

We recommend that modern teaching aids like audio-visual, computer etc. to be increasingly used. In general, shift should be "from teaching to learning," "evoke, inspire and draw-out" by self study sessions, reference work in libraries & tutorials.

- Semester system as opposed to Annual examination system has come to stay in IITs. It has been assailed in a few universities and some have gone back to annual system. IITs should be watchful of the drawbacks/problems, if any, and take corrective action in time.

- In the evaluation system, IITs have to keep a careful watch on the admixture of:

* Internal and external assessment

* Continuous assessment methods and the terminal examinations.

* Positive and healthy discrimination in testing, in favour of comprehension (i.e.) ability to analyse & synthesise, away from memory power (i.e.) retention & recall has not been attained.

- In marking, numerical system continues; letter grades, credit point systems etc. have not made sufficient in-roads. Letter grade system has a drawback and has to be corrected or guarded against, by fixing a minimum in theory, tutorial & laboratory.

- Existing rules for discontinuation of studies at UG and PG levels should not be deleted.

4.7 Departments/Centres

4.7.1 Optimal Utilisation of Scarce Resources

In addition to departments, each IIT has a number of centres (Figure 4.7.1). They were established to promote initially, inter-disciplinary research by linking research efforts in various departments and by linking similar activities in other technical institutions in the country. These centres, in course of time, started teaching programmes and created faculty positions, often working much in the same way as a department in an IIT. While the original objective remains valid, there is a need to critically look into the role being performed by each centre, its linkage with the Department, its academic programmes, relationship with the rest of the IIT. There is also a need to examine whether these centres should offer academic courses and programmes, whether they should have a science-based staff, or have faculty positions. It has been noticed that a few senior professors, singly or jointly undertake research work in the emerging areas with the full support of their respective departments. Later on when they get sufficient funds, they strive to have separate identity and gradually separate themselves from the Department which helped them initially. While the concerned professors are better off, it causes frustration among the faculty left in the Department. It is necessary for the respective Senate of the IIT to critically review activities of each department/centre and place their views to the Board and also the Academic Advisory Committee of the Council (Para 6.1.2) for necessary adjustments to be made.

There is enough evidence available to conclude that a department in the IIT tends to remain water-tight which is strange considering the belief that flexibility of the IIT system is the sine qua non of academic freedom.

The Departments of an IIT are the main operational units on the academic side. We are of the view that wider administrative and financial powers should be delegated to them. Each Department may have a Committee of Management. The composition need not be uniform. Each department must form the committee which will be most effective in their collective opinion. It should meet at least once in a semester to discuss the academic programmes of the Departments and the requirements of the laboratories, and decide on assignment of duties and other related matters. The decisions taken by this committee should be available freely to the faculty of the Department as well as to the Senate. IITs must provide necessary secretarial assistance to each Department for this purpose. It is essential to construe the autonomy of an IIT as the sum total of autonomy of Departments. Otherwise the academic autonomy conferred upon IITs becomes meaningless in real terms.

There are some Professors having a very large number of research scholars under them. At the same time there are others, usually the junior faculty who have no scholars to guide. This situation is academically unhealthy and needs quick correction. Barring sponsored research workers, we feel that generally no research guide, however eminent he is, be permitted to have more than a few scholars registered with him during his academic tenure in an IIT.

There are departments and centres working well below their optimum level. In such circumstances adding more departments and centres means employment of more persons demanding housing facilities and more expenditure on infrastructure. IITs are now short of their critical housing and laboratory's needs. It would be a prudent move institutionally if the IITs on their own examine the areas in which they could reduce their activities, the areas of work that can be transferred from a Department or Centre to another* so as to reduce the total cost and give better output.

There are quite a few M.Tech. Courses whose products are not absorbed by industry. IITs should consider discontinuing such courses for which there is no demand. One must examine whether even the existing centres can be merged into a few Hi-Tech. centres. Similarly such departments whose load is below an optimum level and not likely to build up in the near future, should be either closed or merged with another department.

4.7.2 A Review of the Centres Needed

The Department of Science and Technology, Government of India, suggested establishment of centres of Advanced Studies in the IITs which could initiate intensive time bound R&D; effort in some of the critical areas as identified in the S&T; plan for development included in the country's Fifth Five Year Plan (1974-79). This is the genesis of the establishment of "Centres", on the recommendations of a committee headed by Prof. Nayudamma, considered by the Council of IITs in May 1976.

The Nayudamma Committee recommended at that time establishment of only one centre in each IIT during the Fifth Five Year Plan. It also supported that research activities in another area for each IIT can be accelerated in the same period with a view to develop into a fulfilled centre later. This Centre of advanced R&D; activities in the IIT was conceived by the Nayudamma Committee as a peak point for serving the whole nation (though physically located at an IIT). These were not set up as rivals to the departmental activities but to complement and enhance their inter-disciplinary functions. Some of their defined goals are:

- (a) centres should act as centres of excellence for advancing frontiers of science and give the country a break-through in technology;
- (b) work on specific technological problems of relevance on a time- bound basis and act as consultants;
- (c) promote inter-disciplinary and inter-institutional collaboration and by the effort of excellent team work solve major national problems;
- (d) engage in design and development of equipment necessary for R&D; work; and
- (e) act as a resource-centre for collaboration, collection and dissemination of information.

Operationally they are under the control of the respective Board of Governors and under the executive control of respective Director of an IIT. There is an Advisory Committee to monitor and guide the work of these centres. Centres have faculty, research, design engineers, technical staff, visiting faculty etc. The important principle enjoined upon the centres by Nayudamma Committee is that only 25% of the scientific research staff would be the core staff of the each centre to be specifically recruited by IITs, remaining 75% are for people to be invited from other departments in the IITs and from other institutions on deputations etc.

We note that the work of Nayudamma centres has been reviewed by Menon Committee in 1981. It is sad to note that the principles under which the centres were established, have been breached, in more ways than one. Centres have proliferated and it is said often that when faculty could not get what they wanted in a Department of an IIT, Centres are started. In some IITs, centres functioned without the collaboration and input of other departments and sometimes in opposition to the established departments. Centres thus became the rival sources of claim and power and the specific role assigned to the centres by the Nayudamma Committee appears to have been forgotten. Some of the faculty positions are held by the staff in the centres without any adjunct appointment in the department. As IITs got more and more sponsored projects, some of the IITs created new centres, on their own and appointed more staff. Eventually when the sponsorer did not fund such staff they found no useful avocation. Some centres had to adopt new projects only in order to utilise the staff already appointed. We, however, noticed that some centres have done remarkably well, some of them are engaged in research and development while others have done only peripheral work. We feel that the entire question of the functions and the achievement of the centres needs to be reviewed critically. We recommend that new centres may be established only after proper assessment of the need by outside expert groups. We also recommend that an inbuilt mechanism to evaluate periodically every centre of the IIT be evolved by the Council.

4.8 Students



4.8.1 Refinement of JEE

Admission to a number of undergraduate courses, (Table 4.6.1 indicates the undergraduate courses offered) is mainly made through a Joint Entrance Examination (JEE), common for all the five Indian Institutes of Technology and the Banaras Hindu University (BHU). The examination is very popular among candidates taking it, not only because of its clear time table (e.g. JEE takes place always on 2nd & 3rd May even if these dates are holidays and results are declared on 1st of June every year) but because of its reputation of fairness and the general confidence it has gained among the examinees. The JEE applies to all those seeking entry to B.Tech., B.Pharm. and integrated M.Sc. and B.Arch. courses. Those who come in the JEE merit list are called for counselling between 2nd and 4th week of June. Admission to the course depends exclusively on one's rank. Approximately 70,000 students appear every year for the JEE which includes 3,000 candidates from SC/ST communities. Examination takes place for two days in four subjects namely Chemistry, Physics, Mathematics and English. The merit lists, on the basis of the competitive inter-se marks are prepared-one for general candidates and separately another for the reserved candidates. Candidates from the reserved list get a concession on absolute marks at the level of 2/3 of the marks secured by the last candidate in the general category. Competition for securing an eligible place in the selected list is so high and the chances of success is about 1:60. IITS themselves bring out a study of the JEE problems every year and these are presented to the Council of Indian Institutes of

Technology. This analysis of JEE covers percentage of success and failure on the basis of age group, mother tongue, medium of instruction, medium of taking examination, State from which largest candidates are admitted, number of girl candidates selected, urban-rural influence, median age of success, etc. The JEE serves more as a process of elimination than of selection.

The IITs are considering modification of the JEE on a two-tier basis, the first tier being a preliminary examination on the type of multiple choice objective test out of which about 5,000 candidates are to be selected for a second tier test.

Certain issues connected with the JEE were raised before the Committee such as:

- Many students concentrate-through a number of coaching institutions-on JEE to the detriment of their preparation for +2 examination. Therefore, some suggest that it will be better to recognise these coaching institutions as equivalent to +2.
- The JEE must test intellectual objectivity and their application, as Scholarship Aptitude Test (SAT) of the USA does.
- There are problems of management of the JEE, whatever be the system of examination the academically weaker section of the people is apt to perform poorly in a competitive field as large as 70,000.
- Some of the professors in IIT feel very strongly that there should be a Part I objective test for preliminary elimination and a Part II in the manner as at present being done.
- Engineering drawing as an optional in the JEE examination should be reintroduced as this way students good in science as well as students good in drawing, so essential for engineering education, can also obtain admission in an IIT.
- The choice of profession is generally made by parents rather than by the student based on his interest. Thus, one important dimension of fitness of the candidate is missing in the JEE.
- The JEE does not really test aptitude in engineering and encourages students to cram information.
- The JEE system could be rethought as a challenge to the students for the application of their faculties.
- JEE benefits people with only certain kind of background. It encourages preparation through coaching institutions to get into the IITs.

We feel that it is time to devise a test of measurement of aptitude of candidates in addition to tests at present being conducted. It is perhaps not so easy to devise a satisfactory aptitude test but Educational psychology has advanced much and experiments can be made to establish valid parameters for ascertaining aptitude. A statement of objectives by way of information on his aspirations and expectations could also be asked from a candidate.

We also note that a few students can enter into IIT through a reserved category such as foreign nationals, Indian nationals residing abroad etc. Some' feel that there should be a JEE

for all such candidates and the full cost of education should be recovered from foreign students.

There was also a suggestion that even at the undergraduate level there should be a definite scheme of admitting sponsored candidates from the industry and R&D; establishments. IITs should experiment with taking a number of sponsored candidates even for the B.Tech. level but they also should be subject to the qualifying test and charged the full cost of training in an IIT.

4.8.2 GATE

On the recommendations of the Committee on Postgraduate Education & Research in Engineering and Technology it is now essential to have one All-India test, for ascertaining the aptitude for engineering of a student for admission to a postgraduate programme. This test is called Graduate Aptitude Test in Engineering popularly known as GATE. That committee noted that bright students are not attracted to postgraduate programme in engineering and technology. To remedy such a situation postgraduate committee suggested:

- admission to postgraduate programmes should only be restricted to those who qualified at the GATE examination; and
- the maximum duration of a postgraduate programme in engineering and technology should be three semesters i.e. 18 months instead of two years.

IITs now adopt GATE as one of the entry requirements from July 1983 but sponsored candidates, not in need of scholarship, may be exempted.

Unlike the JEE, GATE is not exclusively meant for admission to IITs. The GATE is currently being conducted on behalf of the Ministry of Human Resource Development by IIT. An Implementation Committee of the GATE is also formed with participation from IITs as well as the Indian Institute of Science, Bangalore: Question papers are set by a board of examiners. Extensive information is given in a brochure regarding the syllabus, which is sent to candidates along with the application forms. The question papers currently follow a pattern of 40% objective type and 60% essay type questions. The results are declared in terms of normalised ranks (percentile score). They determine the cut-off level for qualifying in any discipline on the basis of minimum performance on both absolute and relative scales. For the candidates belonging to Scheduled Caste and Scheduled Tribe the cut-off level is fixed at 2/3 of the general category students on the absolute scale. It is hoped that in a few years' time the intake for postgraduate programme in the IITs will be the best of students available on the basis of these tests conducted uniformly all over India. Table 4.8.2 is the analysis of GATE giving IIT-wise success of their B.Tech. students in the GATE. IITs as a group in 1985 has the highest percentage of success. There are some problems of admitting students to inter-disciplinary programmes but the GATE Committee continuously attends to these problems for solutions.

During our visits to the IITs, a few persons pointed out to us that reduction of duration of the M.Tech. programmes from two years to three semesters is proving to be detrimental to the general level of teaching and research and that a majority of students enter the M.Tech.

programmes because they did not get into an IIT at the B.Tech. level. They pointed out that these students require a semester for making up their deficiencies.

As pointed out elsewhere, there are other reasons also for M.Tech. programmes not attracting better students. We may, however, watch the impact of GATE for sometime more, as it is already reported to have had a favourable influence.

4.8.3 JEE and GATE as National Merit Testing Examinations

A number of people pointed out that the JEE should be evolved as a National Merit Test rather than be restricted solely in its use as an entry examination for IITs.

A view was also expressed that the Graduate Aptitude Test in Engineering(GATE) which is meant for admission for all Engineering colleges may be conducted outside the IIT.

Others felt that both GATE and JEE be conducted by a professional body set up as an Educational Testing Corporation.

Such a body, in our opinion, could develop and perform a number of useful functions in the expanding area of educational testing professionally, and there could be many distinct advantages. But the successful operation of such a body will depend primarily upon the confidence and goodwill it can generate among the IITs who are content with the JEE.

We feel that a national testing agency should conduct objective aptitude test both for JEE and GATE so that the task of selection by the IIT authorities to their B.Tech. and M.Tech. programmes could become lighter and more meaningful by restricting the number from among those qualifying in the national test.

One of the IITs expressed serious reservations about accepting the performance of GATE as the sole criterion for admission to a postgraduate course of a student's choice. They strongly feel that after the prospective candidate qualifies in GATE, the postgraduate teachers in the institution which he wishes to join should have the opportunity to talk to him and evaluate him taking into account his aptitude and yearnings before a final choice is made.

In our view these examinations conducted by such a Corporation could serve as an aptitude testing service as a primary indicator. It will be open then to the IITs to further evaluate a limited number of people 'passing through these aptitude tests for admission to the B.Tech. programmes/M.Tech. programmes. For this purpose they should develop academic indicators and evolve academic evaluation of records of these students related to the course requirements.

4.8.4 Admission of SC/ST

Admissions to the B.Tech. course in the IITs are normally made through the Joint Entrance Examination WEE). All the five IITs have reserved 22.5% of the seats in the first year of all the undergraduate programmes exclusively for the students belonging to Scheduled Caste/Scheduled Tribe candidates for admission to the IITs. This concession was given on base marks secured by the last candidate admitted from the general list of the Joint Entrance Examination. This concession, however, did not enable a sufficient number of Scheduled

Caste/Scheduled Tribe students to join the Institutes. The subject has been under constant review and many ways were tried from time to time.

In the year 1968 the Council for the Institutes of Technology considered the matter and felt that the Scheduled Caste/Scheduled Tribe candidates' performance at the Joint Entrance Examination should not be linked with that of a general candidate. They should be admitted if they secure minimum qualifying marks. In the year 1969, the Council reviewed the matter and decided that all Scheduled Caste/Scheduled Tribe candidates who had secured the minimum qualifying marks in the aggregate of the subjects (viz. 115 out of 400) at the Joint Entrance Examination, even if they have failed in one subject by not more than 5% marks, should be considered for admission. Thus Scheduled Caste/Scheduled Tribe candidates securing about 29% marks in the aggregate were eligible for admission. The revised reduction in the admission requirements was brought in force in the year 1973.

During 1974 it was decided that all Scheduled Caste/Scheduled Tribe students securing 15% marks in aggregate in all the four subjects (Physics, Chemistry, Mathematics and English) would be eligible for admission. It was, however, observed from various studies that the performance of the Scheduled Caste/Scheduled Tribe students after admission was not satisfactory. Even after special coaching several students left the courses and a number of them could not withstand the strain of the five-year course.

In the year 1975, the procedure for admission of the Scheduled Caste/Scheduled Tribe candidates was further revised. The IITs were now to prescribe a cut-off value of marks obtained at the Joint Entrance Examination, approximately at two thirds of the cut-off value prescribed for the general candidates. This meant that the Scheduled Caste/Scheduled Tribes candidates to be selected in the Joint Entrance Examination had to get 66.6% of the marks obtained by the last general candidate selected. In this manner it was expected that it might be possible to fill most seats against the reserved quota of 220, the remaining seats were filled by direct admission through leading newspapers. All the Scheduled Caste/Scheduled Tribe candidates who had obtained more than 50% marks in the higher secondary examinations in the science/technical stream were eligible to apply. The first direct admission was made during the academic session 1975-76 and was continued in the subsequent years.

In the year 1979, direct admission to IITs was discontinued. All admissions were to be made through Joint Entrance Examination and minimum qualifying marks for Scheduled Caste/Scheduled Tribe candidates were prescribed at two-third of the minimum for general category candidates.

The statement contained in Tables 4.8.4A and 4.8.4B gives the details of SC/ST candidates registered for the Joint Entrance Examination, the number of seats reserved for SC/ST candidates and the number of SC/ST candidates given admission with or without relaxation during the years 1979-80 to 1982-83.



Special Coaching for Undergraduate Courses

IITs take different steps to provide special coaching to the weaker sections of students admitted to the IIT, particularly Scheduled Caste/Scheduled Tribe students, twice a week in the evening. Subjects are taught in the regional language also. This is continued during the second semester also so that Scheduled Caste/Scheduled Tribe students do not suffer by

being clubbed with other students. Classes are relatively small-mostly 15 students as against 30 in a normal class. This enables individual attention to be paid to SC/ST students by the teachers. In some cases additionally, postgraduate students are also made to teach special courses. There is also arrangement to give reduced load to weaker students. As against five courses, the 'load' is reduced to four or three in order to help them improve their performance index. They are allowed to carry forward the load to the next year. A thorough review of performance of each student is made at the end of each year. Scheduled Caste/Scheduled Tribe students who show good performance are put on regular stream. Others are given the due credit but they are asked to continue in the special programme for some more time. By this process, most of Scheduled Caste/Scheduled Tribe students join the mainstream in two to four semesters. Indian Institutes of Technology at Madras and Bombay invite Scheduled Caste/Scheduled Tribe candidates to visit the Institute and ask all the schools to recommend the names of the bright Scheduled Caste/Scheduled Tribe candidates and such candidates as turn up are provided with Joint Entrance Examination application forms and information brochures free of charge. Principals of colleges are also requested to recommend the names of potential SC/ST candidates to whom the IIT could provide guidance.

IIT Kanpur had taken the initiative of organising a programme called as slow pace programme by which all students of first year including the SC/ST students were given a special package programme. They have achieved considerable success under this programme. Special Orientation Programmes for weaker students are also organised in this Institute. It has been stated that the programme has worked very well.

The statutory reservation of seats enjoined by the constitution of 15% for Scheduled Caste and 7.5% for Scheduled Tribe as applied at the entry point in the IIT has been a point of comment by individuals as well as by the Parliamentary Committee of Scheduled Caste and Scheduled Tribe. These reservations are viewed against the limited openings available for all those who aspire to enter into an IIT. At present annually over 70,000 students take this examination, against about 1500 seats available (see Table 4.8.4C). Out of this, 361 seats are reserved for SC/ST candidates (Table 4.8.4D indicates from 1974 to 1984 the number of seats reserved for SC/ST, number filled and percentage of fillings). Views exist regarding the need to reconcile articles 15(4) and 16(4) of the Constitution of India to achieve equality between advanced classes and weaker sections of the society. Some are of the view that there can be no equality of opportunity between unequals, while others feel that backwardness should not be based on Castes but on academic or economic status.

It is beyond the purview of the Committee to examine or recommend on any of these issues. We are, however, concerned about the standards of the students who are admitted to the IIT. At present IITs admit students from SC/ST communities on the basis of relaxed standards. Having examined the presentations made by all concerned in this matter, we feel that the steps taken by the IITs are sufficient for the present. We strongly recommend that in no case standards of entry of students to the B.Tech. courses in the IIT should be relaxed any further only to fill the quota of 22.5%.

Since 1983 each IIT has been conducting a preparatory course for coaching the SC/ST candidates for entry into the first year of the B.Tech. programmes. We do not recommend that the IITs should conduct such preparatory courses. However, there is a case to promote, outside the IIT system, a number of measures by several institutions for intensive coaching. Promising SC/ST students should be identified at the school level itself say class 8th and be given special schooling facilities to enable them to compete with other students in the JEE.

These special facilities should, however, be created within the school system and not in IITs. The JEE normally has a cut-off of around 40% for regular students and about 25% or even less for SC/ST students. The experience with such entrants has been unsatisfactory. A suggestion was made that around 2,000 residential scholarships may be provided at the +2 level for SC/ST students in the best schools on a pro rata basis for each Matriculation Board, to be selected on the basis of performance in the Xth Standard Examination. Such students can become a national asset and a valuable pool for further selection not only for IITs but for other institutions also. We hope that steps would be taken soon to ensure that the students from these communities get admission on the basis of training and merit, and they are able to qualify JEE standards sooner without any relaxation. Some of the academically weaker students irrespective of the communities from which they hail must continue to receive attention of the IITs for additional tutorials and help.

4.8.5 Migration of IIT Students

One can hardly discuss the IITs without touching upon the phenomenon of migration of IIT graduates abroad. We did a questionnaire survey on this issue. On the basis of evidences received by us, we find that on an average about 20% of the IIT graduates leave the country constituting what the Prime Minister referred to as India's "Brain Reserve" abroad. We noted also that out of 80% remaining in India the majority engage themselves in managerial jobs and not in the engineering professions or in R&D; sector for which they are trained. We tried to understand the inadequacies, if any, in the IIT system which contribute to this phenomenon and the lack of the opportunities in the country, which causes migration. We addressed 1200 IIT alumni settled abroad, and obtained their frank views. Some indicated reasons for their migrating abroad. Some suggested how India can be benefited by their staying abroad in the forefront of Science, while a few others expressed their concerns as IITians settled abroad. Analysing their replies we felt that there are a number of ways by which the flow of trained IIT talents abroad can be mitigated.

It appears, that IIT students who leave India do not do so because they have some specific educational goals for which they perceive lack of facilities in India, but they do so primarily because they get attractive opportunities to do well for themselves in life. Only a small section of our students settled abroad is doing research work. It is evident that conditions in India have to improve such that will absorb Engineer-Scientists. We felt that some degree of compulsion is necessary at least so far as postgraduate products are concerned, for industry to absorb them.

Some of the replies from the students indicate that though the courses formulated in our IITs are good, practically no guidance is received at any time during a student's stay in the IIT, as to what the country needs from them technologically and how they could be useful to India's developmental effort. Currently the level of interaction between the industry and IIT is low and consequently there is a lack of awareness at the faculty level of what IIT students can do in the industry.

Some of the IIT alumni, on the other hand, have opined that any student who obtains education in an IIT which is highly subsidised, should have to commit himself in writing either to serve the interests of the Indian economy for a certain number of years, or pay back the full cost of education. Some have suggested that no IIT student be permitted to go abroad

unless he serves atleast three years in India in an area that is relevant to improvement of technology. They state that postgraduate education should not immediately follow the B.Tech. course. Eligibility for entry to a postgraduate course also should be after a minimum period of service. Alternatively the parents of the student or somebody has to stand guarantee that he will return to India to serve a minimum period as faculty in a University or in an R&D; laboratory or in the Public Sector Enterprise. We understand that the current cost of IIT education at B.Tech. comes to about Rs. 40,000/- per student per annum and no bond should be less than the actual cost of education.

These suggestions are valid. It will be necessary to consider steps to involve IIT graduates in Technology Development and Rural Development Schemes before they migrate. Necessary bonds can be taken with certain conditions.

But it is far more important to create opportunities in India for utilisation and career development of these and other bright students. IITs can identify bright students well before their graduation and, attract the attention of the High-Technology industries, specifically to absorb them in suitable positions where opportunities and challenges will be available or to adopt them as sponsored candidates while they are students so that they can join the industry at the end of graduation. IITs can also support these candidates and train them eventually for a faculty position. IITs' autonomy and flexibility may be used to evolve schemes whereby such talented persons can be sent abroad at IITs' cost for gaining experience in R&D; organisation etc. They can come back to the teaching profession. A deliberate plan for developing the career of bright students while they are still on the rolls of the IITs is the key strategy we would suggest rather than the punitive provisions of the legal bond later.

These students need additional exposure to practical situation in the industry for a better understanding of the country's economic reality. By and large the faculty of the IITs particularly the senior faculty members, do not exhibit a concern to contribute something worthwhile to the solution of country's problems. This unconcern of the faculty with the technological profile of the country permeates into their students. We also learnt that some of the faculty members of one IIT on their own decided not to give any letter of recommendation to their students for the first few years after their graduation for going abroad. They felt that in this way they underscore an important value system of the IIT graduate viz. serving the country first before going abroad.

IIT curriculum has distanced itself from actual industrial practices and IIT students are likely to have a cultural shock, when they go to the shopfloor. This is probably why most of them do not go into technological areas but prefer to go abroad or take up management posts.

The Indian industrial climate has not so far provided enough professional satisfaction for the bright IIT graduates. There is hardly any independent Research and Development. Some of the engineering services like the Post and Telecommunication Engineering or the Railway Engineering Service are so out-moded that no IIT student feels enthusiastic or willing to join. However, the situation is fast changing with government's emphasis on modernisation of industry through application of Science and Technology and one could expect a favourable climate to emerge soon enough.

The IIT syllabus though of a superior standard partly helps the process. Courses can be chosen by the IIT student where a combination provides an easy way of getting good grades and many who get good grades apply for higher studies abroad without any clear educational

goals. IIT curriculum and programme should be such that at the end of the graduation the student can tune into national problems and national aspirations, to the needs of environment and are motivated to serve the profession, rather than look for avenues abroad or to go for management or marketing which is more remunerative.

We recommend that IITs should conduct studies on their own on topics which affect them as institutes, such as the conditions necessary for retaining trained manpower in this country, the working of the S&T; policy, history of technology development particularly in India, relevant facets of human resource development. Topics like these should concern the Humanities and Social Sciences departments of the IITs.

We were concerned about proper utilisation of trained manpower graduates at bachelor's level from the IITs. We, therefore, commissioned the Association of Indian Universities to conduct a study on our behalf on payment basis. The study made by the Association of Indian Universities very clearly states that:

- The majority of B.Tech. graduates working abroad have emphasised that they have excellent opportunities to:

- (a) achieve their academic and professional growth;
- (b) get recognition of hard work, educational and professional competence;
- (c) experiment and apply knowledge in practice;
- (d) work in their own areas of specialisation.

-The opinion of respondents has indicated that more than economic benefits, it is the lack of opportunities to work in their area of specialisation and inability to experiment and apply knowledge that cause dissatisfaction among the graduates in their present jobs. However, in the case of those engaged in Teaching and Research and Development, it is the financial benefit which is the main cause of dissatisfaction.

- Analysis indicates that only 13 percent of IIT graduates (B.Tech.) are engaged in Research and Development in India. In contrast, 22 percent of those who have migrated abroad are engaged in R&D; sector. This indicates that R&D; sector in India has not been able to significantly utilise IIT graduates. Further, 25% of IIT graduates seek employment in marketing and management, where they hardly utilise their technical knowledge. Possibly, R&D; sector of Indian industry, needs to adopt a more progressive policy in order to utilise and provide challenge to the highly trained IIT graduates.

- At the national level policy initiatives appear necessary for strengthening Research and Development in industry in both public and private sectors.

Improvement of working environment in India with a view to highly trained technical graduates will broadly call for:

- (a) improving economic benefits;
- (b) providing opportunities and challenges for work in specialist area;

(c) employing persons in the right place and providing them with adequate facilities to experiment and apply their knowledge.

A copy of the study report entitled "Placement of IIT graduates". is available with the Association of Indian Universities, New Delhi. Much more detailed study has to be carried out regarding the usefulness of restricting migration of students especially in the context of lack of opportunities in India. A point on which no information is available is whether such migration takes place from other universities as well or is this a phenomenon confined to the IITs.

4.9 Faculty

4.9.1 Ambient Conditions for Work

Next to the students it is the faculty which gives an IIT Campus its uniqueness. Table 4.9.1 gives IIT-wise faculty strength since 1974. Section 33 (2) (b) of the IIT Act, enjoins the Council of IITs to lay down policy regarding cadres, methods of recruitment and conditions of service of employees. The Council at their meeting of 24th June 1974 defined the faculty to comprise only of Lecturers, Assistant Professors and Professors (including Associate Professors). Research Associates who have teaching functions were not considered as a part of the teaching cadre. Some IITs, however, include the latter in their faculty cadre. For the purpose of the report, we confine to the teaching staff (i.e. faculty) as defined by the resolution of the Council.

The faculty is at the centre of all that happens in an IIT. A faculty member is not merely to teach a pre-assigned subject but makes Education as an instrument of technological change. It is he who shapes the minds of those who are placed in his charge. He is his own peer-critic, with a special sense of commitment, to bring out the best from the IIT as an institution. He makes special efforts to interact with Industry and R&D; in order to evolve programme relevant to our needs. To be thus on the edge of excellence, is often by itself a compensation to his efforts and is self-satisfying. If such a faculty is frustrated or selected not on merit or not assessed for excellence, they cannot fulfil this expected role.

The development of excellence in an IIT depends on the level of excellence attained by its faculty. A condition-precendent is good infrastructure and the best of supporting conditions, but the work of the faculty must also be of relevance to the country. We felt that it was essential to discuss "Relevance" and "Excellence" in this context.

'Relevance'

There is no dispute to the premise that the IIT as a part of the public education system should have relevance to the socioeconomic realities and aspirations of the country. However, if relevance is interpreted only as requirement of the industry then many of the IIT activities would appear irrelevant to the present scenario. This is evidenced in the common criticism by the industry that the IIT education is largely theoretical and more useful to the developed countries. It is also reflected in the low demand for postgraduate specialisation in preference to general purpose undergraduate. We do not subscribe to this limited view.

At the same time there is a great deal of ambivalence about the relevance of IITs to the unorganised sector of Indian economy which consists of the vast majority of the rural population engaged in agriculture, crafts, cottage industry and tiny units of production as well as small-scale units of production both in rural, urban and semi-urban areas. Whilst there is intuitive acceptance of the fact that IITs should in some way relate to the economic improvement of this large sector, there is a lack of clarity as to which specific tasks the IITs can perform in this regard. The extreme view is that IITs have no direct role at all and they should not be wasting their time and resources in such fruitless projects. Some have seen it best to take part in the state plans for propagation of Science and Technology and provide consultancy to small units. Some have set up a miniature rural industrial estate where experimentation with conventional low rural-technology is carried out with no long term goal except perhaps to turn over to a cooperative of the people engaged there. Some others have chosen rural projects and extension work mainly in the agricultural sector.

We do not accept the view that the unorganised sector is not of the IIT's concern or that they should steer clear of it. At the same time we agree that the IITs should not and need not be doing the same thing as everyone else is doing. The domain of IIT is the application of Science and Technology. Each IIT should consciously choose from its environment areas and problems where such application of Science and Technology can relieve the back-breaking drudgery of primitive ways of doing things and make the operations more efficient, be it in construction of rural roads OF houses, water management or postharvest operations, cooking or lighting or the running of village smithies or foundries. There is no physical work in the routine of existence that cannot benefit from a touch of technology.

"Excellence"

The dictionary meaning of 'excel' is "do better than" or "be very good at". There is thus a connotation of high quality in absolute terms as well as a relatively higher quality in comparative terms. Relative to the Indian scene, IITs have undoubtedly a higher quality of students, teachers and general teaching than most of the other technical institutions but in absolute terms the excellence has to be measured relative to the state of the art internationally.

A more important consideration is, however, to maintain a state of excellence which continues to upgrade the knowledge and teaching skills of the faculty, the quality of knowledge imparted to the students as well as quality of knowledge produced by way of research and application of the Institute's faculty. This, therefore, adds a dynamic dimension to "relevance". The difficult question arises, therefore, of the ambient conditions, necessary for maintaining a state of excellence namely:

(a) The hygienic factors i.e. facilities for work and absence of hindrance to work:

-a reasonably worry-free living condition including recreational, medical and residential facilities;

(b) the motivating factors i.e. encouragement of good work and its recognition monetary as well as non-monetary; challenging problems;

(c) Continual communication of stimulus and response from other institutes of excellence in the country and elsewhere in the world.

Issues that are relevant to the growth of excellence are many, such as, financial support, climate for technology, institutional structure, inter-disciplinary effort and nucleation of excellence. The problem is multi-faceted and interesting and one can ask several questions in this regard, such as:-

-Are we continuing to attract a talented person in the formative stage of his career as faculty or research scholars into the IIT?

- Does the system permit creation of new openings for fresh talents and avoid inbreeding?

-Are we right in our policies, say, creating facilities for Ph.D. in the IIT? Or is this effort best concentrated only in a few selected areas?

We shall touch upon these issues in course of the report but let us first state what we gathered as the perception of the faculty, pertinent to these issues:

- All the IITs particularly in the early stages of development adopted policies of accelerated promotions. Therefore, there are a number of faculty members who feel today that they could be as good as Directors of the Institute. But there can be only one Director.

- It would require extra-ordinary courage on the part of the Director in such a situation to interact, create and sustain a climate necessary to bring forth excellence. Compromises alone ensure peace on the campus and continuous compromise breed mediocrity.

- It is a reflection of the value-system which recognise the post of the Director-which is basically administrative in nature-as apex of power and the most desirable assignment rather than the greater satisfaction to be derived from allowing national and international recognition as a leading academic in the field of specialisation.

- This is a feature in direct contrast to the academic institutions of the developed countries and is probably the outcome of the hierarchical bureaucratic structure and culture replicated in all government funded organisations- autonomous or otherwise.

- Academic leadership is weakening in the IITs and it should be the first concern of the Faculty and an autonomous academic community.

- Some faculty felt that there are very few individuals who have a standing of their own and are respected not only by their colleagues but also by outsiders. IIT's share in national awards and prizes is also dwindling.

- Many in the faculty felt that they did not have challenging enough tasks of national priority and publishing papers abroad appears the most visible goal.

- Members of staff also complained that they have become stale because they have no means to maintain contact with latest trends in research. They felt the need of more opportunities of exposure to different forums like seminars, refresher courses, industries, and other developmental activities in the country during sabbatical and summer holidays,

reimbursement of subscription to professional journals and payment of subscription fee for membership in the professional bodies.

- There is an urgent need to ensure campus peace. Any hindrance to work by any group of employees affects the entire tenor and tempo of work. Government could even consider disallowing strikes in such institutions.

- There is no reward system for good work and indeed there is no acknowledged method of measuring extraordinary achievement. There is no distinction between the non-performers and conscientious workers.

- The ambient conditions do not enthuse people to take up challenging work, but encourages them routine rather than creative work.

4.9.2 Faculty Assessment

Teaching and research are the primary functions of the IITs facilitated by efficient and imaginative administration. Service to the community and nation is also an inherent obligation. These four namely teaching, research, administration and public service are to be regarded as essential features of the academic activity.

Teaching:

Teaching in formal classes, in laboratories, in formal groups and conferences are all part of primary task of the faculty. Preparation for such teaching by keeping abreast of current developments and studying ways to present the subject matter more effectively means improving teaching skills. Participation in curriculum development and in preparation of syllabi, laboratory manuals, texts and other material written primarily for their value to teaching is another facet of teaching. Providing counsel, guidance and example to students is the duty of a teacher. Participation in student life to help them broaden their horizons and prepare responsible citizenship is an integral part of the teaching profession. Faculty assessment has to take note of all these aspects.

Research and Scholarship:

Research likewise comprises all forms e.g. contribution to scholarship resulting from research and study, including publications of books, and reports, contributions to academic journals, meetings or other activities of professional organisations.

Administration:

Members of the faculty are expected to share the burden of institutional activities such as participation in administration of the IIT e.g. as Dean, Chairman of committees, Head of the department, Head of the centre, membership on faculty committees, planning of institute-wise functions and formulating developmental plans of the IIT and contributing to the departmental administration. For senior members, the development of junior staff is a special responsibility. Participation in extension activities of the IIT and promoting inter-disciplinary i.e. interdepartmental effort are also expected of the faculty.

 **Public Service:**

The sphere of duties of the faculty extends outside the bonds of the campus. To mention a few-strengthen other educational institutions in India through the Institutional Network Programme, Joint Research Programme with institutions in India or abroad, participate in the faculty development programmes, solving specific problems sponsored by the industry in participating in activities of professional bodies and providing consultancy service or advice to the government and governmental bodies.

It is possible to evaluate teachers fairly accurately without subjective bias, once the areas of work a faculty is expected to cover are clearly known. The objective criteria have to be set by the IITs themselves and not by any outside body. It is essential to evolve accepted objective criteria of regular faculty evaluation in each IIT for several reasons:

- To eliminate or remove complaints of nepotism by selection committees which were invariably brought up by individuals and groups;
- To encourage and recognise good work and conversely to discourage indifferent work;
- To identify and eliminate ineffective deadwood which any system would tend to accumulate over time.

To talk of excellence would be futile unless there is continuous peer pressure for high performance standards, and there cannot be any motivation or incentive without an objective assessment system which can distinguish outstanding work from the average, irrespective of age or seniority. It is imperative for such a system to be accepted as fair and representative of the values and priorities of the entire faculty community.

After 25 years of existence, one might expect the problems of retirement and ageing in any institution and IITs are no exception. Table 4.9.2 indicates the number of faculty expected to retire in the next five years (the base year 1985) and next ten years. This has also been shown in Figure 4.9.2. In IIT Kharagpur and Bombay in the next 15 years nearly 80% of the faculty will retire. In IIT Madras and Kanpur in the next 15 years 30-40% will retire. Therefore, the problem of faculty retirement is more acute in the case of IIT Kharagpur and Bombay who need to take special efforts to recruit younger faculty. We have made some specific suggestions in this regard later (Para 4.9.3).

If some visitors to the IIT campus had remarked on the tired outlook of the senior faculty and their lack of enthusiasm, they were in fact only commenting on the absence of any significant peer pressure to rouse them to make some efforts for doing something meaningful. At the same time one could not also fail to notice a number of comparatively younger members of the faculty, who have the enthusiasm and willingness to experiment with new ideas; who are trying hard to achieve something special. Many of them felt, however, that the attitude of some senior members in the faculty is an inhibiting factor. It is necessary that the system demands the best from everyone young and old.

There were several perceptions regarding this problem of gerontocracy, if one may call it so:-

- The routine work of an IIT demands a lot of stamina to fight off its tiring effects. It might be necessary to compel the faculty to go at least for one semester to industries on a specific project or go on a lecture tour within India to other institutions for stimulation in a change of environment.

- It is more of a problem in India because of our inclination to a-priori equate age with wisdom and to accept the greater power of seniority in the establishment without much opposition, than is prevalent anywhere else.

- Stagnation occurs when there are no opportunities to refurbish one's talents, no pressures demanding excellence and no exposure to new ideas. These conditions have to be removed.

- Stagnation is not necessarily related to age. There are examples of senior teachers who continue to have active contact with current knowledge and are examples of life-long learning. There are also examples of relatively young faculty whose creativity dries up as soon as they reach an academic status.

- There will be some impairment in the activity of an elder professor because of age. The young entrants in the Institute should take up their work and the system must encourage such a handing-over.

- If a faculty member is not up to the mark, it is better to try him out of his department and find him an alternative work in administration or in any other engineering college or in other words 'ease' him out. The phenomenon of inadequacy in some staff members is to be expected in every institution and there is no perfect solution to this problem. Simultaneously recruitment of higher calibre faculty to the department may to some extent compensate.

- The primary symptom of gerontocracy is lack of interest. It sets in early in a system where there is little appreciation of efforts to develop excellence, where mediocrity is promoted and incompetent people find their way to higher position. Some refer to this as politicisation of IIT which results in frustration if not in the erosion of one's sincerity to one's job. If an IIT faculty has a three- in-one role-a teacher, a research worker and a consultant and he is expected to excel preferably in all the roles then this must be recognised and the system must reward him with better pay-scales, and better perquisites than in a standard teaching institution.

- It is necessary to recognise direct experience in industry and due weightage should be given to relevant experience in industry in faculty evaluation.

Like the employees the teachers in the IIT also have a scheme designated as the 'Personal Promotion Scheme'. It is on the lines of the flexible complementing scheme, but it virtually operates as an automatic Promotion Scheme. The word promotion itself is alien to academic culture and repugnant to the ethos of the academia; it is an intrusion from the governmental bureaucracy. We were surprised that many teachers who demand autonomy for the IIT as a superior academic body and criticise bureaucratic interference have also become supporters of this bureaucratic invention of promotion within the academia. In fact many in the academia wished to be equated to a Secretary of the Government of India or similar ranks in the bureaucracy.

It is unfortunate that the recommendations of the Committee set up by the UGC under the chairmanship of Prof. Sen who was the Chairman, Board of Governors, IIT Kharagpur till his death, were not implemented. An important requirement of an IIT is that there should not be large scale stagnation. Just as the IAS cadre has more posts in the senior scale than in the junior scale IITs too can have more Professors than Assistant Professors or Associate Professors. It is important to judge the right time when a person is due on merit for promotion and promote him and this is possible in the IIT where there are no fixed number prescribed for each grade. But such promotions should be on merit and not automatic.

The current practice of promoting everybody in the faculty and "finding a berth for your brethren" is no substitute for a wholesome method of faculty evaluation and can never lead to excellence. Even the current personal promotion scheme could be improved by relating performance to several factors such as continuing education, consultancy, industry R&D; etc. There should be constant motivation to retain excellence and help those who have reached a plateau, to shift themselves to other pastures. There should be an urge to select fresh blood for new positions. The IIT faculty have asked for higher salaries and benefits. This is legitimate on the ground that a professorship in the IIT is very special. This demand can be sustained only if the IIT system can demonstrate that it not only bestows professorship only on the ground of high standards of academic performance, but that the system is equally strong in condemning the non-performer if not rejecting him altogether.

We realise that given the present climate, weeding out is hardly possible without a good measure of support from the public and the government but we do recommend strongly that such support be given because one cannot deserve excellence from the IIT without the corresponding feed on to ease out the poor in quality.

But this commitment must be institutional and Faculty Associations too must demand it. The current practice of recruiting generally from within the same IIT does not seem to indicate that the faculty are concerned, about excellence and aware of the dangers of inbreeding.

A number of ways are open whereby a teacher's lot can be improved:

- Currently they are not entitled to medical benefits after retirement. This may be relaxed.
- They could be given more generous terminal benefits.
- Membership to two recognised professional bodies upto a ceiling may be borne by the IIT.
- A book/journal allowance up to a ceiling could be given.
- Loans for house building could be given more liberally.
- Medical benefits may be extended to hospitals run by the Government.
- Providing funds for greater participation in International and National Conferences of relevance.

A faculty member now joins the institute at the age of 25-28 years as a lecturer, and as the existing scales do not attract sufficiently qualified people, a number of advance increments are invariably granted at the start, so the end of the scale is reached in two to three years. It is

much better, in these circumstances to recruit at the initial level of Assistant Professor's cadre, but with no advance increments. There should be a self-assessment report by each faculty and their performance regularly evaluated. In the IIT a person could become a Professor at the age of 35 years and there may not be much motivation thereafter. One way to avoid it is to always operate at the bottom of the scale, so that the faculty will earn increments during the full span of the scale. We recommend also that awards by professional bodies should be recognised as an incentive for teachers to aspire and to do their best.

4.9.3 Attracting Competent Youth as Faculty

The IITs presented to us that they are facing serious difficulties in their efforts to recruit young and competent faculty. With large scale retirement due there is a genuine anxiety that the academic functions now being carried out in the IITs are literally in danger of a collapse, unless a vigorous drive is now launched to attract competent youth in several emerging disciplines and the IITs are able to retain them in their faculty. It was presented to us that it is not good enough to identify and choose a limited number of research scholars or academicians already in the Us and appoint them but if one has to keep up excellence, it is far more important to locate and attract many competent people from outside the IIT system. It is such outstanding outsiders who could promote inter-disciplinary research and contribute to the excellence of the Institute. IITs must, therefore, constantly attract people from divergent specialities. Several persons represented to us that IITs should, within their overall staff strength, be able to invite experts and outstanding and successful scientists/engineers from Industry or R&D; organisations etc. for adjunct and visiting faculty positions. We fully support that it is necessary to concentrate on this problem seriously and prepare a plan for the next few years with a view to bring-in young and outside talent.

Better Salary Scale and Perquisites

We sought the opinion of many in India and a number of experts abroad who assisted the IITs in the earlier years, on many aspects of the IITs. On the question of attracting bright young men to the IITs, some of their views are:

- Better salary, money and perks do attract young men, particularly those working in institutions abroad. They are also attracted by the designations offered and the freedom given to them to apply their experience in the Indian context.

In order to attract bright young people, IITs should consider:

- (a) Paying them substantially more money on salaries and providing them with necessary equipment needed for advanced research;
- (b) Giving them special status and support funds for relevant research work;
- (c) Making their job prestigious;
- (d) Permitting them to go abroad and be in touch with new trends and new environment;
- (e) Exposing them to Indian industry and R&D.;

- The problem of younger people is organisational. It is necessary to maintain their enthusiasm and allow them to be promoted on the basis of their personal success. At present IIT promotes more by seniority and hardly by merit. This provides no incentives to young outsiders;

- More than the salary, the young faculty is attracted by funds available for their research work, and adequate equipment, and provision of research scholars to-work with them. Widening of activities, such as research projects for industries, which incidentally adds to one's income, will be a plus point.

- The advantage of an occupation in the academic profession cannot be equated with the financial rewards or advancement available in the industry. Most teachers are attracted by the satisfaction they get from a transfer of their own knowledge and ability to the next generation, the possibility of developing new measuring methods and equipment formulating and testing new models or theories. It is this basic commitment that should be looked for and once a teacher is recruited he should be given all incentives financial or otherwise to retain this commitment.

- Faculty members should be given fringe benefits to the maximum extent possible. We have already mentioned book allowance and membership of professional bodies. Even a small amenity like a telephone at the work place can give immense satisfaction.

-At the time of starting of most IITs, faculty pay was better in comparison with those prevailing in other technical institutions in this country. That is how many competent and committed teachers were attracted to join IITs. Over the years IITs were unable to attract quality teachers. The main reason is the application of revised scales of pay on the basis of the UGC model to the IIT system. This levelling of the IITs to the common denomination could not but imply encouragement of mediocrity. In fact others now get more money separately for examination or for extra teaching. It is important that IITs are not equated with the UGC system, if they have to be special institutions.

-Even public sector organisations revised their pay and raised salaries whereas IIT faculty pay scales have remained static for over a decade.

-IITs were not even equated with the other professional teachers like the teachers in the medical institutions. These escaped the levelling down of the UGC system merely because they were not under the same Ministry of Education. It is apparent that the authorities were more concerned with uniformity than with fostering excellence. This distinction must be faced squarely now.

-While IIT faculty get the same pay scales as any other university teacher, it is claimed that work load of a university teacher is far less.

-The argument for removal of differential of salary scales between IITs and other university institutions is that differences promote inbreeding and reduce mobility between. On the other hand it can also be argued that flow between institutions occurs only when there are different scales of pay in much the same way energy flows between different gradients. If anything, it is this single instrument that attracted talent in the earlier years. It is the revised pay scales introduced from 1973 that brought difficulties to IITs in the way of attracting calibre and competence to their fold.

- IITs are sought to be measured against prestigious institutions abroad but not many professors have even a telephone available at work. Many do not have the facility of a typewriter where they can type themselves and many such minimum facilities for transacting their academic work. It is necessary to give these facilities which go to save real time.

- If we look into other prestigious institutions abroad, the MIT pays a lower salary than most of the other universities but compensates the staff by the emoluments which they get from sponsored projects. Therefore, it is necessary for IITs to generate more sponsored income.

- IITs need not necessarily have a regular pay scale. If IITs are to be special, their pay scales should be different sometimes less, sometimes more. It is the flexibility available with them that should be utilised to award additional amounts for commendable work acknowledged by the academic community.

- If salary differentials are not possible, perquisites could be increased. For example, the faculty can be given free housing or free electricity or water supply.

- An argument in favour of higher pay for IIT teachers which we found difficult to refute runs as follows. IIT professors when they go abroad easily earn \$ 60,000 per annum as they are internationally competitive. This cannot be said for all the teachers enjoying UGC pay scales. It is this calibre of international competence that should be evaluated and a higher scale of pay, is justified. We pay our Airline pilots a higher pay because of international standards but we do not complain that their pay scales are too high compared to the Indian situation. Faculty who are internationally competitive should be regarded as an important resource paid for.

- Every teacher who publishes a full length paper in an international journal could be financed to attend in that year an International Conference.

-Since Institute Professorship has become unattractive financially, it would be worthwhile to get industries to endow projects with remuneration and perquisites comparable to what one obtains in the industry. This way instead of everybody being given higher pay there will be a selective reward for work of practical relevance to the industry.

Pay scales were revised for IIT teachers with effect from 1.1.1973 and the comparative pay scales existing prior to 1.1.1973 and after 1. 1.1973 cadre-wise are given in Table 4.9.3A. The comparative pay scales of persons in different positions are given in Table 4.9.31B.

While everybody in these sectors can aspire to the top most positions with higher pay scales available, people who are considered the best in Engineering and Technology and in-charge of production of excellent manpower do not have this opportunity. This is one of the reasons, which makes them feel that they have an inferior social status.

In addition to social status, in terms of real value of the pay scales and gross salary income, there is erosion. This is explained in Table 4.9.3C.

A UNESCO report on "Status of Teachers" published (1967) says, teacher's salaries should:

(a) Reflect the importance to society of the teaching function and hence the importance of teachers as well as the responsibilities of all kinds which they shoulder from the time of their entry in service;

(b) Compare favourably with salaries paid in other occupations requiring similar or equivalent qualifications;

(c) Provide teachers with the means to ensure reasonable standard of living for themselves and their families as well as to invest in further education or in the pursuit of cultural activities, thus enhancing their professional qualifications;

(d) Take account of the fact that certain posts require higher qualifications and experience and carry greater responsibilities.

The IIT teachers have a research obligation apart from teaching which the University teachers may not have. Nor can they be given scientific pay scales because they are not mere research workers. We recommend that salary scales and attached 'perks' be made more attractive, maintaining a differential between IITs and other related Institutions.



Need for a Clear Personnel Policy and Policy Support Measures

A number of presentations were made to the Committee in the area of personnel policy and policy support. The following points were made:

- The only effective measure to attract good faculty is a clear personnel policy, discipline among all staff and a working atmosphere. There should also be a policy of discriminate funding according to efficiency and output and not, as now obtains according to the senior position of Professor or according to the number of persons in a Department. This way younger people could be attracted, because they could hope to be funded on the basis of their merit and performance, and, not on the basis of their relative seniority.

- Conditions of work have to be made attractive. In particular sufficient free time should be given for the faculty to pursue their own research with least cumbersome procedures to enable them to get what they want for their academic advancement, be it purchase of a new equipment or attending an international conference. They also need clear spelling out of and what is expected of them, in simple language and adoption of conduct rules suited to the role so defined.

- The attributes expected in the faculty, as a group, are creativity, professional competence, leadership, ability and desire to teach, and, willingness to cooperate. It is, therefore, the duty of those who are administering the policies in the Institute and within the Department to ensure that a proper balance of attributes exists among a faculty group.

- IIT faculties appear to be getting under the shadow of mediocrity, professionally. There are hardly any names from the IIT in professional awards or activities of the professional bodies. They have to establish their professional competence and policy support is necessary to prime incentives for higher achievements.

Considering all these, we feel that personnel policies regarding faculty have to be clearly stated. Among other things such policies will specify the method of recruitment, obligations, rules governing outside professional activities, their responsibilities, salary and benefits, their sabbatical leave and other leaves due, retirement benefits, procedures for settling grievances, housing, medical, and other privileges and rules governing patents and discoveries etc.

Similarly, it is necessary to clearly specify policies regarding:

(a) Research staffs the procedures for appointment of staff, emoluments, benefits and their tenure;

b) Graduate students (including Lecturers, as recommended by us in this report, Para 4.9.4), Teaching and Research Assistants-their appointments, benefits and objectives.

It is also necessary to define the inter-relationship between various academic staff such as faculty, research staff & graduate students and relating their roles to goals and charter of the IIT suggested by us. Personnel policies should not only be clearly spelt-out but widely made known amongst all affected.



Building More Faculty Accommodation

A point repeatedly made before us is the shortage of faculty accommodation. Table 4.9.3D indicates IIT-wise appropriate housing available against each category and the extent of shortage. In some of these cases the sanctioned strength is a total figure and not a figure for each category. The shortage indicated is, therefore, the total shortage of housing available against the sanctioned strength of Director, Professors (including Deputy Director, and Associate Professors), Assistant Professors and Lecturers. Housing shortage in IIT Bombay in the category of Professors and Assistant Professors is acute though they have a surplus of faculty houses in the lecturer's category. They have an overall shortage as well. In the case of IIT Kanpur the housing shortage with regard to Professor and Assistant Professor is also acute though there is a marginal excess in the case of lecturer and overall shortage in the case of all faculty.

Some of the points made in this regard are as follows:

- The interaction between IITs and high-technology science groups, the industries and research organisations do not take place because of lack of housing facilities.
- Shortage of faculty accommodation is the biggest handicap to recruitment of new faculty members specially those willing to come from abroad.
- A good way to attract the younger people is to offer liberal house-building loans.
- Just as the biggest bottleneck in attracting young faculty is paucity of accommodation in the same way the biggest frustration facing senior people is the difficulty they have in building their own residences.
- At present there is only transit accommodation available in many campuses which is insufficient to attract younger people to newer faculty positions.

We shall draw reference to the recommendation of the Scientific Advisory Committee to the Cabinet (SACC emphasizing the need for full residential accommodation for the scientific community. Teachers in the IITs who contribute to the core Research and Design development and are expected to maintain contact with the laboratories and students day and night should also be eligible for benefits of the recommendations of the SACC. Each IIT should plan in the current Five Year Plan (1985-90) the accommodation needed for the faculty. There are two possible solutions, namely:

(a) IITs could lease a suitable part of their estate, to an Estate Developer, on a nominal fee but on certain conditions, e.g. that he should build appropriate flats on multi-storeyed building and that 75% of the flats should be available to the faculty on the rolls of the Institution. These flats should be continuously available to the IIT. The remaining 25% can be left to the Estate Developer to rent to outsiders. IITs should compensate the faculty for the differential between the rent actually charged and what is due from the teachers.

(b) IITs should acquire in the vicinity, till full housing facilities are created, as public sector organisations do, a number of suitable flats on lease contract directly from the parties concerned. These flats should be available to the faculty who should be expected to pay prescribed percentage of the salary, the balance being paid by the IIT.

In any case we are convinced that making more accommodation available for teaching staff in IITs is urgent and essential. In addition we would suggest that wherever loans are extended to the faculty to build their own houses they must be compelled to move to their own houses or else they should be penalised for not moving out to the extent IIT pays to a similar faculty at the market rates. Merely following government rules by allowing teachers to remain in the campus, while their houses fetch a high rent would not be valid because the critical need of IITs is to attract young faculty and retain them. This is not a critical issue in the government service.

We, therefore, recommend that steps be taken to ensure faculty residential accommodation. If it is not feasible to build new flats, alternative arrangements like leasing to estate developers should be explored.



Faculty Development-an early beginning

In addition to the foregoing measure we would suggest looking out for younger talents even while they are students in the IITs, and, moulding them for teaching. In the early years the Ministry of Education started a Technical Teacher's Training Programme (TTTP) to catch bright young graduates and train them as teachers in India and abroad. In this regard we received a number of views and some of them are as follows:

- Capable young men who are abroad should be invited to apply and not required to appear before a Selection Committee. They could be evaluated by the IIT faculty members or their peers in India or abroad. In the same way, the peers abroad be encouraged to recommend candidates from several sources, personally known to them.

- Currently there is considerable inbreeding in some of the IITs. 22% of Professors, 62% of Assistant Professors and 75% of the Lecturers had Ph.D. awarded by the same Institute where they joined as faculty.

- There is no faculty development programme for IIT teachers. A conscious development for faculty position would mean that a bright student is given advantages to complete his education faster and encouraged to go at the Institute's cost to developed laboratories abroad and come back and start research work for which Institute funds him sufficiently. This type of specific encouragement would retain the best of students in the teaching profession. The top-most graduates, who go abroad in any case, could be offered this encouragement.

- Take a fresh B.Tech. student, give him five to seven years contract during which he gets a Ph.D. and a good salary quite comparable to what he would get in the industry. But he is not eligible to take any job in the IIT, unless he has had five to six years of institute experience. He is exposed to industrial experience, part-time teaching and research experience and thus develops into a good teacher. This investment is worth making.

Talent Spotting

The first step in attracting young faculty is to look for them and find them. The current system of advertising and selecting mostly from the same IIT does not appear to have added on to their pool of scholarship. Scholarship is best stimulated when divergent, critical and high quality minds interact. Such persons may not often respond to advertisement. In a few cases there have been promotions of teachers from other IITs but fresh recruitment of young people from other systems are getting less and less. This is a matter of concern. Table 4.9.3E gives the number of people selected in IITs category-wise during the period 1974-84. In the case of IIT Bombay, in the category of Professors, out of 94 people, 83 were selected from IIT Bombay, among Associate Professors out of 53, 49 selected from IIT Bombay, in the case of Assistant Professors, out of 175, 119 were selected from IIT Bombay, in the case of Lecturers which is the base recruitment level, out of 100, 19 were selected from IIT Bombay. In IIT Delhi in the category of Professors, out of 102, 88 were recruited from IIT Delhi, among Assistant Professors, out of 185, 130 were recruited from IIT Delhi.

It was suggested to us that promotion procedures including accelerated promotions should be delinked from the process of recruiting new faculty members. One way is to assign each year 25% only by promotion and the other 75% by recruitment of outsiders. This idea is worth examining by the Council of IITs. Equally important is the need to look outside for candidates, especially Indians abroad. A number of them could come to India, who might not have seen the advertisement but known to IIT faculty for their talent and scholarship.

We recommend that no Ph.D. scholar of an IIT should be eligible for consideration in the same IIT at least for five years since his getting Ph.D. He must go for an outside exposure and experience. We are recommending (Para 4.9.4) also that the position of a lecturer is not to be carded position, and lecturers will henceforth comprise Teaching Assistants, Research Assistants and Ph.D. Scholars.

Interviewing alone cannot be an adequate way to judge their capabilities. Assessment made by peer groups or friends abroad should also be available. When senior persons including Directors go abroad they could personally judge and bring the bio-data of working Indians abroad, views about their talent and knowledge about their work to the IIT authorities concerned, for appointment. In short a vigorous hunting for first rate candidates is more necessary now in order to keep the freshness and vitality in the system going.

At present people do not respond to these advertisements because they perhaps feel that these positions are advertised to regularise candidates from inside. Advertisement must say clearly and specifically that these vacancies are reserved for candidates other than from inside.

4.9.4 Teaching Cadre to Start from Assistant Professor's Rank

At present IITs have, according to the Visitor's orders, a three-tier cadre of faculty viz. Lecturer, Assistant Professor and Professor. In the cadre of Professors some are in a lower segment of the salary scale with a title of Associate Professor. IITs are free to determine within the overall staff strength number of Professors, Assistant Professors, etc. needed by them from time to time. Nevertheless over a number of years most of the IITs have gravitated towards an inverted pyramid having a larger number of Professors and practically no Lecturers.

IITs also have the problem of attracting qualified candidates for the position of lecturers. Lecturer in an IIT gets the same scale of pay like that of any other engineering college (Rs. 700-1600) though he is expected to excel both as a teacher and as a researcher. This situation has come about when the IITs adopted the UGC scales of pay from 1.1.1973 even though at that time their scales of pay were far better than similarly placed teachers in other Educational Institutions. They have now nothing special to offer; many young teachers get a better pay even in a local college. It is difficult to correct this situation. We therefore, feel as an important step, this three-tier faculty system must operate as Assistant Professor Associate Professor and Professor. Their relative pay scales and numbers should be determined by the Council of IITs. When a person is appointed in an appropriate pay scale no advance increments need be given. IITs should be given proper pay scales and everyone should start at the lowest end of the scale.

With the abolition of the Lecturer position suggested by us it is important to note that the grade of lecturer goes out of the faculty cadre. Lecturers then will be drawn from IITs' own Ph.D. scholars, Research Associates, Teaching Assistants etc. They may be all on contract and will assist teachers in several ways. We would, therefore, like to define the terms "faculty" and "lecturers" as follows:

- The term 'Faculty' will include Professors, Associate Professors, and Assistant Professors only, having full time appointment in the IIT and other positions created like Adjunct Professor, Emeritus Professor on part-time basis. The term faculty will not include Teaching Assistants and Research Associates.
- The term 'Lecturer' will consist of non-cadred positions like Research Scholar, Research Associate and Teaching Assistant. Lecturers will assist the full time faculty in grading test, class rooms and laboratory instructions, preparing apparatus and material for conducting tutorial and discussion sessions.

It will be the responsibility of the IIT faculty like Professor, Associate Professor and Assistant Professor to groom Lecturers to take up teaching positions not in their own IITs but in other institutions. Nobody should be retained as a Lecturer for more than five years but usually for a period of two to three years. Lecturers will not thus be regular employees of the institute getting benefits accruing to permanent employees. We anticipate that IITs in order to remain dynamic and able to fulfil goals we have indicated may have to create a number of

positions in the scientific and technical areas. It would be necessary to spell out the purpose of these positions, their relationship with the faculty etc. whenever such posts are created.

4.9.5 Mobility of Faculty

We have been emphasising in the report the need for a cross flow from one IIT to other IITs, to other Engineering Colleges, to R&D; organisations, and the industries. Apart from lack of housing, which has been discussed (Para 4.9.3), one important reason is either denial or long time taken for faculty to carry benefits of their service including terminal benefits etc. to wherever they move. The problem is relatively easier to solve and must be resolved.

Mobility of teachers within profession, between one institutions to another, encourages cross-fertilization of ideas and exchange of varied experience. This process encourages innovation and involvement of teachers as a group. However, the sectors to which these teachers move, be it Engineering Colleges, Industry or R&D; organisations, are likely to have different pay scales. It is not possible always to demand uniform scales of pay nor are they necessary. Therefore, we also recommend that they must carry the benefits of scales of pay in the parent institution. They should be permitted also to opt for better benefits so long as the recipient or parent organisation is prepared to pay for it. Similarly a teacher from another institution or from another organisation should be paid in the IIT the higher pay scale as long as he is useful to the IITs. Difference in pay scales should not become a block to mobility.

There are other constraints to mobility. Some of them are personal and some are professional. IIT staff should be enabled to remove these personal and professional impediments. We are aware that there are personal impediments like education of the children, housing problem in the new environment. Gaining the trust of a new group or a colleague in a new environment can also be seen as an impediment. Encouragement should be given so as to remove these difficulties and foster mobility.

There is a need to devise a mechanism that encourages, and rewards mobility between various sectors. With this in view we suggest that there must be a National Pension Scheme. Governmental support to such a plan is necessary. All faculty should be eligible automatically to such a scheme. The scheme can work on the following model. A teacher will carry a national pension record. Wherever he serves in segment, approved by the Council of Institutes of Technology, his actual service is recorded. He only carries a record of his service duly attested which is to be interpreted as a commitment of any organisation where he is serving to pay their share towards his terminal benefits. With such a scheme an IIT faculty should be able to move freely to R&D; organisation, industry, other engineering colleges and institutions. The last organisation from which he retires may pay to him on the basis of the service record all his terminal benefits and claim back from other organisations their respective shares. We consider this as an easily implementable measure which will encourage mobility.

SUMMARY

IITs should continue to offer both undergraduate and postgraduate programmes. (Para 4.1.2)

The student strength of undergraduate and postgraduate courses should be aimed to be maintained at 1:1 ratio. (Para 4.1.3)

The overall student strength at any one campus should not ordinarily exceed 2500. (Para 4.1.4)

Instead of starting new IITs, wherever higher technical manpower is needed, support to Departments/Engineering Colleges/Centres who have done well, is recommended. (Para 4.1.5)

B.Tech. level programmes in the IITs should aim at:

- greater flexibility and actual availability of a wide choice of electives;
- new technology and system involving cross-disciplinary perspectives;
- experimental and innovative programmes to foster creativity; - maintaining a science-based engineering curriculum. (Paras 4.2.2 to 4.2.4)

M.Tech. programmes must be carefully chosen and designed to serve the following objectives:

- prepare teachers for engineering education;
- provide trained manpower to industry with the capability to influence upgradation and absorption of technology and setting up of new high-technology industries. (Para 4.3.1)

We endorse the recommendation of the Postgraduate Committee that the M.Tech. degree be prescribed as a minimum qualification for recruitment to many positions in the engineering profession in industry, R&D; organisations, Electricity Boards, PWDs, Post and Telegraphs, Railways etc. The present policy and practice of recruiting graduate engineers at the lowest levels (single point entry) to many services should be modified to allow for lateral entry at higher levels. As an incentive and mark of recognition it should be mandatory to give not less than two advance increments wherever postgraduate degree holders are recruited. (Para 4.3.2)

Conscious and concerted effort is needed to excel in research activities so as to be in the forefront of research in atleast a few of the emerging areas, and to build competent research groups of international standing. (Para 4.4.1)

The impact of the IITs through research and development activities has not been conspicuous for varied reasons, including the unpreparedness of industry, policy support for technology imports and foreign collaboration and non-involvement with development-oriented projects. Conscious and positive steps should be taken to make the presence of IITs felt in this area. It is recommended that:

- an Industrial Foundation independent in its normal day-to-day functions, may be set up in each IIT. It should work as a commercial corporate body with its own budget and Plan for marketing its research and consultancy capability (CSIC of the Indian Institute of Science_ Bangalore is one example);
- IITs may get involved in setting up innovative centres, S&T; parks, industry owned research centres etc., adjacent to the campuses;

- faculty members may be encouraged to become entrepreneurs taking three year leave following the CSIR pattern. (Paras 4.4.2 to 4.4.6)

IITs either directly or preferably through the proposed Industrial Foundation should compete for and get plan assistance from Department of Science and Technology (SERC and GRS), Department of Electronics, Department of Defence Research, Department of Energy and others to do research and consultancy work in identified "thrust areas" in the national S&T; plan. (Para 4.4.7)

A number of "thrust areas" have been identified and a synoptic view given on them by faculty of IITs. These should be examined by the Academic Advisory Committee of the IIT Council. Internal and external funding of these projects is recommended. (Para 4.4.8)

IITs should have greater interaction between themselves and with outside educational institutions, universities, CSIR and other research laboratories, taking a lead in technology missions of national priority. Industry-Research-Education should become a closely linked triad. (Para 4.4.9)

Besides the newer areas of high technology in the emerging fields, IITs should also take up research and development activities related to the environment in which they are located. If successful, the impact will be more visible and the role of these higher seats of learning will be well appreciated by the community.

It will also condition the student to relate to his surroundings. It is recommended that:

- public service in some meaningful form should be organised for participation both by the teachers and the taught;

- the IITs should diagnose problems/needs of nearby rural community and work on their solutions through application of technology;

- the IITs should enlarge their interaction with other technical institutions and colleges in the region. The interaction can take varied forms. A periodical review of the above functions should be carried out. (Para 4.4.10)

Industry-IIT linkages have to be strengthened considerably. There are now a number of technology-oriented industries who are appreciative of the importance of the linkages and inclined to cooperate fully in giving access to the facilities and resources available with them. It is recommended that IITs (through Industrial Foundation, as and when it is formed), take more positive steps in this direction to remove the shortcomings. (Para 4.5. 1)

To promote greater linkages between IITs and Industry and IITs' involvement in national development projects, it is recommended that:

- Faculty should spend compulsorily one of their sabbaticals in industry;

- IITs should invite competent persons from industry to be adjunct professors;

- IITs should be involved in technology missions connected with national development projects;

- The government may extend tax concessions for contributions made by the industry to IITs. (Para 4.5.2)

IITs should also undertake technology surveys. IITs should have some association with bodies like DGTD, DOE etc. who regulate import of technology. (Para 4.5.3)

It is recommended that IITs use their facilities more intensively to spread education. Some of the suggestions are:

-evening classes in some specialised subjects for employed persons;

- Continuing education through seminars and other programmes. (Para 4.5.4)

A large number of programmes at undergraduate and postgraduate levels are being offered by the academic departments and school of studies. While this is as it should be, some important points have to be borne in mind:

- Programmes should be reviewed periodically and updated and modified to match with the needs of the country, and the developments in Science & Technology. New programmes (like Bio-science) may have to be introduced as interlocking/supporting ones to produce doctoral manpower to work on "thrust areas" and leading edge of technology.

- Doctorate degrees may be offered on work relating to developmental projects, hardware, experimental work, instrumentation etc.-areas in which the IIT faculty seem to have an ambivalent attitude.

- Programmes be shifted from the traditional areas towards inter- disciplinary ones like Materials Science, Energy System, Instrumentation etc. These should be normally offered as postgraduate programmes. Over the years separate undergraduate programmes in these areas be evolved, giving up the traditional areas. In the early stages, these postgraduate programmes of inter-disciplinary subjects can be based on elective course structure instead of starting a separate department/centre for it.

- Innovative ideas should be attempted such as starting of integrated five year course leading to M.Tech. Degree; and modular courses to give students greater flexibility in transfer between institutes and to change disciplines.

- Modern teaching aids like audio-visual, computers etc.to be increasingly used. (Para's 4.6.1 to 4.6.7)

Academic departments in the IITs handle both teaching and research. The number of departments vary from IIT to IIT-largest at Kharagpur and smallest at Kanpur. It is recommended that such departments whose load is below an optimum level and not likely to build up in the near future, should be either closed or merged with another department. This will help utilisation of scarce resources, better elsewhere. (Para 4.7.1)

Departments should have more autonomy delegated to them and run them with their own committees of management. (Para 4.7.1)

'Centres' were started as nodal points to foster research and become peak points in some selected areas of importance, generally inter- disciplinary in character, drawing talent from other departments, other IITs and from outside organisations. The tendency for Centres to function like any other academic departments has to be curbed. An immediate review and evaluation of all Centres is necessary to ensure proper focus and character. New centres may be established only after proper assessment of the need by outside expert groups. An inbuilt mechanism for periodical evaluation of every centre is also suggested. (Para 4.7.2)

Students are inducted into undergraduate courses through the Joint Entrance Examination (JEE) barring a very small number who are either Foreign Nationals, or Indian Nationals residing abroad. While this test has been well-developed and is able to pick up high calibre students, it has been noticed that some of them do not have any marked inclination for a profession in engineering/technology. It is recommended that this entrance examination scheme should be refined by evolving and introducing an aptitude test. (Para 4.8.1)

For inducting into postgraduate courses, recently a Graduate Aptitude Test in Engineering (GATE) has been introduced. Though this is being organised by IITs, it is not exclusively for entrance to IIT postgraduate courses; nor, is it compulsory that all should come through this test. It is necessary only for those who want scholarship from government. Sponsored candidates normally do not take this test. It is recommended that this method of multi-entry should be watched for some more years for its efficaciousness. (Para 4.8.2)

Both JEE and GATE are being conducted at present by the IITs. There are both scope and need for a specialised national testing agency. The task of selection by IIT authorities to their B.Tech./M.Tech. programmes could become lighter and more meaningful if restricted to a smaller number from among those qualifying in the national test. (Para 4.8.3)

Special dispensation is being given to SC/ST candidates admitted at the entrance through JEE. In this context, it is recommended that:

- this be continued while at the same time ensuring that positive and effective steps are taken to coach them up before the start of the very first semester;

- while every attempt should be made to fill the reserve quota fully, entry standards should not be further lowered;

- concrete and positive steps should be taken by bodies/agencies outside IITs to coach such of those SC/ST students who show promise, so that they can take JEE and get entrance on their own competitive merit without the aid of special dispensation. This can be undertaken by specialised agencies/institutions. (Para 4.8.4)

Steps are required to reduce the incidence of migration abroad of fresh graduates from IITs. This may be done through conscious career development planning for bright students, their involvement in technology missions and rural development schemes rather than rely on restrictive measures alone. The Department of Humanities and Social Sciences in the IITs must emphasise in the curriculum the socioeconomic ethos in which technology development is taking place in India, so as to inculcate distinct Indian values. (Para 4.8.5)

Faculty is the back-bone of these institutes. Necessarily they have to be highly competent and committed to teach, conduct and guide research, and interact with industry and society. It is

recommended that conscious efforts be continuously made to maintain an environment where excellence will be sustained and even enhanced.

The ambient conditions are:

- Reasonable facilities for work;
- Absence of hindrance by any section, specially the supporting staff;
- Motivating factors i.e. recognition of good work and posing of challenges;
- Continual communication of stimulus and response from other institutions in the country and elsewhere in the world and easy mobility between Education, Research and Industry;
- Involvement in national development programmes in the realm of high technology;
- exposure to challenges in technology missions and development projects of national priority;
- close coordination of technology imports, technology policies and technology manpower needs with education and research;
- Opportunity for extension/consultancy/research for both industrial and rural development;
- Encouragement of risk-taking in an atmosphere of trust. (Para 4.9.1)

At the start, IITs attracted an excellent faculty team, well qualified and committed. But with passage of time gerontocracy is likely to be established. Added to it, is the deteriorating environment with increasing indiscipline, constraints on resources, etc. It is time, steps are taken to arrest this trend. These steps are:

- a strict and objective assessment of all faculty against well-laid norms; mechanism and criteria needs to be developed by the IITs themselves with expert assistance, if necessary;
- give special status and additional 'perks' to highly merited people and at the same time 'ease out' those who continue to perform poorly. (Para 4.9.2)

IITs are not able to attract, retain and motivate high calibre young entrants for the teaching profession. Bright students are not coming to study M.Tech. and Ph.D. courses. A large number of faculty members are due for retirement. All these will reflect on the future of IITs. It is, therefore, recommended that:

- Salary scales and attached 'perks' be made more attractive, maintaining a differential between IITs and other related institutions;
- introduce a clear personnel policy;
- Steps be taken to ensure faculty residential accommodation. If it is not feasible to build new flats, alternative arrangements like leasing to estate developers should be made. Lack of accommodation discourages new entrants;

- At the undergraduate level, bright students who show aptitude for teaching should be spotted and groomed for service. They should be specially trained to Ph.D. level, sponsored for specialization abroad and during the senior studentship phase, be given a teaching assistantship;

- The present method of selecting faculty by advertisement alone should be supplemented by active search' for talents; as is done by some corporate bodies, with a determination to induct fresh blood into the system. (Para 4.9.3)

The Committee recommends that a Ph.D. from the same IIT should not become a member of faculty till he has served outside for a period of not less than five years. Similarly lecturer in an IIT should be encouraged to go out to other IITs or institutions before he is taken in the same institute. (Para 4.9.3)

IITs should have the cadre of Associate Professor in the three-tier system of Assistant Professor, Associate Professor and Professor. Lecturers will comprise of Research Scholars/Associate Scholars and will not be part of the faculty cadre. They could be employed on contract for a trial period of two to three years and in no case exceeding five years. (Para 4.9.4)

Mobility of faculty, between IITs, R&D; organisations, other engineering institutions, and industry needs to be deliberately fostered. Impediments to such a mobility need to be identified and steps taken to remove them by introducing measures like National Pension Scheme, carrying the privileges, seniority, pension etc. wherever a person moves. (Para 4.9.5)

FINANCE AND ITS MANAGEMENT

◆ 5.1 Plan Funds

◆ 5.1.1 Areas for Which Funds are required

All the IITs presented to us documents containing their estimates of requirements for the Seventh Five Year Plan. Table 5.1.1A gives Seventh Five Year Plan requirements item-wise IIT-wise. The total Seventh Plan requirements of the IITs included in these estimates come to Rs. 258 crores. The estimates range from 67 crores of IIT Kharagpur to 38 crores of IIT Bombay. The activities proposed by the IITs cover strengthening of the departmental activities, work on thrust areas and emerging areas, augmenting central facilities, making good critical gaps in infrastructural facilities including housing and campus development. The total equipment requirement is indicated as Rs. 85 crores. The recurring expenditure estimates for faculty and non-faculty including working expenditure totals Rs.40 crores for all the IITs. During our visits to the IITs, they presented to us detailed descriptions of their current and future work programmes. They emphasised that their work programme in thrust areas and emerging areas are increasingly related to the priorities identified in the S&T; core sector. There can be no two opinions about this thinking and approach. We feel that the IITs must be consciously and adequately supported and enabled to achieve their potential by provision of the needed infrastructural facilities and promoting conditions for excellence in research. To this extent meeting the plan needs of IITs become critical, for, it ultimately contributes to the S&T; components of the national perspectives in particular and 'National Development in general. We are, therefore, happy to see that the enthusiasm of the IIT faculty for work in the leading areas of thrust. While their Plans have to be examined in detail by the Academic Advisory Committee of the Council of the IITs (Para 6.1.2), we would emphasise that their critical requirements need special support basically in four main areas.

The first aspect of their plan requirements is the removal of obsolescence and updating their equipments and other experimental facilities. The IITs were set up over 25 years ago and the oldest of them, IIT Kharagpur, did not receive any substantial foreign assistance. Their equipment including instruments in the laboratory became increasingly obsolescent over the years thereby impairing their ability to remain as leaders in Research and Development and Consultancy work. This has been prominently brought out in the Sahai Committee Report. The other four IITs were initially supported by foreign assistance, but, the problem of obsolescence in their cases too was noticed by the Sahai Committee in 1977 and is more real today. The Sahai Committee had observed as follows:

"Almost all the IITs raised the question of lack of funds for replacement of unserviceable and obsolete equipments. The Committee noted that there is no specific allocation of funds either under non-plan or plan for this purpose..... the Committee considers that a logical approach would be to treat replacement needs of small value equipments, arising out of wear and tear and breakages on an item by time basis as legitimate non-plan expenditure and for this purpose suitable annual provision should be made in the non-plan funds. All other equipment needs which include removal of obsolescence, modernisation of laboratories etc. should be reflected in the plan allocations. The IITs should be required not to treat this merely as a provision for replacement of obsolete models by more modern versions, but consider modernisation as a complete project involving study and improvement of the processes and

techniques involved in the various laboratories and workshops and matching equipment provision with those requirements. This kind of futuristic planning must, more or less be a continuous exercise in the IITs and unless this is done, the Committee feels that high-cost equipment acquisition will over a period of time, result in unbalanced growth and will not keep pace with the requirements of the changing needs of Science, Engineering and Technology in the country"

We are aware that in recent years non-plan grants to IITs include a special provision for replacement of equipment of small value when they are wasted out by use. Table 5. 1.1 B indicates the amount utilised by the IITs for replacement of equipment and computer facilities. This has helped to some extent. However, the IITs could not obtain adequate plan provisions for modernisation, although recommendations are available from 1977. The problem has since aggravated and has assumed greater dimensions. Our examination of this problem of obsolescence indicated:

- Not all ranges of equipments have become equally outdated but updating is required more critically in the range of equipment in the electronic field. Equipment in use in some areas of engineering sciences, also need modernisation to cope with the scientific advances that have taken place in that field.
- For many years, no budgetary support was provided for making replacement of wasted-out equipment. However, from 1983, Ministry of Human Resource Development has started to provide funds for this purpose. The amount provided has proved inadequate in the context of the staggering backlog for replacement.
- A good part of funds needed for modernising existing facilities and for creating new facilities can be met by careful planning in the application of funds for equipment out of the sponsored research projects of government agencies and industry. This is not to deny that the IITs must have certain basic equipments in order to bid for the R&D; funds from scientific agencies and Industry.
- Some of the equipments in the laboratories are now not in working order due to non-availability of spares. Many of them were donated to the IITs under various Aid Programmes and there was no provision for continuous supply of spares.
- There is need to achieve and enhance the capability of the Instrument Technology and Repair Divisions to record inhouse support in upgradation.
- The obsolescence is rapid in computer related disciplines. The change in Computer applications viz. from the, data capture and processing to design and control in many fields underscores the compelling need for upgrading the computing facilities in the campus as training of IIT students in these areas is of vital importance.
- In the area of production with the advent of Robotics and Automation, the scenario has been completely changed by CAD/CAM. If the Indian Industry is to have students having competence in these areas, the laboratory (and teaching) in the IITs must suitably change.
- Old equipment need not-always be scrapped. It offers many possibilities for students' training. Some of these could be put to use in Engineering Colleges or schools needing them.

By doing so the recipient gets the equipment free, and the much needed laboratory space in the IIT is saved.

- Old equipment and equipment not in use are sometimes useful teaching supports. Therefore, it is not necessary to assume that equipments not working are useless. The IITs (and, within the IIT, the individual departments) should themselves carefully conduct a survey and list out equipments that could be donated or sold.

- Problems of obsolescence are universal and are corollaries of fast change in technology and engineering sciences. The least that we can do is to ensure that premier institutions like the IITs are not disabled by build-up of massive obsolescence gaps in teaching and research infrastructure.

- Some suggestions were made to us that each IIT could concentrate their research in some specialised subjects so that other IITs need not spend money on duplicating. We would suggest that this should be kept in mind so that in areas which require provisions of costly equipment, one IIT should develop a nodal centre, and, faculty and other staff from other IITs and other Institutions should share access to these facilities.

It is critical that, in addition to the existing Non-Plan grants for replacement of equipment which needs to be enhanced there is a need to provide plan fund support to execute projects/programmes of obsolescence removal and laboratory and workshop modernisation.

The second critical aspect of the Plan requirements of the IITs, relates to the campus facilities particularly deficiencies in faculty housing, hostels, library and laboratory space. Table 5.1.1C indicates the space built in IITs and Table 5.1.1D indicates the shortage of space in the IITs. The IITs should provide hundred percent housing for the faculty and also have a little more spare faculty housing to attract adjunct and visiting faculty. At present, we understand that due to shortage of houses for teaching staff (Table 4.9.3D) in these campuses they are not able to 'attract competent and qualified people. Similarly there is shortage of hostels particularly for girl students. There is a need for expanding Central Library building and for building some more Laboratory space. The overall shortage of space is shown IIT-wise in Table 5.1.1D. These should, therefore, be remedied forthwith.

The third area where Plan-funds are essentially required by IITs is good computation facility. Computing power per second is an index of the capability of any technological institution. The data processing requirements of IITs have increased manifold. The existing computers with a main frame centrally located is inadequate to meet even the current needs. Advances in Science and Technology, on the one hand and advances in computer application on the other, in mutually complementary roles are accelerating the change process. In this context, teaching and research related to manpower development for S&T; thrust areas and emerging areas depends for its strength and quality on the computing resources of the Institute. Gaps in computer resources in front rank technology institutions would then be a great misfortune. Selected Institutions in India like IITs now need a Super Computer supported by many dedicated terminals at the laboratories and on the tables of the faculty. This has become a minimum requirement. We learnt that in a small Institute like the Asian Institute of Technology, Bangkok, they have a number of computer consoles, whereas IITs still have to go to a Central Unit for necessary computational work. IITs in this sense are no longer comparable even to some of the smaller Institutions located abroad. Their capability and reputation, in this sense as leading-edge institutes, are now being impaired.

Similarly some of the equipments available in the IITs mostly received under the foreign assistance, could be made serviceable provided there is a Central Instrumentation Service which also could get enough spare parts. Such Central Instrumentation Unit could save on the need for replacement by energising equipment currently not working. Repair or reconditioning of the existing equipment is an important aspect which IIT could do, as they have sufficient technical competence and manpower. Such efforts add to the development experience for their staff which in turn will enhance the quality of training and education in the IITs.

The fourth area for which Plan funds should be made available in sufficient measure is to support the work programme of IITs in S&T; thrust areas. We have already referred to the possibility (and necessity) of finding the funds not only through the grants of the Ministry of Human Resource Development but also through sponsored research funds on project basis from Government of India agencies as well as Industry. The role of the IITs in supporting the national R&D; effort in relation to thrust areas have to be fully recognised and their resources and capabilities for performing their role enhanced. There is considerable enthusiasm and keen interest among the faculty and research students to actively get involved in research and project work in such areas and this potential should not be allowed to suffer for want of essential facilities and appropriate funding. Investments in IIT to support related work programmes are doubly fruitful since they provide a strong motivation to the IITs to look ahead and excel in their research function but also contribute manpower in such advanced and sophisticated areas of work for this country. We wish to particularly emphasise that areas may be carefully selected, but funding should not be sub-critical. Each work programme must be projectised, with specific R&D; goals, and in a feasible time-frame, and support provided after expert scrutiny and appraisal. In the past, support had been given but funding had been sub-critical in some cases and in some others, R&D; goals had not been clearly identified while setting up facilities. Table 5. 1.1 E lists the support to work in emerging areas in the past.

Having regard to the past experience and the uneven flow of sponsored research funds from S&T; agencies to the University systems (including IITs), we are tempted to conclude that the important work that institution of higher technical education can and shall do in the S&T; thrust areas, is not sufficiently acknowledged. We think that the S&T; agencies could be asked to earmark 5% of their R&D; budget for funding sponsored research work in the higher technical education system.



5.1.2 Need to Provide Critical Plan Funds

We received strong representations from the IITs that the plan funds for the IITs in real terms have shrunk in the successive Plans and the IITs felt a considerable constraint in the actual availability of the Plan funds and on time. Whenever the IITs presented their Plan requirements initially, they included funds for innovative programmes but ultimately because of short-funding, the Plan funds could barely suffice for ongoing activities. When the scholarship value was raised, the increased liability was adjusted in the Plan budget though any change in value, like salaries etc. ought to be a charge on Non- Plan funds. The IITs pointed out that the Plan funds in the successive Plans were more or less of the same order and if one allows for inflation, the plan support became even less. Table 5.1.2 indicates the allocation of Plan funds to IITs during Sixth Plan. Out of Rs. 39 crores, IIT Kharagpur and Bombay got over Rs.8 crores each while the other IITs got less than Rs. 8 crores. IITs have felt that the order of funding them is low and needs largescale improvement.

The IITs have been dependent almost solely on the Government for their development. They have been no doubt getting sponsored research funds from S&T; agencies but these again happen to be predominantly from the Government as most of the S&T; agencies are Government Departments. It is now necessary and essential for IITs to use their talents and capabilities to generate resources from alternative sources like Industry, both in private and public sectors. A suggestion was made to us that Public Sector should support the development of IITs more substantially. It could be examined if one giant public sector unit adopts an IIT each and helps out with funds for infrastructure and R&D; facilities as a quid pro quo for a lasting R&D;/consultancy support to the public sector unit itself and using this linkage to strengthen the bonds between IIT and Industry. If such a linkage is possible, the IIT can develop more flexible options in resource mobilisation and a greater freedom of choice in building up its R&D; facilities.

We have earlier referred to the estimates of plan fund required by the IITs during the Seventh Plan totalling Rs.258 crores. We have also dealt with, in a conceptual framework the essential areas where plan funds would be most needed. We have, elsewhere in the report (Para 5.2), dealt with the need to generate additional resources, within the IITs, to obtain part of the funds for modernisation of R&D; facilities from S&T; agencies under sponsored projects, to strengthen the bonds in the industry and the consultancy function both of which could bring in additional resources to the IIT. It is possible that in the process of a detailed and expert scrutiny of the Seventh Plan estimates, the requirements could be scaled down somewhat. Even after allowing for all these, we are of the considered opinion that the recommendations of Rs. 50 crores in the Steering Group Report (Dec. 1984) on Education and the provision of Rs. 35 crores ultimately in the Seventh Plan document is wholly inadequate and could prove to be a severe handicap in the desired growth profile of the IITs. Our view is that Rs. 100 crores would be a modest and reasonable plan grant to the IITs.

5.2 Non-Plan Funds and Block Grant

IITs have both Non-Plan and Plan components in their budgets. The Non-Plan component generally accounts for maintenance of activities as reached by the end of the previous plan period. The Non-Plan budget includes salary and allowances, scholarships to students, maintenance of buildings, and provision for replacement- of equipment etc. Table 5.2 A and Figure 5.2 give IIT-wise a Non-Plan budget grants from 1974. The past decade has shown a very substantial increase in the Non-Plan budgets of the IITs. While much of it may have a rational explanation, it is needless to emphasise that there has to be a check and scrutiny on the growth of the expenditure. The IITs have more or less reached their saturation points with regard to student population. It will, therefore, be all the more appropriate to seek and work for a containment of non-plan budgets. We have reasons to make this observation since during our discussions we could not avoid the impression that there is not enough awareness in the IITs of the fact that almost the entire cost of education and training of students is in reality paid for by the tax payer and that the Government/the tax payer/the IIT system ought to be looking for all possible avenues of effecting cost reduction and economies of operation to improve the cost-benefit ratio of this tax payer's investment in the future of the country.

During their discussions with us, an Employees' Union of an IIT assured us that they are interested in the cost-effectiveness of the investments made. As long as none of the existing employees is laid off, except by attrition, retirement etc., they indicated their support for containing fresh recruitment. They felt that the main drawback in the IIT system is that there

is no proper placement of its staff. In many laboratories and workshops, the placement of staff is irrational. Some of the workshops were without supervisors whereas some others have little or no mechanics. The Union felt that (in that Institute) while the overall ratio of supervisor-mechanics is satisfactory, the wrong placement or misplacement of persons hampered output and that there was no proper utilisation of the work resources. There should be constant awareness on the part of the IIT management for the effective and optimum utilisation of the human resources, including their training and retraining for specific jobs in the IIT rather than recruiting more staff. It was also pointed out to us that a number of staff have been employed in excess at some places and IIT could shift few surplus staff from one department to another, support programmes that go to increase their efficiency and make sure that there is adequate work available in every department. We appreciate the general sense of these perceptions and endorse them. Generally there is a feeling that the teeth-to-tail ratio is rather large in the IIT system. We think that recruitment and utilisation of the supporting staff is one of the major areas of scrutiny if containment of the non-plan budgets is to be achieved. We give weight to what the particular Union told us because it is an in-house testimony to what we consider as conveniently feasible if the IIT managements become more cost conscious.

In this context, we consider that two steps are essential. The existing practice of justifying the next year's budget on the basis that it is a modest and reasonable increase on the budget of the previous year conceals and overlooks many options of exploring avenues of cost reduction. An expenditure in the previous years becomes an authentication for its continuance in future. In such a situation, growth of expenditure over time is accepted as an inescapable fact. No system, much less the IITs, with the highly equipped people at its helm, can justify the continuance of the present state of affairs. We consider that the budgeting system in the IITs should become zero-based and every year, the budget estimates of each department/activity/function should be thoroughly gone into, to identify what can be economised or eliminated and what money savings can be generated and not merely, to find additional units or levels of spending. The second is that specific time-targeted goals should be set for each IIT to plan and limit its non-plan budget and expenditure and the IITs which adhere to or achieve such targets could be permitted to retain the consequent resource generation for development purposes or staff welfare purposes.

The suggestion above can be illustrated by an hypothetical example. If an IIT is given a target of reducing its Non Plan budget by 3% in a one-year time frame and if, over a budget of Rs. 8 crores of the previous year, the next year's budget shows additional expenditure of Rs. 50 lakhs and a saving of Rs. 25 lakhs due to reduction of expenditure, the IIT should be allowed to retain the resource of Rs. 25 lakhs generated by economics and this would not be adjusted in that year's budgetary support. What the Government and the IIT gain is in the saving of recurring expenditure for the future while for the year in which the saving is made, the IIT benefits by the additional resources.

There is a definite need to augment the income of the IITs. Their income at present other than from the government is abysmally, low. Table 5.2B gives IIT-wise income generated in 1984-85 separately for academic fees and other income from students. Income from the fees from the students accounts hardly for one percent of the budget generally. Other miscellaneous income include Application fee for advertised posts, fines, sale of tenders forms, library book bank, leave salary contribution, Guest House income, interest in investment, Joint Entrance Examination, Graduate Aptitude Test in Engineering (GATE), income from Testing and Computer charges of consultancy projects, rent from residential

houses/shops/water charges, electric charges and income from sale-of unserviceable items etc. Income from all sources received by the IITs is 6 to 14% of their total expenditure. IIT Madras covers 14% of its expenditure, IIT Bombay 11 %, IIT Kanpur hardly 9% through such income. There is a need to demand from the IITs that they increase their income while containing their Non-Plan budgets.

The academic fees statutorily charged (Table 5.2B) bears no relationship to the actual cost of training and has remained static over a number of years. We consider that academic fees should be increased so as to bear a reasonable relationship to the cost of training. This would be the most feasible method of augmenting the income of the IIT and thereby some-what reduce the burdens of the subsidy borne by the government. There is no logic in continuing with a fee structure which makes it almost a token payment. The fee should be revised from time to time. Some guiding principles ought to be laid down by the government for revision of fees from time to time, say that academic fee should generate about 10% of expenditure on the wage bill and direct expenditure related to teaching. We would suggest that IITs should charge higher fees from foreign nationals. They should also attract by their reputation more sponsored candidates particularly for their graduate programmes.

We consider that each IIT can aim to have ratio of income from all sources (except government grants) to expenditure as 3:10. This would mean improving the existing ratio of approximately 1:10. The increase in fee would partly cover this. For the rest, the IITs should explore all other avenues of augmenting income including consultancy, computer and test facilities and these would demand more efficient use of resources.

An incidental reference to training, retraining and conversion training of all categories of supporting staff is necessary here. The teeth-to-tail ratio in the IITs is prima facie high. There is need to curb the growing wage bill. There is also the need to progressively improve the teeth-to-tail ratio. This is possible with a determined plan of action and execution. We are not suggesting retrenchments. But, we are firmly of the view that the strengths available in the already recruited staff could be properly channelized for better use and output by an effectively laid out training and conversion programme oriented for career development of individuals. Both vertical and horizontal mobility in the system can be made more feasible and attractive to enthuse and motivate people to acquire new skills, sharpen and upgrade existing skills and increase output. It should, through such an approach, be possible to resist addition to staff by fresh recruitment and increasing numbers but redeploying present staff more productively. We are labouring this point since wage bill of supporting staff constitute a good 20 to 25% of the Institute budgets and this is an area where considerable restraints are possible.

We have suggested increase in the tuition/academic fees. It may be argued that in spite of low or nominal fees, education in IITs for students from poor families is possible only with scholarships and government should provide scholarship funds to the IITs in substantial measure. At present, nearly 25% of the UG students get scholarships which cover tuition and hostel expenses. All the postgraduate students get scholarship at rates fixed by the government and are extended to cover not only cost of residence and food, but also essential educational and personal expenditure. The postgraduate scholarship is extended to sustain the scholar on a modest scale instead of his being dependent on his parents to any extent. There are also some postgraduate scholars supported by sponsor's funds. The present system in OUT opinion needs a radical review. The present system tends to be mechanical in administering scholarship funds. Getting a scholarship is a matter of eligibility based on

economic status at undergraduate levels and not even that at the postgraduate. The academic performance within the system contributes to neither forfeiture of or accrual to any privileges already availed. In systems like IIT, where striving for excellence is expected to be a creed, scholarship supports should also be used as good instruments of motivation towards this end. A rigid system should yield place to a flexible system. Towards this end, we recommend institution of a system of bursaries in each IIT. The existing scholarship grants of the Government would go into the bursary. Other funds-from industry, allocations from consultancy or other earnings of the institute, donation and gifts-could be generated to augment the bursary. There ought to be a Trust-like body (Bursary Committee) in the institute to administer it. It should lay down criteria for extending scholarship supports and their continuance. Economic backwardness would be an important criteria but academic excellence should also be able to earn scholarship. The scholarships can take the form of waivers-tuition and other fees or grants to cover cost of books or boarding charges. Students from poor families may be guaranteed full support in the first year on poverty criteria but the continuance of the 'support must bear a relationship to performance. The waivers and grants can be full or half depending on consistent criteria to be followed. The postgraduate scholarship value may be at rates fixed by government but the bursary may support not more than 25 to 30% of students while the IIT look for sponsor's funds for the balance. We are making two important points in suggesting these changes. The scholarship support within a system like IIT ought to be administered as an in-house function with a considerable degree of flexibility which ensures that poverty does not deny access to the educational facilities in the IIT and at the same time uses the scholarship support as a discreet instrument for motivating students towards excellence. Scholarship funds from government will have to continue but we are suggesting substantial funds from other sources including sponsors' for PG courses, to supplement the bursary.

We would suggest yet another form of help to students who need help but cannot get scholarship-viz educational loans at low rates of interest. IITs could tie up with banks and offer the facility of servicing the student who needs a loan and to a limited extent, agree to service the bank also in getting repayments. An appropriate loan scheme-between Government/IIT/Bank, if worked out, which is specific to the needs of the students coming to the IIT, would be a welcome addition to existing methods of helping students-particularly those from the economically weaker sections.

We suggest that even with all these forms of help, there will be students who need help to meet their expenses in campus life. The students are usually more than willing to "work and earn" and the IIT system could devise various alternatives. At least in one IIT some steps had been taken. Students were deployed to supervise the campus bus operation with fruitful results for the IIT as well as for the students deployed. While we are strongly suggesting economies on supporting staff, students needing help and willing to put in extra hours could be intelligently mobilised to carry out some of the items of campus work whether in the office, or departments, or campus. Such efforts ought to in the long run improve the overall work culture in the campus.

There is a general consensus of opinion among the IITs that the present system of determination of government grants annually is not conducive to adoption of practices of sound financial management within the IIT. It is argued that such determination through annual budgetary exercises tends to become routine and the bill is accepted if it is a modest increase over the previous year. Essential and valuable reforms or changes in system operation become irrelevant to concerns of financial management, since almost everyone

knows that if the IIT needs money to invest for a long term benefit, it is not likely to get it. If it saves money currently, the grant will be reduced. This is also corroborated, by the fact that opening balances in account at the beginning of the year (unspent money of last year) is automatically and fully adjusted in the year's grant. We need to get out of this situation. We want the IITs to manage their affairs in a professional way in which financial management and cost awareness would enhance the benefits of investment in the IIT. There is no point in applying to them the principles of grant support which government adopts for any public or voluntary agency or aided institutions. The government covers the deficit and therefore, the budgetary exercise is aimed at keeping the deficit low. An expenditure deferred or avoided is hailed because it keeps the deficit to be covered lower. While in most cases government is compelled by circumstances to adopt this regimen in extending grant support, we feel that IITs as premier institutions, should be given a chance to prove their ability to manage their affairs (including financial) well and efficiently. In this context the first crippling factor of annually determined "deficits grant" system should, in our opinion, give place to a system of block grants, determined for a block period of five years, on the basis of assessed gaps between expenditure and institute income. The process of gap assessment itself would provide opportunities to explore avenues of reducing the gap by augmenting income or through economics which would need to be pre-determined and planned. The annual block grants would be payable to the IIT automatically year after year until at the end of the five years period, a stock-taking is done before assessing the needs for the next block of five years. Such predetermined block grants to IITs, will compel them to take resort to prudent financial management since they would know that every rupee saved could be put to better use for the good of the Institute and its community. We must add a word of caution here-that the annual block grants would need to be increased to compensate for the value of wage or welfare expenses which government notifies and mandates/permits the IIT system to follow. This relates really to DA increases, statutory wage revisions and the like.

5.3 A Professional Financial Management

We are rather appalled to note that generally the IIT system follows procedures which have been bodily lifted from the government departments. They have been in existence for over 25 years and it is sufficiently a long time to have evolved their own procedures and systems if the government rules and procedures are cumbersome for their purposes. While generally there is a feeling that the rules and procedures in vogue are not wholly conducive to the functioning of an institution like IIT, they have not found it convenient to give them Up and find workable alternatives. Perhaps the one stumbling block has been the inability to institute a financial management system in the IIT which takes on a management perspective in addition to its accounting perspective it has at present. We are constrained to make this observation because we are conscious of the multi-faceted responsibilities and huge investments in the system on the one hand and the singular lack of perceptions that financial management calls for much more than budget control and accounting functions. As a result, there is very little evidence of use of management accounting, to use accounting and financial information in interpreting and evaluating functions, sources and other system outputs in a methodical and continuous basis, to attempt streamlining, simplifying, speeding up, mechanising routine operations like campus billing and recoveries for services, or repetitive store purchase operations, or inventory and purchase control. These are illustrations but the general impression of the committee is that financial management is an area in which the IITs have to break new ground and become modern, if they wish to contend with scarcity of resources and constraints on funds, and yet would not compromise on excellence. It is a pity

that government's attitudes and insistence on conformity with practices and procedures in government have themselves been partly responsible for the present situation. We would suggest that the IIT system is firmly encouraged to review its financial management thoroughly, with the help of experts (or consultants), if necessary, and introduce comprehensive changes at least for

(a) providing financial data relatable to performance on a continuous basis for better monitoring and evaluation and for channelising resources in scientific way;

(b) adopting management accounting practices in selected areas for cost control and seeking economies (e.g. critical analysis of ratios between personnel and operating expenses, academic and non-academic staff and establishment expenses, academic and non-academic activity expenses, computing of per capita costs in departmental expenses, analysing per student costs for selected functions and activities, etc.);

(c) looking critically into the procedures of stores purchase, inventory control, billing and recoveries for campus services, disbursements of money etc. with a view to simplifying, rationalising and mechanising (reduce paper work but improve speed and reliability).

We consider that major efforts in these directions are long overdue and it is time that the IITs sought a new and credible image for themselves in this part.

SUMMARY

The IITs will need to be supported by provision of substantial Plan Funds by the Human Resource Development Ministry to cater for:

- removing obsolescence and modernising of the laboratories and workshops; 3 - filling up critical gaps in campus facilities more particularly faculty housing, hostel, library and laboratory space;

- upgrading computer facilities and central instrumentation facilities;

- establishing facilities for new thrust areas on project basis. (Para 5.1.1)

The provision of Rupees 50 crores suggested by the Steering Group on Education for the Seventh Five Year Plan would appear to be a subcritical investment. Broad estimates presented to the Review Committee by the IITs indicate the need for an investment of about Rupees 258 crores. The Committee would recommend that the Plan Funds to the IITs in the Human Resource Development Ministry's Seventh Plan should be atleast of the order of Rupees 100 crores. The IITs must be able to earn and attract substantial funds to support a major part of their research activities, through sponsored projects and consultancies. This is a corollary to the need for strengthening the linkages with industry and R&D; funding agencies. (Para 5.1.2)

The Committee recommends that the Ministry's support to the IITs through Non-Plan budgetary support must be contained. Each IIT will need to critically examine the Non-Plan expenditures and adopt zero- based budgetary principles. A closer internal scrutiny of cost of administration services and its effectiveness is necessary. Avenues for augmenting the

income of the IITs needs to be explored. The Committee recommends that approximately a third of the operating cost should be met by their own generations. In relation to the cost of education in the IITs, the tuition and academic fees charged is negligible. The Committee recommends that these fees should bear more reasonable relationship with the cost of imparting education in the IITs. The students who would be unable to meet this enhanced fees, should be helped through bursaries created out of endowments from the government as well as from other sources. Loan schemes from banks should also be introduced to help students meet cost of their education. The existing scheme for provision of scholarship will need to be appropriately reviewed. (Para 5.2)

The Non-Plan budgetary support to the IITs may be determined on a five year grant basis, on realistic estimates of projected gaps between income and expenditure. Adjustments should be annually made only to compensate for increase in wage-bill due to liability for additional emoluments on account of government decisions. (Para 5.2)

The principles and practices of professional financial management should be adopted in the IITs to serve as meaningful tool for relating performance to budgeting and mobilising and channelising resources in a scientific way. It is necessary to introduce modern methods of management accounting. It is also necessary to simplify and rationalise procedures relating to purchase, stores and inventory, municipal services, bills and disbursements etc. (Para 5.3)



GOVERNANCE AND MANAGEMENT STRUCTURE

◆ 6.1 Council of IITs

◆ 6.1.1 Erosion of Autonomy

A common perception of all IITs is one of interference with their autonomy by the Ministry of Human Resource Development. A Chairman of the Board of Governors of IIT in his address to convocation made the specific point that autonomy both in academics as well as in governance for the IITs is a must. At the same time many felt that it was the autonomy the IITs enjoyed which enabled them to function in a manner that promoted excellence. Therefore, the objective situation in this regard required to be examined.

The IIT Act and Statutes clearly specify the respective roles of the Council of the IITs, the Boards of the Governors of the IITs, their Senates and the duties and responsibilities of the Director.

We noted that the Council of Indian Institutes of Technology, which coordinates all the IITs, is a broad based body with the Union Human Resource Development Minister as its Chairman and an Officer of the Ministry of Human Resource Development as its Secretary. The Chairmen and Directors of all the IITs are there along with the representatives of the Central Government, Parliament, Indian Institute of Science, UGC and others. Even though the IITs are largely funded by the Central Government there is no formal representation of the Central Government on the Board of Governors of any IIT. Therefore, the Board is free from direct interference by the Government of India. Government itself is represented in a minor way on the Council whereas all the IITs and Academia put together have a major representation. Why then is this feeling of interference by the Government?

Evidences presented to us indicated that certain actions taken by the Ministry do make these Institutes feel that the Ministry is interfering in their domain of delegated authority. Some instances brought before us are:

-Not holding the Council meetings regularly. (There was no meeting held between June 1983 and February 1985). The bureaucracy in the Ministry actually shapes the decisions and gets it approved by the Minister-as Council's Chairman- without wide participation and discussion by the IITs, and orders are then issued to the IITs.

- The Institutes are bound by many rules and regulations and the IITs stated that Ministry's permission seems to be an absolute necessity for many things such as:

- * whether a faculty member can receive a grant from a foreign academic foundation;
- * whether a foreign scientist can visit a Department" or
- * whether a faculty member can go abroad.

- There was a report on the case of a student who had done so badly that he had to be sent out of the Institute. He was given an extra chance before he was sent out of the Institute. The

Ministry brought pressure on the Institute and the boy had to be admitted after one year. This boy was an SC/ST student but well educated in a good school; his father being an officer of the Cabinet Secretariat, influence was brought to bear on the Ministry.

- Similarly, in the case of an Indian national residing abroad who could not qualify in the Joint Entrance Examination, pressure was brought upon the Director of an IIT by the Ministry to admit him.

- In the name of commonality between the IITs attempt is made to offset the advantages of the operational autonomy and the individual character of the IIT which is considered to be a major source of academic strength.

- Decisions taken by the Visitor on the reports of the Review Committee or other committees are in fact formulated by the Ministry who are free not to implement a recommendation, if they so choose.

- Inability of the local administration, hamstrung by financial constraints, to resist bureaucratic interference from the Ministry.

- Influence by Members of Parliament writing to the Minister regarding the reinstatement of a student or pleading the case of an employee.

- Favouring some in the IITs who are close to the officials in the Ministry.

- Alleged misuse and control of official transport.

On the other hand the absolute freedom enjoyed by the respective Boards of Governors enables a Board of Governors decide in a particular way which affects the morale of other IITs creating problems for them and financial commitment for the Government. There was thus a need to redefine that the autonomy of IIT cannot be absolute. It has to be moderated by a common body such as the Council of the IITs where each IIT is represented, in order that a commonality of commitment is arrived at. Some instances where the decision of one IIT brought difficulties to other IITs are:

- An IIT gave a B.Tech. (Arts) degree to students who could not complete the level of full programme satisfactorily.

- One IIT unilaterally revised upward the scale of pay of the Registrar.

- One IIT implemented on their own retrospective promotions antedating (for fixing of salary) the benefits accruing to the employees to the detriment of the employees of other IITs.

- An IIT paid higher value of scholarships to Postgraduates resulting in strikes taking place in other IITs over this issue.

- An IIT implemented a Personal Promotion Scheme long before the IIT Council so decided.

- An IIT promoted wholesale non-faculty employees on the plea of the merit-promotion etc.

- Erroneous notions about powers had also given rise to a feeling of erosion of autonomy. For example the IIT Council alone has the power and not the Senates for fixing the duration of courses. When the duration of undergraduate courses was reduced to four from five years after due exchange of ideas, there was complaint by Senates of some IITs that their autonomy has been eroded. So also was the case of reducing the duration of PG course to three semesters. In all these cases, there was adequate participation by Senates of IITs but authority for decision- making was with the Council.

The formal position is that, if in any IIT, there are serious aberrations government can only raise the matter with the Visitor for appointment of a Committee whose report is examined by the government, and the order of the Visitor obtained for communication to the IIT.

The real problem of autonomy in the IIT as in any other autonomous institution funded by government is the rigidity of the financial rules. In all autonomous bodies there is provision for them to frame their own rules. But such rules are subject to government approval and the requirements of the government audit. So ultimately such institutions adopt the government financial rules as the safest course.

The Education Commission (1974) while dealing with University autonomy clearly stated:

"The proper sphere of University autonomy lies principally in three fields:

- The selection of students;
- The appointment and promotion of teachers;
- The determination of courses of study, methods of teaching, and the selection of areas and problems of research".

They further said "While universities must have this autonomy, it should be interpreted in the larger context of their obligation and responsibility to the nation and to mankind as a whole. For instance, the national need for trained manpower has implications for the teaching functions of the universities and similarly decisions about research which, in a way must be taken primarily by the universities cannot be taken in isolation from the economic and social needs of the country which must influence them in a large measure. Such decisions are national decisions in which the competing claims of different sectors of the Society must be weighed against one another and in which long range programmes must be balanced against immediate needs. It is apparent that the conduct of university affairs cannot be left solely to the academics; their relationship to social needs requires the admission of non-academic persons within the machinery of their government. The universities have thus to share their decisions with lay agencies or authorities outside the system."

It would appear that sometimes the IITs have been disturbed by letters from the Members of Parliament or other references made in connection with queries to assist the Minister to dispose of complaints. On the other hand many employees felt that the Directors of the IITs do not use their autonomy. It was alleged that the Directors either refer the files to the Chairman or to the Ministry particularly in matters concerning the employees, and that the ideas presented by employees are often rejected. Here again we would quote the Education Commission's observations:

"In the governance of a University, the principle that good ideas often originate at the lower levels of the hierarchy must be recognised and respected. The tendency to attach importance to ideas and proposals merely because they emanate from persons who happen to hold important positions is unhealthy and particularly out of place in a university where they must be judged objectively and on their intrinsic merit. As Sir Eric Ashby has observed: 'This principle of upward flow is vital to the efficient administration of a University and for the survival of autonomy and self-government.... Not all Professors consult their Lecturers before decisions are taken as scrupulously as they themselves expect to be consulted by the lay governors in similar circumstances. As faculty boards become larger, there is a temptation for an oligarchy of Senior Professors to take over the responsibilities of government on behalf of their more junior colleagues. That way danger lies, for any weakening of the principle of self-government within the academic body makes it harder to preserve self-government within the University as a whole and correspondingly harder to maintain the autonomy of the University in the modern democratic States'".

There was also a suggestion made that the Ministry should not advise the Director on issues which lie within his powers to decide. In our opinion such a general fiat is not a valid proposition because IITs have a relationship with the Ministry and the relationship extends through the Ministry to the Parliament. There will be thus some matters or issues which require consultation with the Ministry or by the Ministry with the IITs. IITs cannot in all matters decide on their own. For instance they cannot decide in isolation how much they can spend without knowing what money is available as a government grant. It is not only the Ministry that is concerned but often their programmes of investment, concerns the Planning Commission and the Parliament where budgets have to be voted. Therefore, autonomy cannot be said to have been violated when references of this kind are made to and fro.

It must be recognised that educational policy and planning are intimately linked with and determined by what society pursues. To great extent educational policies or other policies accepted by the Parliament such as Science Policy Resolution and Technology Policy have a close bearing on the working of the IITs. By and large IITs are free from political interference. IITs are not completely divorced from the society. They are being watched by the Parliament where they are also being protected by the Union Minister of Human Resource Development. The Council of IITs have three representatives on it elected by the Parliament. IITs are fortunate in having a healthy structure in the form of the Council of the IITs and the political support through its Chairman who is a Minister. The Council is a good agency where healthy relationship exists and which permits IITs to extend the political will of the Nation and the Parliament. IITs themselves owe their genesis to the Parliament. We do not think that IIT should remain outside such a symbiotic relationship with the Council.

We feel in conclusion that freedom and autonomy for IITs are essential, but these have to be exercised judiciously. There will be a limitation to this freedom in so far as the decision of one IIT affects the other IITs and enhances the financial commitment of the Government. Secondly, it is good for the IITs to have the views of a similar peer group outside the IIT system, as the Council embodies. Thirdly, it must also be realized that accountability goes with autonomy and the IITs are accountable to the Parliament and the people through their Council, whose decisions cannot be considered an infringement of the autonomy. Government on their part may refrain from referring cases to the IITs which can be construed as interference.

Having emphasised the authority of the Council in principle, we must also state that in our view the Council at present, does not function effectively. The Council must meet more frequently and make structural provisions whereby decisions can be taken faster and collectively. It is for these objects that we are suggesting some changes in the management and structure of the IIT system such as the Council and the Board of Governors. Representation of the Government on the Board of Governors of the respective IITs was suggested by some. IITs in general perceive Government representation on their Boards as an unnecessary interference and, we find that it is wise to continue the status quo.

We also received a suggestion that, 25 years ago, it might have been valid to create, the IITs as special institutions but there is no reason now to keep them isolated from the main stream of the country's academic life; and that they should fully participate and cooperate with the other institutions in the University system. It was suggested to us that the UGC which was created for overseeing the whole of higher education, should also look after the IITs. On the other hand we also received strong representation that the institutions taken over the UGC are not being looked after well and that the IITs' pre-eminence is entirely due to their autonomy and ability to decide things for themselves. Therefore, if the goal of excellence is set for IITs, it is absolutely essential that they are not brought under the UGC system. IITs also have complained that adopting the UGC pay scales and in some cases UGC norms, which may otherwise be valid for engineering colleges, has adversely affected the IITs and that it will be a retrograde step to disassociate IITs from its Council and hand them over to the University Grants Commission. Except the State Universities established by an Act of State Legislature, a number of institutions such as NITIE, NIFFT, Institutes of Management are already outside the UGC system. Kothari Commission (1974) too examined this problem and did not recommend the IITs being brought under the UGC. They said "The Institutes of Technology have already made a significant contribution to Technical Education and to provide for their further development they may be brought under UGC-type of body." We recommend that it would be unwise to bring IITs under the UGC system and attempt uniformity.

6.1.2 Council and its Advisory Committees

The Council of IITs, as constituted at present, with the functions stated in the Act and Statutes, provides a good balance between the IITs and also acts at an interface between the IIT system and the government through the Minister of Human Resource Development, who is the Chairman of the Council of IITs. During our visits, we gathered that the IITs themselves prefer an autonomous body like UGC to look after their interest but they would not like to be a part of the UGC. We however, noted that infrequent holding of the meetings of the Council for various reasons, not excluding the preoccupation of its Chairman, delays decisions. The Ministry, with a view to speed up, places a view to the Minister and the orders of the Minister are passed in his capacity as Chairman of the Council which do not always get acceptance of the IIT system as a whole.

Basically, therefore, there is no need to change the composition of the Council. However, there is a need to make specific provisions for the Council to meet regularly.

It was pointed out by many members of the Council/Board that undue secrecy is maintained with regard to decisions of various authorities like the Council, Board of Governors etc. We feel that all persons in the system must be encouraged so that the views of these groups. Are placed correctly and in order that these organisations/groups are aware of the decisions, we

recommend that specific decisions taken by the Council/Board of Governors/Finance Committee/Senate etc. should be made available to all concerned without restrictions.

Opinion was voiced by many in response to our questionnaires both from India and abroad, that the way the Council of IITs now functions does not help the IITs. Many feel that there is a bureaucratic interference with the IITs and the Council is not managing the IITs on any firm basis. At the same time there was a felt need for an interface between the IITs and the Government of India and that the Council of IITs could be made to function more effectively to solve the problems of IITs.

We feel that a Council of IITs is essential and that the functions of the Council can be discharged more efficiently by two separate Advisory Committees of the Council viz:

1. Academic Advisory Committee

2. Administrative Advisory Committee

These Committees will transact the business in a professional way between the Council meetings, as against the practice now obtaining viz. Ministry advising the Council's Chairman. The Academic Advisory Committee will deal entirely with the academic functions of the Council as stipulated under the Act; while the Administrative Advisory Committee will deal with administrative functions of the Council.

The Administrative Advisory Committee shall have twelve members. The Chairman of the Council will nominate one of the Council members as the Chairman of this Committee. The other eleven members will include:

- all the five Directors of the Us;
- three management experts from outside, nominated by the Council;
- the Financial Adviser of the Ministry of Human Resource Development (Department of Education);
- Senior-most officer of the Ministry of Human Resource Development dealing with the IITs;
- the Secretary of the Council as Member-Secretary.

The Academic Advisory Committee will have ten members. The Chairman of the Council will nominate one of the Council members as the Chairman of this Committee. The other nine members will include:

- five eminent people from Industry, Economic Departments/agencies of the Government and from leaders in S&T; and higher education, nominated by the Council;
- Three Directors of the IITs on rotational basis;
- Secretary of the Council as Member-Secretary of the Committee.

Academic Advisory Committees will deal with all other aspects of the Council stipulated under the Act other than the administrative functions of the Council.

Both the Committees will meet in between the Council meetings and consider all relevant items on behalf of the Council. Whenever the Chairmen of these Committees are not present, a member will be temporarily elected to the chair and the meetings held. Whenever there is an urgency the recommendations of these Committees could be considered by the Chairman of the Council for passing his orders. It is also necessary that the Chairman of such Committees should not be an official of the Government or the Minister himself. We feel that the Council should lay down the functions, duration and frequency of the meetings of these committees from time to time.

We recommend that the Council as well as these Committees should consider all items prepared by the individual IIT's Board of Governors, individual Directors or other groups in the IITs such as the Senate, Faculty Association etc. as long as it forms part of the Charter of the work, rather than the Council confine itself to the items prepared by the Council Secretariat as at present. The decisions of these Committees and the Council be made known to all concerned and not kept secret.

There may be apprehensions that the two Advisory Committees might come into conflict with the powers of the Board of Governors or the Senate. This need not be so because these committees will be functioning as the Council's Committees in respect of the areas on which the Council has powers derived from the Act. It is these functions that will be allocated to one or the other Advisory Committees; the question of conflict between these committees and other authorities does not arise.

We have also examined the proposal for a committee of Directors to act on behalf of the Council. We do not agree with this proposal on two grounds:

Firstly the composition of the Council is broad-based and it comprises, apart from the five Institutes of Technology equal number of representation of academic and other Institutes outside and, therefore, it will not be fair that the functions of the Council could be relegated only to the five Directors.

Secondly the idea of making the Council an overall policy making body, is a salutary idea that should not be compromised. We received evidences, during our visits to the IITs, both from the faculty and others that the Director does not represent the entire spectrum of an IIT. Therefore, as a group, the Directors cannot adequately represent either the IITs or the Council in its entirety. Whereas their association and experience is useful to the Advisory Committees, these committees must remain broad based.

We are concerned that funds for IITs specially the Plan Funds for development have not so far been distributed on the basis of well laid principles. It would be essential for the Advisory Committees of the Council to lay down well established norms of funding the programmes in the IITs, related to the past performance, quality of programmes being undertaken, achievements expected and its importance in the national S&T; Plan.

6.2 Board of Governors

The role of the Board of Governors of each IIT has been defined under the Act. It is the first of the authorities of the Institute apart from the Senate in its own sphere and the other authorities declared by Statutes thereof. The Act also states that the Board is responsible for the general superintendence, direction and control of the affairs of each IIT. It is thus the most important body so far as an individual IIT is concerned. The composition and functioning of the Board and its cooperation with the Council and the other IITs, the leadership provided by it, its ability to utilize powers vested with it are all crucial and will spell out the difference between success and the failure of an IIT. The Board has a Chairman who is nominated by the Visitor. The Director is a member of the Board on ex-officio basis. It has linkages with the State Governments of the region through a nominee of the State Government selected from among eminent persons who are technologists, industrialists of repute. It has also the nominees of the Council of IITs and two Professors of the Institute nominated by its Senate.

During our visits to IITs, it was pointed out that sometimes the Chairman assumes a superior executive role over the Director, runs an office, and also enjoys other perquisites. He often exercises a final say on matters passed on to him by the Director or other authorities even though no such authority was vested in him. The Chairman acts on behalf of the Board in between its meetings, or he acts in performance of certain statutory functions. He also enjoys certain executive privileges. There were references before the committee as to the need of making the Chairman a non-executive one, for, it contradicts the powers of the Chief Executive viz. that of the Director. It was also presented to us that the Members of the Board should be leaders in administration, industry or in the academic world capable of anticipating and appreciating the fast changes and developments in the field of Science & Technology and guiding these Institutes. We agree with this view and recommend that the State Government nominates such persons instead of persons from the Directorate of Technical Education or from the PWD system on an ex-officio basis as at present. We recommend that the Chairman of the Board should be a non-official of eminence and that he must not hold any statutory powers of execution. The Act & Statutes where necessary must be amended.

There were also repeated references to the Board's spending most of its time on routine administrative matters and not on the development activities of the Institute. There was also a suggestion that the Central Government should have its nominees on the respective Boards of Governors. We agree that the Board should engage in substantial items concerning the development of the IIT, linkages with other academic bodies etc. rather than routine administrative issues. We feel that over the years the Central Government had adopted a wise policy in not being associated with the Board of Governors thus ensuring that IITs work in an atmosphere of freedom. The Central Government through the Council can nominate eminent technologists, educationists and scientists as Council's nominees on the Boards. The Government has also a say in nominating the Chairman of the Board. We therefore, feel that it is far more important at this stage to ensure that the academics feel free to express legitimately what they think in the Board of Governors' meetings without the presence of the representative of the Government of India. We, therefore, do not recommend direct representation of the Central Government on the Board.

We were informed that the Members of the Board, as constituted now, have little or no interest in the Institute's welfare since they represent the State Governments or other outside

interests. Several solutions were offered and we were particularly attracted to a suggestion for having alumni of the IIT on the Board of Governors. There were suggestions for having a nominee on the Board not by State Governments but representation of interests such as Professional bodies, Engineers, Science, Technology and Industry etc. There were a number of other suggestions too. With the broader conciliatory machineries available in the IITs for all the employees there is no advantage to be gained by introducing representatives of the associations or unions of employees on the Governing bodies, academic bodies etc. In fact it may indeed be counterproductive. The management must take into account the larger and long term interests of institute and all its components such as teachers, students, karamcharies, and, therefore, representations of each interest group is neither healthy nor practicable as they would be mostly concerned with urgent demands.

There was also a mention of the infrequency of meetings of the Board, enabling Chairman of the Board resort to emergency powers. We suggest that the Board must meet at least four times in a year. The gap between any two meetings should not be more than 90 days. This must be made obligatory.

6.3 Finance Committee

IIT Act and Statutes declare the Finance Committee of each IIT as an authority under the Act. It lays down the composition of the Committee and enjoins upon them to

- examine and scrutinise the annual budget of the Institute prepared by the Director and make recommendations to the Board; and
- give its views and make its recommendations to the Board either on the initiative of the Board or of the Director or on its own initiative of any financial question affecting the Institute.

The Finance Committee of an IIT deals with the entire financial needs of the Institute on the basis of demands made, by various Departments, Centres or arising out of various orders issued by the Government of India etc. Currently they deal with the distribution of the overall finance available. There is really no exercise made to judge financial needs of the Institution and make a viable programme for matching the needs of the IIT and the resources. They do not endeavour to find alternate means of generating resources for the IIT, say from sources other than the direct Government grant. A number of evidences suggested that resources can be generated through loan, grants from industry and others who could endow bursaries and create chairs. Finance Committee in our view should be more concerned with resource-generation, rather than balancing income and expenditure and bring about a culture of trying to earn one's keep. It would also set a healthy trend of building linkages with Industry. R&D; organisations etc. Finance Committees should help the IIT system, develop innovative links. The Finance Committee should also examine and advise on proposals for financial support for students, faculty and other employees.

Many of the financial procedures currently adopted by the IITs need to be altered, strengthened, modified or deleted to suit the specific needs of an IIT. Currently IITs predominantly follow rules and regulations of the Government of India for their administrative purposes. These rules are evolved by the Government to meet their requirements and for easy auditing of funds and Government itself is considering useful

changes. Technical Institutions like IITs, should evolve procedures suited more to their needs keeping in view the necessary financial checks and balances; they need not be wedded to the rules of the funding organisation.

There are a number of critical items in IIT for which financial resources are needed. It is necessary for instance to estimate resources for housing for the faculty and suggest ways and means of generating resources for this purpose. There is no need to change the composition of the Finance Committee. The Board can nominate persons who they think can be useful. Basically their tasks will be to suggest ways and means of resource-generation, to devise appropriate fiscal methods to implement the developmental programmes of the Institute and to encourage outsiders to contribute more to the IIT resources.

6.4 Senate

The IIT Act and Statutes declare the Senate of an IIT as an authority of the Institute and describe the composition and the functions of the Senate. The Act and Statutes say that the Director will be the ex-officio Chairman of the Senate and it will include as also Members on ex-officio basis the Deputy Director, the Professors appointed or recognised as such by the Institute, three persons who are not employees of the Institute nominated by the Chairman of the Board, and the Heads of the Departments, the Librarian of the Institute and the Warden of the Hostels by way of rotation, the Workshop Superintendent of the Institute and six members of the staff appointed by the Chairman as Members of the Senate.

It was represented to us that while this composition might have been valid in earlier days when the number of Professors were few, with the increase in number of professors in the Senate, the size of the Senate has become unwieldy and, therefore, it is necessary to alter the composition of the Senate. Typically, in an Institute which started with only 20 Professors, they have now about 190 Professors and Associate Professors. Suggestions were made that there should be a departmental quota of about six to ten representatives so that size of the Senate can be pruned to a manageable proportion. It was stated that a body with such a large membership is not able to discuss many things which the Senate as a policy making body in academic matters, shoulders. Apart from the proportional representation we are in receipt of suggestions that only Heads of Departments could represent a Department on the Senate. However, an opposite view was also expressed that it is absolutely essential in academic circles that all faculty should together constitute the Senate and the larger the participation the better are the academic policies evolved. Suggestions were also made for representation of the administration in the Senate in order to commit them to various policy decisions being taken. We also received suggestions from the students for elective representation on the Senate. In their view the Senate considers and decides matters which are directly related to their interests. We examined these suggestions and felt that there was no need to change the composition of the Senate as existing. To obviate the difficulties felt currently and make the Senate work functionally we suggest that the Senate be assisted by Senate Committees which should consider issues in depth and present the conclusions for a final debate and endorsement by the Senate.

The Act also provides that the Senate of the Institute shall have the control and general regulation and be responsible, for the maintenance of standards of instruction, education and examination in the Institute. They shall exercise such other powers and perform such other duties as may be conferred or imposed upon it by Statutes. Our examination showed that this

function needs to be done more effectively by each Senate. The Senate must periodically review the academic activities of each Department in depth and take a view on the efficacy of the Department. The successes and failures of each Department, its strengths and weaknesses should be discussed in the Senate and their findings and specific suggestions should be regularly available to both the Board of Governors and the Advisory Committee of the Council. We also received evidence that the Senate is slow in deciding and looks merely into routine programmes rather than engaging in innovative activities. We feel that the Senate as the highest academic decision-making body is responsible to constantly watch that excellence is achieved in each department. The Senate must make it a part of the regular agenda to cover all the departments in a year.

6.5 Management Structure

Whilst on the one hand the IITs emphasised the need for absolute autonomy and non-interference by the Ministry, on the other hand many pointed out that IITs are not able to utilise even such autonomy as they have because of lack of proper delegation of authority all through and a demand for accountability from the system. This aspect of delegation of powers is more important than mere autonomy, which we have discussed earlier (Para 6.1.1). It was pointed out to us that a number of amendments to the Statutes and the IIT Act are required to make them functional. Some suggested that the existing form of Statutes regarding quantum of fees, scholarships which are explicitly mentioned need changes. Some suggested that the current provision for employees of the Institute to hold office till the close of the academic session be got amended too (till the end of the month in which he attains the age of 60 years). There were suggestions for making suitable provision for CPF-cum-Gratuity scheme, voluntary retirement etc. Some Statutes shall specify figures worked out at the cost obtaining a long time ago. Some of the Statutes which were valid at the time of the start of the Institute are now no longer valid. We received a number of suggestions for amending the Statutes from the Faculty Forum and the Employees' Union. They pointed out that the Conduct Rules of the Institute and the Schedule for Contributory Provident Fund requires rationalisation. Some of the provisions are not valid, a few others have lost significance and a few have not taken into account developments that occurred later. We note that the Council of IITs have appointed two Committees-one for Administrative Staff Structure and another for Works Department Staff Structure. They will no doubt take into account the amendments to the Statutes needed to give effect to their recommendations.

Radical measures are needed for toning up the system such as amending Statutes that are no longer relevant, modifying regulations, decentralising powers all-through and demanding people to be more and more accountable. It is equally important that the entire system should tune itself to the objectives and goals of the Institute. The rules should be modified so that the system can obtain better end- results from the financial inputs made. In order that the IIT system can respond quickly and well, their administration needs to be revamped. Delegation at all levels of power and responsibilities is a key to these reforms. Financial procedures should be looked into so that these can be simplified to meet the objectives.

It is necessary to evolve a participatory management and to make provisions for proper training of people in the various administrative functions. The non-faculty group is no longer an insignificant or a non-participatory limb of the organisation. Their unstinted support and committed contribution is necessary to provide a proper atmosphere in the IITs which is a condition-precedent for attaining excellence. The rules and regulations of any Institute like an

IIT should be so as to allow people to put forth their best. IITs who have good Management Department and expertise available, should be able to formulate necessary changes in their own management training, and make their structure and regulations, respond to their objectives.

6.6 Director and his Academic Team

The IIT Act provides that the Director of the IIT should be appointed by the Council of IITs with the prior approval of the Visitor. The Council has evolved its own procedure for the appointment of a Search Committee who after contacting a number of people on a wide base, suggest a certain name in respect of whom, a prior approval of the Visitor is obtained. The Council then appoints such a person as the Director. The Act declares that the Director is the Principal Academic and Executive Officer and is responsible for the proper administration of the IIT complex and for the imparting of instruction and maintenance of discipline therein.

The Director's position in the Institute is a crucial one. The functions of the Director are very complex in as much as he has to perform the academic duties of the Vice-Chancellor and the Mayoral functions of the Campus city. He is both the academic leader and the manager of the IIT. By virtue of being the Chief Executive Officer, he should be able to take and implement several decisions. He therefore, needs a good deal of administrative experience. The Director, therefore, is one who must possess and exhibit leadership qualities and is respected for his erudition and management abilities. We hesitate to lay down guidelines for the choice of the Director. We would only suggest that the Search Committee should look for the high qualities necessarily to be found in a Director rather than confine themselves, as suggested by some, to a targeted group, disciplines or institutions. We also received evidence that reputed people are reluctant to take up the Directorship of the IITs. This is really a matter of serious concern. The perquisites attached to the post should be high enough to attract the best of the talents available. An eminent person as Director also attracts the best of faculty to come to the IIT. The appointment should be on a contract basis for a specified period.

We also received evidence that serious gaps have sometimes occurred between the retirement of one Director and the appointment of another. Such delays and the accompanying uncertainties are bad for the institution. As the contract period of the Director is known, the Council should start looking for the new Director well in advance.

A point was also made that when eminent people are appointed as Directors, their national commitments reduce their availability on the campus. We feel that the Director is a crucial person involved in the development of IIT. It is necessary that he should be available on the campus for the majority of his time. It is only by his participation in the academic and non-academic activities of the IIT, that he could evolve traditions that are lasting and valuable. His ability to effectively coordinate the conflicting and competing interests of different activity groups in the Institute will be the determining factor in achieving high standard of performance by the IIT. His ability to inspire both the academic and the supporting community to strive for excellence will depend a great deal on his qualities of leadership and his personal conduct and example. The Search Committee appointed for the Director's selection have to look for these qualities specifically.

A Director will have to be assisted by a number of faculty and non- faculty officers. He can have Deputy Directors and Deans to share the burden of academic administration. Deanship

is a corporate function and not a separate cadre position. The logical extension of the concept of a team is that these appointments should be co-terminus with the Director's tenure. A point has been made that if the tenure of all the functionaries like Deputy Director and Deans is co-terminus with that of the Director, then there could be a vacuum when the Director retires. On the other hand a Director whilst leaving the Institute may nominate people of his own choice which is unfair to his successor. The Deputy Director should be able to provide the guidance whenever Director is out and, therefore, he must have the confidence of the Director and must attune himself to the policies and guidelines evolved by the Director. Therefore, on the whole, we feel that balance of advantage lies in making these positions co-terminus with the tenure of the Director.

6.7 Heads of the Departments/Centres

The academic work of the IIT is transacted through Departments and Centres. The Statutes provides that:

- Each Department of the institute shall be placed in charge of a Head who shall be appointed by the Director from amongst the Professors, Associate Professors and Assistant Professors. Provided that when in the opinion of the Director the situation so demands, the Director may himself take temporary charge of a Department or place it under the charge of the Deputy Director or a Professor from another Department for a period not exceeding six months.
- The Head of a Department shall be responsible for the entire working of the Department, subject to the general control of the Director.
- It shall be the duty of the Head of the Department to see that the decisions of the authorities of the Institute and of the Director are faithfully carried out. He shall perform such other duties as may be assigned to him by the Director.

Similar practice is followed in respect of the Head of the Centre also. We have the following observations on the actual working of this structure:

- Academic ability of a faculty member is by no means an adequate criterion for good management, which is what the Head of Department is essentially required to ensure. There is a vital need to train both non-faculty and faculty members including the Director on modern management principles and procedures. It has been pointed out that the Head of the Department should be a selection post and not offered automatically to a professor on the principle of rotation. We agree with this suggestion provided persons so selected are those who have exhibited a flair for management. Therefore, we recommend that generally the principle of rotation of headship may be followed but with some flexibility.
- There is also a need to inject greater autonomy in the normal functioning of the Institute. To this extent there must be decentralization of administration and delegation of powers, accountability and responsibilities. Head of the Departments must enjoy larger freedom and should be able to act and take decisions within the framework laid-down by the Director.
- Heads of the Department will have to be responsible for the work of the Department to the Director and assist him. However they should be responsible to the respective Deans in the broad corporate areas assigned to them.

- The Head of the Department acts as an interface between his Department and the Institute. In spite of such a prominent role assigned to him there is a strong feeling that headship lacks the status and effectiveness attributed to the position. Therefore, it will be the responsibility of the Director to choose a person who will not only exhibit managerial talents, but also can fulfil the role of a spokesman for the department. Currently the tenure of Headship is for three years but it should be left to the Director to let one run the full term or make a new selection before the term ends, depending on the Director's assessment of one's effectiveness as a Head of the Department.

Apart from coordinating the academic administration of the Department, the Head has also some intangible roles e.g.

- He has to ensure that members of the department are familiar with the goals and objectives of the IIT.

- He has to ensure that members of his department or centre are aware of the procedures relating to their professional activities inside and outside the Institute and enforce them.

- He has to counsel and advise the faculty members in matters where individual interest may conflict with the goals or the image of the IIT.

- He has to supervise the outside professional activities of junior and senior faculty, and the students with a view to ensure academic integration.

6.8 Accent on Management

6.8.1 Registrar and Other Managers

The IIT Act specifies that:

- the Registrar of each Institute shall be appointed on such terms and conditions as may be laid down by the Statutes and shall be the custodian of records, the common seal, the funds of the Institute and such other property of the Institute as the Board shall commit to his charge;

- the Registrar shall act as the Secretary of the Board, the Senate, and such committees as may be prescribed by the Statutes;

- the Registrar shall be responsible to the Director for the proper discharge of his functions;

- the Registrar shall exercise such other powers and perform such other duties as may be assigned to him by the Act or the Statutes or by the Director.

As a Statutory Officer he thus constitutes an authority and a focus of power. This runs counter to a cardinal principle of efficient management viz. there can be only one source of power in one organisation. The title of the Registrar, therefore, needs to be redesignated and his functions performed by those who are trained to execute these functions with professional competence. The suggestions and recommendations contained in this regard need amendments of the Act and Statutes.

The Registrar with his supporting staff is the key figure in resolving problems of the workers, providing special knowledge in the management of estate, giving a thrust in financial management and providing a support to the primary functions of the IIT as a teaching and research Institution of National importance. The dimensions and complexities of problems in the areas mentioned are such today that the old concept of an all-pervasive authority like a University Registrar as conceived in the IIT Act is outmoded and needs a radical change.

There were many indications of lack of administrative competence and leadership which led us to come to this conclusion. We have mentioned earlier that the acceptance of government rules in toto is the cause of much of the rigidity felt by the academics. The IITs could have over the years framed their own rules but they did not do so. Likewise many of the Statutes need revision in the light of experience. In a sense, the absence of adequate administrative leadership is one of the reasons why necessary amendments of the Statutes leave alone a comprehensive study of them by the institute, has not taken place. It was brought to our notice that different rules have been applied in similar cases in the same IIT. There are no definite rules of fixation of pay and preparation of seniority lists etc. In the absence of any grievance procedure, the cases are decided in a variety of ways. Violation of the principles of natural justice is also alleged in such cases. There is an Institute Engineer who handles a large number of maintenance staff but he does not have time either to manage, assist or develop personal relationships with the staff working with him. Presentations made to us showed that a single-point authority like that of the Registrar is inadequate for a multi-faceted function. This is why the position of a Registrar is unable even to provide adequate administrative support to the faculty.

It is important that the staff officers are trained Managers and not mere Administrators. They should not deal with administration of crisis but work as Managers anticipating problems and provide managerial solutions thereof. We suggest, therefore, that the current functions expected of the Registrar should be done by specially trained persons-i) who may be called as a Chief Administrative Officer and (ii) a Finance Manager. The Chief Administrative Officer will, however, have to be assisted by a Personnel Manager. In addition to these each IIT should have (iii) an Estate Manager to look after the work relating to the Estate. Broadly all functions connected with the campus administration and academic administration etc. currently dealt with by Registrar, should be dealt with by the Chief Administrative Officer. Financial matters and matters connected with the funds of the Institute should be looked after by the Finance Manager. Similarly the campus and township buildings and assets and all work connected therewith should be looked after by Estate Manager. It is important that the qualifications for recruitment for these positions, cadre strength and administrative supporting staff for them, should be clearly prescribed from time to time. We understand that the Council of IITs has set up a Committee to look after the administrative staff structure as well as staff structure relating to engineering works. We hope that necessary strength and qualifications will be determined by this Committee. We suggest that appointments to the position of Chief Administrative Officer and other senior positions should be solely on contracts. Competent people may not normally come for short-contracts. The salary and the perquisites attached should therefore, be high enough to attract competent people. A suggestion was made that these changes can be brought about without creating a new designation of Chief Administrative Officer and it is advantageous to retain Registrar as that designation is sine-qua-non of a university. We are not merely suggesting a change of designation but a basic change in management structure where a statutory office is likely to be more a handicap than a help.

We also suggest that both the Finance Manager and Estate Manager should have, professional qualification, competence and experience. They should be of real assistance to a Director and his colleagues.

A key appointment will be that of the Personnel Manager assisting the Chief Administrative Officer. A Personnel Manager is required to interpret, to communicate and to administer the personnel policies of the IIT. His functions will include:

- Induction. of suitable persons consistent with the high standards of the IIT;
- Wage and salary administration;
- Relations with unions;
- Administration of terminal and other benefits;
- rendering advice and assistance in personnel matters to the employees as well as to the IIT management;
- developing and implementing programmes of personnel development and training.

All actions affecting the status of non-faculty personnel must be processed through the Personnel Manager including fresh appointments, promotions, transfers, change of pay, leave of absence and terminations. Generally his office should monitor the needs-of the IIT well in advance and have plans to match these with competent trained personnel. The Personnel Manager will make employees familiar with the policies of the IIT, attendance requirements and deal with grievances and Unions. The Personnel Manager will have to deal with various suggestions that we have made in our report.

We would reiterate that the key change in administration is the accent on management. The appointment of Personnel Manager and the way he establishes traditions would be very crucial for the future of the IIT.

It will be seen from diagram at Figure 6.8.1 that the Chief Administrative Officer only manages the administrative functions. Present functions of the Registrar in the matters of finance would be done by the Finance Manager and the administrative functions connected with the estate will be done by the Estate Manager; and they will both be reporting directly to the Chief Executive Officer viz. the Director. In this way the Chief Administrative Officer does not replace the Registrar and there are no dual power centres.

6.8.2A New Style of Management

IITs have at present neither the commercial nor the university type of management structure. Neither style of management is indeed appropriate. The IITs need their own special management style.

We have emphasised that the autonomy of IITs also implies internal autonomy and delegation of powers all through. The management must be able to give adequate powers to appropriate bodies and encourage them to use the powers and be accountable. The Board of

Governors should delegate most of its powers to the Director and ensure that the Director in his turn delegates downwards all through. Similarly there is a need to have academic delegation to various Boards of Studies and other authorities.

It is necessary to have a performance-oriented administrative structure.

We suggest that IITs should move towards a cluster type of management structure rather than a hierarchical and vertical one. The idea is to encourage a high degree of initiative and autonomy with responsibility and accountability. The system must support more people lower down to act in the best interests of the Institute rather than pass matter up for a decision. There must be a greater sense of a larger number of people participating in managing the IIT rather than a sole authority issuing final orders. The current ethos in administration is not in consonance with the academic climate needed for reaching excellence. Nor is the participation of the faculty indiscriminately in all administrative areas healthy. IITs must be bold enough to experiment and create their own culture, management style and structure to fulfil their own needs. We found nothing in the Act and Statutes which prohibits them to do so and the suggestions we have made in this report should be interpreted in this context.

SUMMARY

The Committee does not recommend any change in the composition or functions of the Council. However, there is a need for the Council to be assisted by two advisory committees, one for academic matters and the other for administrative matters. The Chairman of the Council will nominate the Chairmen of these committees from among the Council members. The Secretary of the Council will act as Member-Secretary of both these committees. (Para 6.1.2)

The Academic Advisory Committee will have in addition three Directors on rotational basis, five eminent men from industry, economic departments/agencies of government and from leaders in science, technology and higher education. (Para 6.1.2)

The Administrative Advisory Committee will have in addition three management experts from outside, the Financial Adviser to the Ministry of Human Resource Development and the senior most officer of the Ministry of Human Resource Development dealing with the IITs. All the five Directors of IITs will be members of this Committee. (Para 6.1.2)

The Council shall meet twice a year. The Advisory Committees shall meet four times a year. Whenever the Chairman is not present, a member will be temporarily elected to the chair and the meetings held. (Para 6.1.2)

The agenda for these meetings will include subjects proposed by various Boards of Governors, Directors and the Secretariat of the Council. (Para 6.1.2)

The Chairman of the Board of Governors should ordinarily be a non-official and a person of eminence. He should not be involved in matters of day-to-day nature in the running of the IIT. Where necessary, the Act and Statutes should be amended to ensure this. (Para 6.2)

Other members from outside, nominated to the Board by the Council and State Governments should be from among outstanding well reputed industrialists, technologists, scientists and

educationists. Such nominations should not be on an ex-officio basis. As far as possible, one distinguished alumni should find a place on the Board. (Para 6.2)

Agenda for the meetings should not be crowded with routine administrative matters. The Board should set up a committee to assist them in such matters. The Board should devote more time on items concerning growth, academic performance and linkages with outside bodies like industries, research and development institutes and other academic institutions. (Para 6.2)

The Board should meet at least four times in a year with a gap between any two meetings not exceeding 90 days. (Para 6.2)

The Finance Committee of IIT should also examine and recommend methods of resource-generation; examine and advise on proposals for financial support for students, faculty and other employees. (Para 6.3)

The Committee does not recommend any change in the composition of the Senate but it should appoint more committees to assist its work effectively. The Senate must review periodically and in a systematic manner the work of the Departments and Centres and present their appraisal to the Board. (Para 6.4)

Radical changes in the management structure are recommended. These will necessitate amendment of the Act and Statutes. (Para 6.5)

The Director shall be the Chief Executive as at present having a dual role-an academic head and an administrator. The post of Director shall be on contract as at present. (Para 6.6)

There should be no gap between the retirement of one incumbent and joining of another in the post of Director and the Search Committee should initiate its work well in time. The Director will be assisted by Deans in academic matters, students affairs, planning and research & consultancy. (Para 6.6)

The rank and requirements of the Deputy Director should be such that in the absence of the Director, he will act as Director. (Para 6.6)

The tenure of Deputy Director as well as of all Deans should be preferably co-terminus with that of the Director. (Para 6.6)

The set-up of the Heads of the Department/Centre should continue. The principle of rotation of headship may be followed but with some flexibility. They will work in close cooperation with Deans and the Deputy Director but will be accountable to the Director.

(Para 6.7)

The statutory position of the Registrar is incompatible with the management structure needed today in the IITs. All functions other than those connected with campus administration and finance, presently dealt with by Registrar, will be performed by the Chief Administrative Officer. The Chief Administrative Officer will also be incharge of personnel functions in which he will- be assisted by a trained Personnel Manager. (Para 6.8.1)

The campus and township management will be in the charge of an Estate Manager, finance and all matters connected with funds will be looked after by a Finance Manager, both professionally qualified. (Para 6.8.1)

The proposed structure is intended to facilitate a transformation in the style of management of the IIT and move to a cluster type of management structure from the present hierarchical and vertical one, and

-to derive optimal advantage of the degree of autonomy statutorily conferred on the IIT system;

- to decentralise decision making powers while ensuring conformity with corporate policy and goals;

- to ensure that administrative support system subserves the academic activities of the institute;

- to develop a greater sense of participation in management of the IIT, of all interested and concerned groups like the students, faculty, researchers and other employees. (Pars 6.8.2)

PERSONNEL MANAGEMENT

◆ 7.1 Personnel Policy

◆ 7.1.1 Laying down a Clear Personnel Policy

During our visits to IITs, a common complaint voiced was that there is no clear-cut enunciation of responsibilities and duties expected of the employees and that it was necessary to lay down in clear terms personnel policies and circulate them among the employees. As an example it was stated that there are many in the staff holding higher positions who are not given higher levels of responsibilities commensurate to their status. The Unions made the point that there is improper and uneven distribution of work leading often to the loss of interest among the employees, and reduced efficiency. It can ultimately result in lack of confidence in the authority and in the Institution as a whole.

Some Unions pointed out to us that in much the same manner as the faculty goes abroad in order to refurbish themselves, staff should be given opportunity for training and updating their skills. Whilst the analogy is fallacious we agree that each IIT must have well laid-out plans to train and retrain their staff and adequately support them to adjust quickly to the demands of newer ways of working and of higher productivity as well as help career progression inside or outside the Institute whenever opportunity offers.

A major grievance of the employees is shortage of housing on the campus. IITs now have a policy of hundred per cent housing for the faculty and 50 per cent for the non-faculty. Even the commitment of fifty percent housing for non-faculty is not fulfilled. Housing is a difficult problem but the IITs have to progress towards their target of 100 percent for faculty and 50 per cent for non-faculty by employing various measures such as acquire on rental basis a number of equivalent houses, lease those houses by themselves and let it to the employees on the payment of 10 per cent of the salary; IITs also can allow and assist private builders to build houses on their own which should be leased by the IIT to let it out to employees.

We have suggested introduction of computers and other modern means of management. IITs should help the staff for a smooth transition so that the staff can transfer their abilities and skills from the "ledger and voucher" level to one "operating computers and other modern office instruments".

Laying down a clear-cut personnel policy both for faculty and non- faculty and making it available to all employees are essential for a better functioning of the IITs. IITs must update from time to time these policies.

Faculty responsibilities should include;

- Understanding and administering of the policies of the IIT;
- establishing good relations with the employees;
- recognising work well-done and being concerned with the development of the capabilities of those working with them.

These should be regarded as obligatory and inherent responsibilities of all senior people.

We do not feel that a mere personal promotion, as it now obtains, can really instil in employees the joy of job-satisfaction. IITs initially did not make much progress in training 'on-the-job'. No thought was then given for a ladder of promotion but now some thought has been given in the form of a personal promotion. Our recommendation, however, is to aim at job-satisfaction and insist on performance at a higher level of efficiency rather than a mere award of a higher salary. If everybody by efflux of time gets promotion and no special effort is needed, the system ceases to stimulate anyone.

We noted that delay in making temporary appointments permanent, lack of social amenities and such other factors had lead to explosive situation from time to time in one IIT or another. While no one can prevent altogether the entry of politics into an IIT there is a need to look into grievances in advance and prevent entry of political pressure. Further, IITs' personnel policies should be such as to enthuse group-loyalty to the values and ideals for which the Institutes of Technology stand.

7.1.2 Improve Personnel Management Practices

IITs have a large staff particularly non-faculty who man the supportive services. Healthy personnel management practices in respect of this group is, therefore,

- a sense of accountability;
- an urge for development of their career useful to the IIT; and
- a commitment of discipline at all time to put forth their best.

We have already emphasised that the IITs have a programme for career- management with a view to improving efficiency, instil a value system for hard work, and provide them with opportunities for improvement, and upgrading their overall skill and efficiency but the IITs must evolve a good grievances settlement procedure.

We heard from the Employees' Unions that excellence in the IITs is possible if IIT managements are kind and generous to the employees and parity is maintained with faculty in the matter of awarding benefits by the IIT administration. The non-academic staff felt that they are discriminated against and neglected in respect of their career- planning. The academic staff on the other hand felt that cooperation from the employees is definitely wanting and they need to participate in the activities of the IITs more actively and enthusiastically.

To ensure such collective participation the first step is to lay down a clear and unambiguous procedure for mitigating legitimate grievances of individuals and effectively sort out the problems. Such procedure will, therefore, include;

- encouraging employees to discuss their work situation and problems with their immediate supervisors;
- expect supervisors to provide a supportive environment;

- fostering open communication related to their work-life;
- encouragement to resolve work-problems and grievances at the unit level;
- whenever a problem arises at the unit level individuals should feel free to discuss it with the next higher supervisor including and up to the Departmental Head or Personnel Manager and his designated colleagues;
- it should be open to individuals who do not feel that the matter has been resolved to ask for a formal enquiry. A senior person (say the Deputy Director) should attempt to resolve the matter within a specified time and give his report to the Director.

Once a formal enquiry starts, the attempt should be to resolve the issue within a limited time period. We would suggest that it should be possible to resolve issues within a month or so. If they are not resolved they should be referred to the next higher step within a month. If this cannot be followed then the aggrieved employee must be informed in writing and the Director kept informed. Every collective grievance has to be resolved with the respective representative groups by the management and there must be a clear procedure evolved.

We suggest that all decisions taken should be recorded in writing and given to the concerned administration or departmental head as well as the aggrieved party. Evolving sound personnel practices with a view to arrive at solutions will promote cooperation among all employees which we think is essential for the sound growth of the IITs.

7.1.3 Train Key Personnel in Management Areas

The IITs need to train their personnel, including the Director in modern management principles and practices so that they are able to;

- assess the cost effectiveness of their decisions;
- plan educational programmes other than the standard courses;
- acquire management skills such as problem-solving, team- building;
- instal a task-oriented system with programmed activities backed by an adequate information and monitoring system;
- projectise outside assignments from industry within time and cost boundaries;
- introduce more efficient equipment and systems in office administration.

IITs must provide an opportunity for training to their employees, to adapt to the changing needs. Retraining of technicians in computer and sophisticated instruments has become essential. There is a need for IITs to examine if the rules and regulations adopted by them earlier are able now to meet the objective of the Institution. Similarly several supporting functions like projects, symposium etc. could be organised in a better way provided the approach is one of 'management' rather than of 'administration'.

Much of the demand for representations on the Board or Senate etc. arises out of lack of participation in the decision making process by the employees, students, etc. We have recommended encouragement of participation in all decision-making processes. All employees/students must be a part of the process of arriving at decisions that affect their lives. It is this participatory ethics, as against rule by Statutes and preordained solutions, which will impart a new vitality to the working atmosphere of the IITs.

7.2 Other Services

Some of the IITs have nearly six times as many employees as the number of faculty. These employees aspire and wish to know the kind of future they could look forward to irrespective of the job they are doing. The broad categories of the employees are workshop staff, supporting staff-both technical and non-technical, administrative staff, clerical staff, peons/security guards etc. IITs were made responsible for their own water supply, electricity supply, drainage, road-construction, maintenance of buildings, hostels, gardens and so on. For all these purposes they required staff and numerically such staff recruited by them became larger than their faculty. This staff, of course, was necessary for the running and maintenance of workshops, laboratories-both teaching and research, for support facilities such as instrumentation, glass blowing, special fabrication, graphic arts and so on. They also needed supporting staff for library, academic records and for examination etc. But over a number of years attention was not paid to effective methods for containing the number and helping the existing ones to function more efficiently. It is clearly not possible to provide adequate career paths for such large number within the IIT. This is the biggest problem the IITs have today and time and again it has erupted disturbing the system.

In addition, they have a problem with the mess employees working in the Halls of Residences (or hostels) who are not considered, as the employees of the Institute but of the Hall or the Hostel. They have been gradually conceded all the facilities of the IIT employees yet they are not satisfied. We hope the Administrative Staff Structure Committee of the IIT Council will recommend solution to these problems.

We however, recommend meanwhile that as a matter of policy, IITs should not fill-up the vacancies arising unless they make a thorough study of the problems and arrive at a total solution. This study may be undertaken by the Council through a Committee or Consultants specifically appointed for this purpose.

It may be advisable in future to get as many technical staff as possible on deputation from organisations outside. This will at least obviate the disgruntlement arising out of lack of promotional opportunities. IITs by themselves can but create very limited promotional opportunities and, therefore, should resort more and more to contract appointments.

Similarly, it may be advisable as far the non-technical staff is concerned, to create a few selection grades rather than personal promotions with higher designations. Some positions of tradesmen, e.g. drivers and mechanics; medical and hostel employees or catering personnel can be hired on contract. A number of posts arising out of retirement should be given to the students for campus work on payment. This way they would support the students to earn extra money especially those who do not get any scholarships. Cutting down permanent staff on the Institute's role while at the same time taking steps to train the existing staff, improving their skill and efficiency would considerably improve the overall health of the IITs.

Some of the problems now perceived may have their roots in political and other situations outside the control of the IITs. The support of the Government would be necessary to contain or resolve some of these problems which may be beyond the control of the IITs.

7.2.1 Effective Maintenance, Up-keep and Repair of Equipment

IITs have a number of technical staff as instrument Mechanics. In Para 5.1.2 we have discussed about funds needed for removing instrument obsolescence. There is a need for a strong working Central Instrumentation Division centrally located in each IIT so that all instruments could be repaired. Such a division should also stock sufficient spare parts. This is an important and serious matter and we feel that equipment repaired and reconditioned saves money and time entailed in the purchase of new equipment. It is necessary that these personnel are given encouragement and status not as mere Mechanics but at a proper level so that they could put forth their best to solve the instrument and equipment maintenance problems which is a big handicap for the IITs.

7.2.2 Core Staff for Sponsored Projects

In Para 4.4.7 we mentioned the pestering problem of staff engaged for sponsored projects who have continued to linger on from project to project. This was compounded further by some IITs regularising some of such staff as Institute staff, even though Institute requirements did not warrant such addition. However, the human problem of these project staff in the campus still need resolution at least for the future.

We suggest that:

- The IIT Management should take extra care in future while employing project personnel. They should continue to help the existing ones by increasing their technical competence in an area where jobs are available and help them move out.
- IITs should actively convass with those who sponsored the projects to absorb the competent technical staff who worked on their projects and would be useful to them to implement the solutions arrived at the IIT through the project.
- IITs should build up a core of higher qualified scientific staff to work on various mission-oriented programmes which Departments like Defence Research, Space, Atomic Energy, Electronics etc. are regularly sponsoring. This staffs is not to substitute faculty duties in laboratories. These cadres should have career-opportunities equal to faculty.
- The core strength in future should be determined strictly related to the needs and not as a social measure of employment. If any extra staffs are employed to cover a situation in future their services must be terminated at the end of a project and they should not be continued in another job.
- The proposed Industrial Foundation should give priority to competent and qualified persons available at present in the IITs.

SUMMARY

There is a need for the IITs to have clear-cut personnel policies which include provision for career development, in-service training for vertical, and horizontal mobility and enhancement of skills. (Para 7.1.1)

It is recommended that IITs improve their personnel management practices especially with regard to non-faculty employees.

These include:

- method of recruitment;
- method of evaluating them for purpose of career development and promotion against a well set visible promotion policy;
- methods of rewarding and punishing them;
- a sound grievance procedure. (Para 7.1.2)

In handling of the affairs of the institute, the IITs have to shift their perception from one of administration to one of management. For this purpose it is necessary that all key personnel should have exposure to management training. (Para 7.1.3)

There is a need to increasingly resort to contracting for services rather than building-up permanent staff establishments. Gradually such an approach would help in reducing the burdens of administration and enabling the IIT to devote more time and energy to its primary functions. Students can also be given the opportunity to earn by doing some of the campus work part-time. (Para 7.2)

Some of the problems faced in the IITs in relation to deficiencies noticed in work-ethos and discipline have their roots in the external environment for which the IITs cannot be faulted. (Para 7.2)

Staff for instrumentation, maintenance, upkeep and repair of equipment should be given every encouragement and status to ensure the effective maintenance and use of high cost equipment and a central division be created in each IIT for this purpose. (Para 7.2.1)

The Committee recommends that IITs should have a core of competent scientific staff on permanent basis with all service benefits for sponsored projects. Expenses on account of the core staff should be suitably covered as overheads, charged to the projects. Other temporary staff recruited for a project must be terminated at the end of the project. (Para 7.2.2)

ACKNOWLEDGEMENT

The task assigned to us was interesting and absorbing. It could have never been accomplished without the cooperation of many who gave us their time, who attended interviews arranged for them and who supplemented the data whenever requested. We wish to record our sincere thanks to all of them. It Is impossible to individually acknowledge their efforts but we would like to make a mention of some groups such as:

- The Boards of Governors of all the IITs;
- The Unions/Associations of specific employees' groups;
- Individuals in the IITs who gave evidences and represented some aspect or the other of the working of the IITs;
- Research Scholars;
- The Faculty;
- Senate Members;
- Directors of the IITs;
- The Chairmen of IITs;
- The past members of the Board of Governors;
- Representatives of the Industry, alumni, other Engineering Colleges, R&D; Organizations etc.

Others who helped us were from Government Departments like:

- The Education Secretary;
- The Educational Adviser (Technical);
- Representatives of the Scientific Departments of the Government of India etc.

Yet others were those who responded to our enquiries such as:

- Secretaries to the Government of India;
- Directors of National Laboratories and Principals of Regional Engineering Colleges;
- Vice-Chancellors of Central and some other selected Universities; -important Industries/business organisations, State Governments, Electricity Boards;
- All Science Academies, Directors of the Institutes of Management;

- Heads of Public Sector Undertakings;
- The University Grants Commission and a few other universities/institutions.

Another category of persons who helped us were Indians settled abroad, particularly IIT alumni and IIT Professors. Some of the Professors from the foreign countries were those who helped to set up the IITs initially through the Aid Programmes. In this group we particularly thank the large number of alumni who responded to the advertisement made through our Embassy in Washington. Their candid response appreciative as well as critical was most useful to us. In addition, we wish to thank our Embassy of India, Washington, U.S.A. also.

While we considered most of the suggestions from others relating to our terms of reference, some of those received after we concluded our deliberations could not be taken into account. However, much a Committee tries to be comprehensive there are always some interesting aspects which are left uncovered. In this case they are:

- A cost/benefit analysis of IITs;
- Locational advantage, if any, of each IIT;
- Relative advantages gained by technical collaboration with different countries in the IITs;
- Whether the JEE preferentially helps the urban elite;
- Data on placement of IIT graduates in India and abroad;
- A fuller assessment of IITs' contribution to industrial, economic and social development and to the store of fundamental knowledge as well as its position as a leader;
- Technical manpower planning relating to technology development;
- Technology and the future.

We hope that the Council or other Committees of the Council will initiate some of these studies. We wish to end with the thought that if the IITs wish to become torch bearers of Technical Education of the Twenty-first century they ought to be more critical and demanding about themselves than we may appear to have been in our comments. If they do so on their own, we are sure that they will reach their ideals sooner and in a better way. They hold the future in their hands. It is a bright future. We wish the IITs well.

SUMMARY

The Committee could not cover some aspects of interest for lack of data and time. It is recommended that IITs take up or sponsor studies relating to some of these aspects viz.

- cost/benefit analysis of IITs;
- The locational advantages, if any, of each IIT;

- The advantages gained by the IITs through technical collaboration with different countries;
- Whether JEE preferentially helps the urban elite;
- Data on placement of IIT graduates in India and abroad;
- IITs' contribution to industrial, economic and social development and to the store of fundamental knowledge as well as its position as a leader;
- Technical manpower planning relating to technology development;
- Technology and the future. (Pars 8)

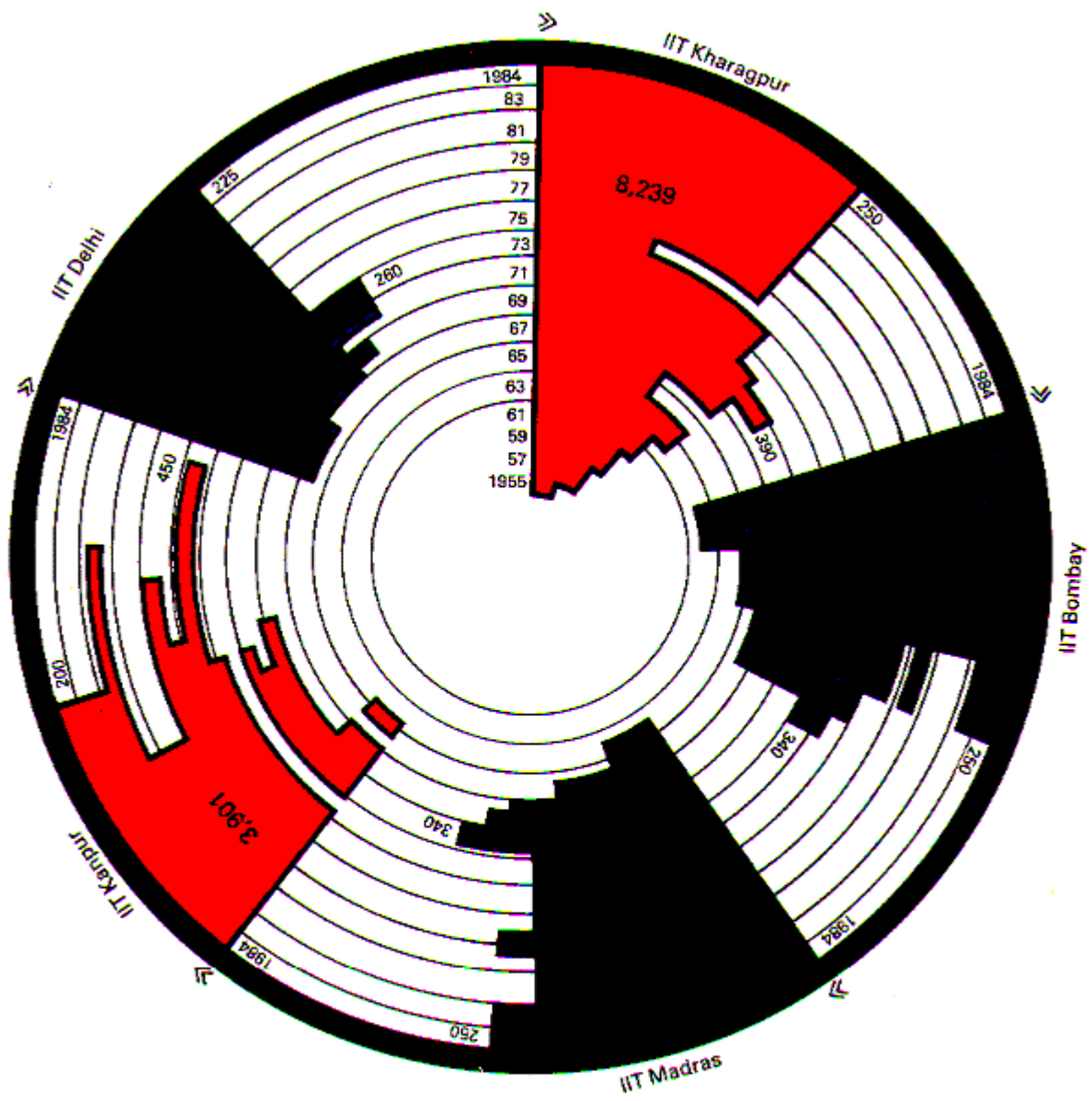
TABLES & FIGURES

Out-turn of Undergraduates from all IITs

Year	IIT Kharagpur	IIT Bombay	IIT Madras	IIT* Kanpur	IIT Delhi
1955	169	-	-	-	-
1956	221	-	-	-	-
1957	236	-	-	-	-
1958	253	-	-	-	-
1959	280	-	-	-	-
1960	317	-	-	-	-
1961	306	-	-	-	-
1962	354	70	-	-	-
1963	318	79	-	-	-
1964	215	115	92	-	-
1965	248	197	115	66	-
1966	344	289	203	-	111
1967	351	304	259	85	202
1968	393	285	292	247	229
1969	332	302	321	197	186
1970	290	274	345	234	258
1971	288	330	230	-	246
1972	312	342	235	243	251
1973	157	304	209	452	187
1974	266	268	236	-	197
1975	272	256	244	258	215
1976	235	209	280	323	227
1977	251	263	267	182	212
1978	218	213	219	173	187
1979	304	214	234	172	224
1980	273	223	214	368	208
1981	293	242	251	222	203
1982	270	253	260	255	203
1983	211	253	216	221	209
1984	262	289	261	203	225
Total	8,239	5,574	4,983	3,901	3,980

* Unlike other IITs, IIT Kanpur has intimated the figures for the Years based on the Convocation held and hence the gap during the years 1966, 1971 and 1974.

Table 2.2A



B.TECH. GRADUATES PRODUCED BY IITs

Fig. 2.2(i)

Q.I.P. Scholars Trained

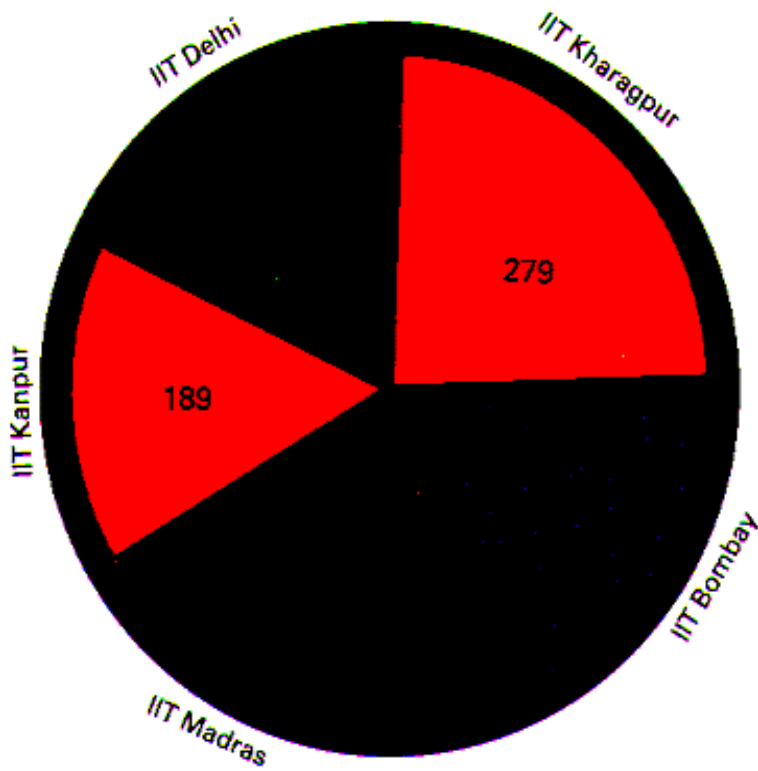
Year	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi
1970	1	-	12	-	-
1971	43	10	18	-	-
1972	31	16	20	16	-
1973	32	15	23	15	-
1974	29	21	23	-	18
1975	21	13	31	30	28
1976	19	16	22	15	22
1977	17	17	18	20	17
1978	17	14	17	14	17
1979	25	8	18	9	10
1980	15	12	14	16	16
1981	23	11	19	13	18
1982	1	17	25	15	12
1983	5	12	22	15	25
1984	-	17	-	11	16
Total	279	199	282	189	199

Table 2.2B

F.I.P. Scholars Trained

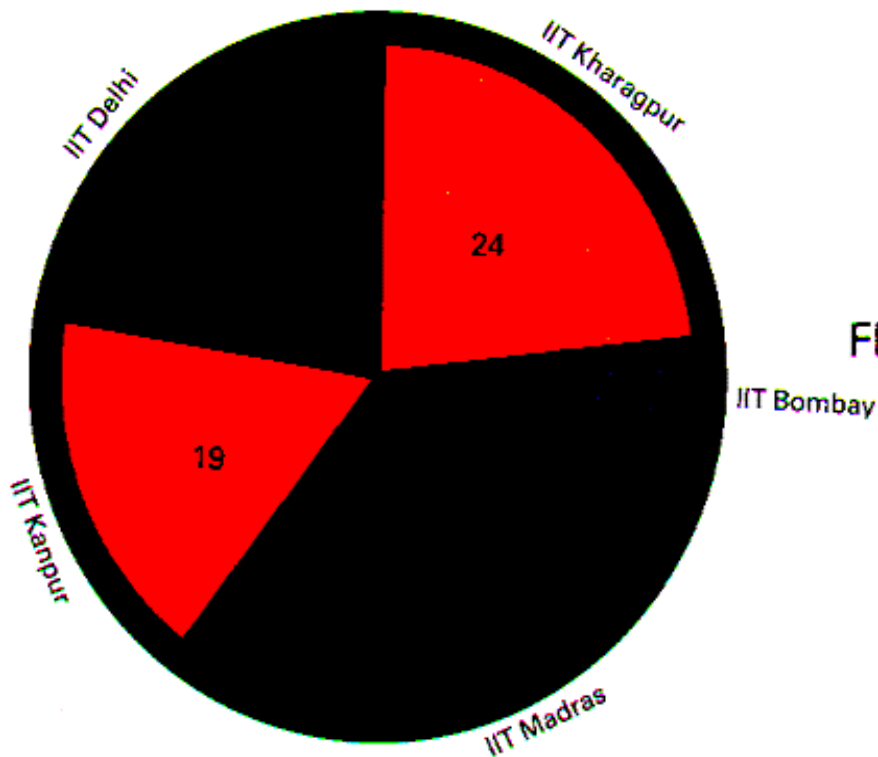
Year	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi
1975	-	-	-	-	1
1976	8	-	4	-	-
1977	5	-	10	-	-
1978	3	-	1	-	-
1979	3	-	1	-	1
1980	4	-	15	4	8
1981	-	2	5	2	5
1982	-	2	-	5	2
1983	1	-	-	8	1
1984	-	-	-	-	6
Total	24	4	36	19	24

Table2.2C



QIP SCHOLARS

Fig. 2.2(II)



FIP SCHOLARS

Fig. 2.2(III)

TRAINING AT IITs

◆ Number of Institutions Helped by IITs
under the Institutional

Network Scheme of the Ministry of Human
Resource Development

Year	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi
1971	-	-	-	-	3
1972	-	-	-	-	6
1973	-	-	-	-	6
1974	-	-	-	-	7
1975	-	-	-	-	8
1976	8	-	-	-	10
1977	5	-	-	-	10
1978	3	-	-	-	10
1979	3	1	-	-	10
1980	4	1	-	-	10
1981	-	2	5	2	10
1982	-	2	5	2	10
1983	1	5	5	2	10
1984	-	2	5	-	10

Table 2.2D

Student Population

Year	IIT Kharagpur		Ratio	IIT Bombay		Ratio	IIT Madras		Ratio	IIT Kanpur		Ratio	IIT Delhi		Ratio
	UG	PG		UG	PG		UG	PG		UG	PG		UG	PG	
	1974-75	1631	629	2.59:1	1441	781	1.85:1	1231	1023	1.2:1	1271	639	1.99:1	1156	745
1975-76	1629	709	2.30:1	1344	668	2.01:1	1244	1086	1.15:1	1116	745	1.50:1	1125	796	1.41:1
1976-77	1722	713	2.42:1	1288	715	1.80:1	1259	1006	1.25:1	1161	788	1.47:1	1111	908	1.22:1
1977-78	1605	781	2.06:1	1303	970	1.34:1	1223	1104	1.11:1	1256	789	1.59:1	1097	1010	1.09:1
1978-79	1575	749	2.10:1	1347	1047	1.29:1	1240	1286	0.96:1	1269	751	1.69:1	1140	1083	1.05:1
1979-80	1522	684	2.23:1	1375	920	1.49:1	1237	1282	0.96:1	1263	737	1.71:1	1170	1213	0.96:1
1980-81	1428	666	2.14:1	1350	1159	1.16:1	1242	1352	0.92:1	1213	729	1.66:1	1189	1269	0.94:1
1981-82	1405	928	1.51:1	1355	1207	1.12:1	1208	1323	0.91:1	1146	708	1.62:1	1125	1461	0.77:1
1982-83	1397	900	1.55:1	1372	1359	1.1:1	1191	1387	0.86:1	1126	682	1.65:1	1130	1604	0.70:1
1983-84	1458	923	1.58:1	1307	1339	0.98:1	1244	1102	1.13:1	1156	736	1.57:1	1153	1415	0.81:1
1984-85	1367	660	2.07:1	1309	1499	0.87:1	1246	1207	1.03:1	1167	763	1.53:1	1151	1557	0.74:1

Table 4.13



IIT BOMBAY—CAMPUS LAY-OUT

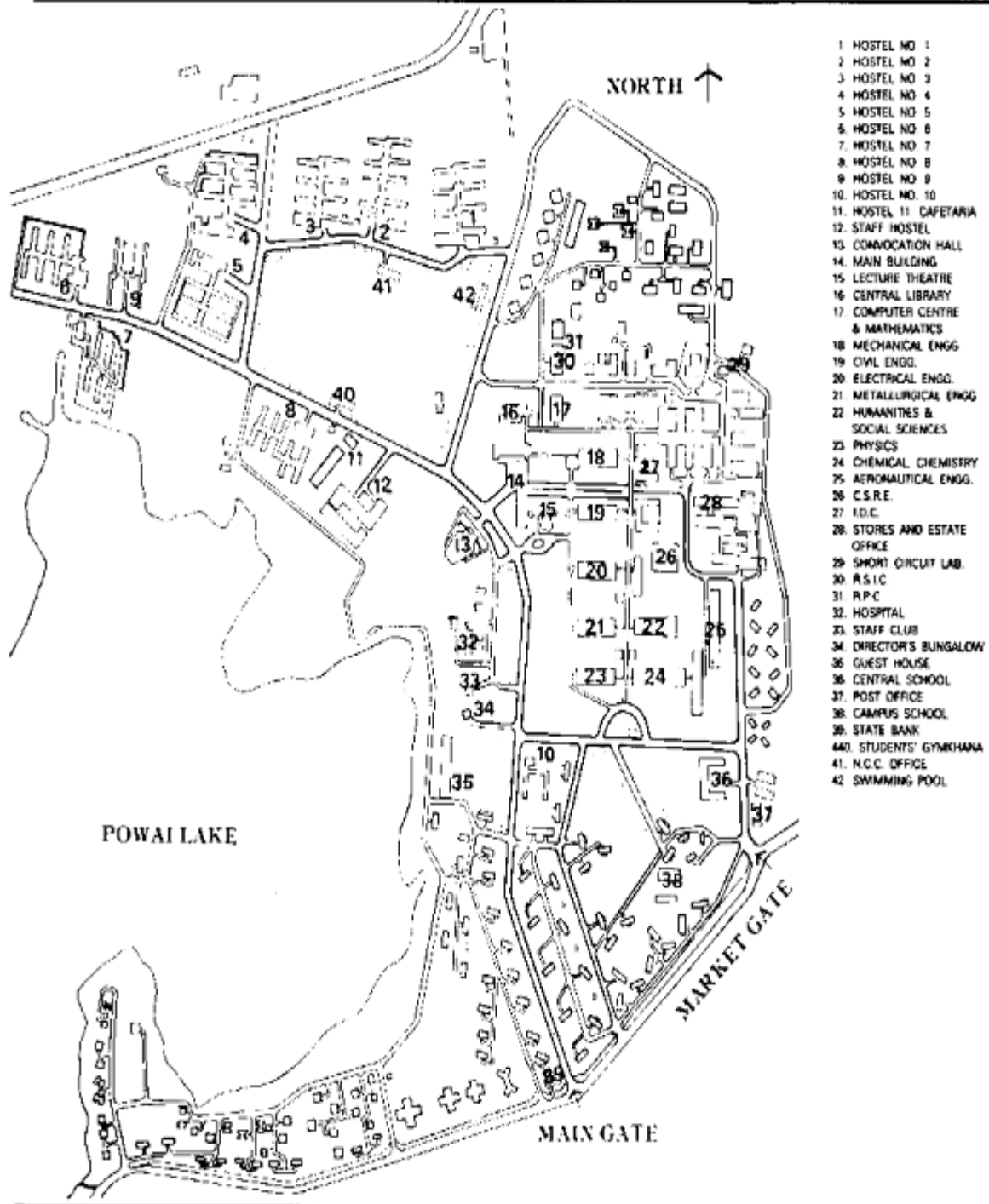


Figure 4.1.4 (II)

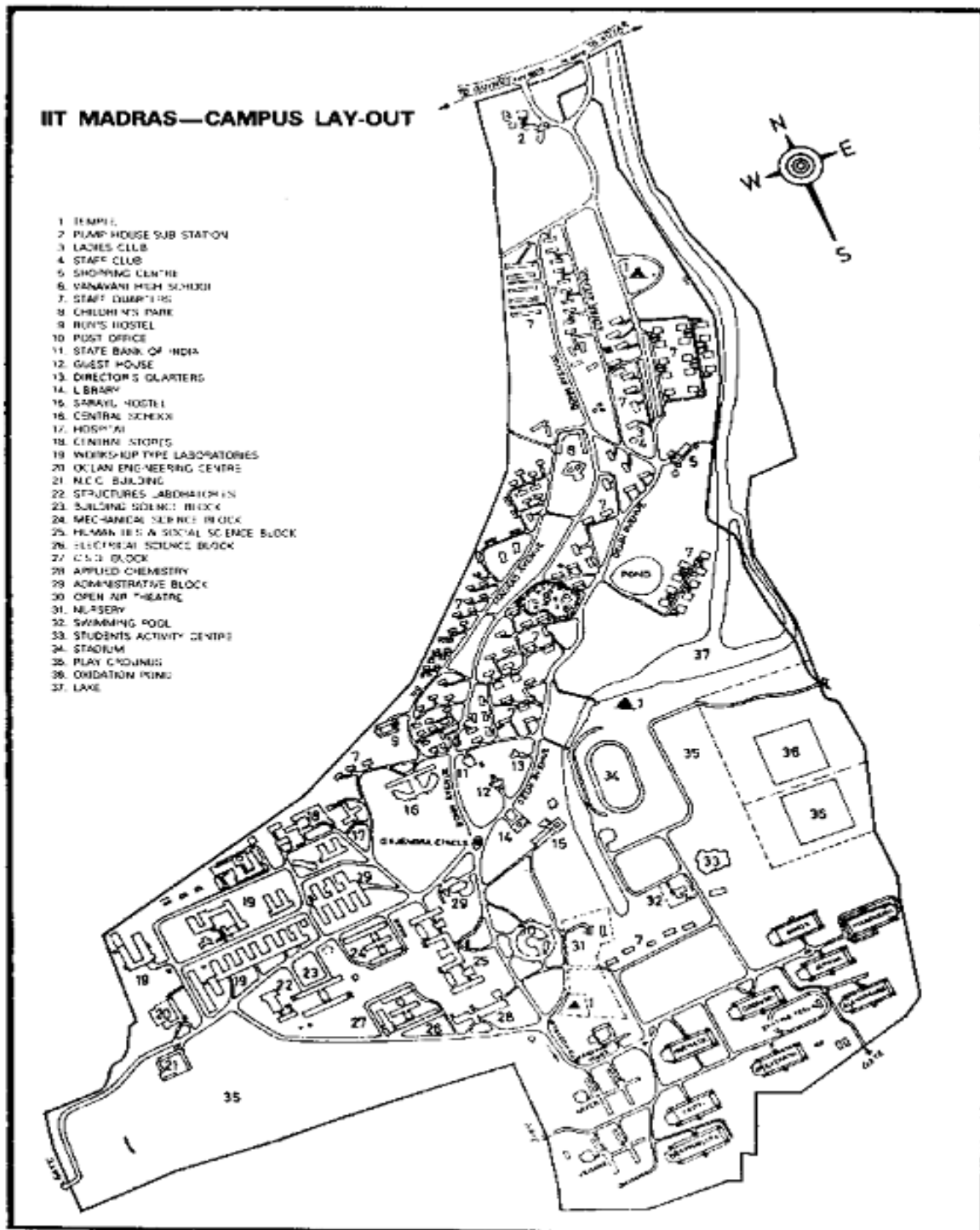
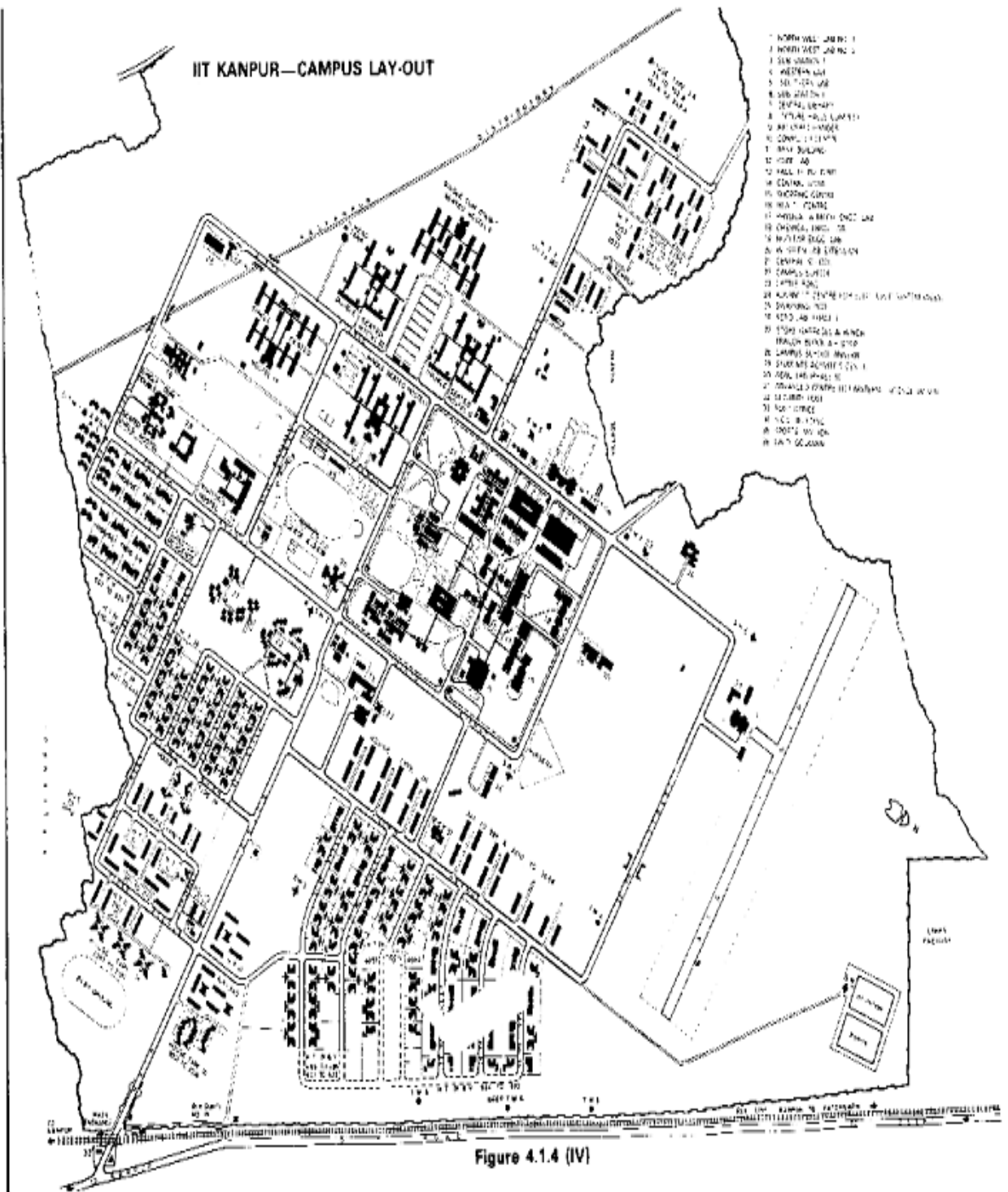


Figure 4.1.4 (III)



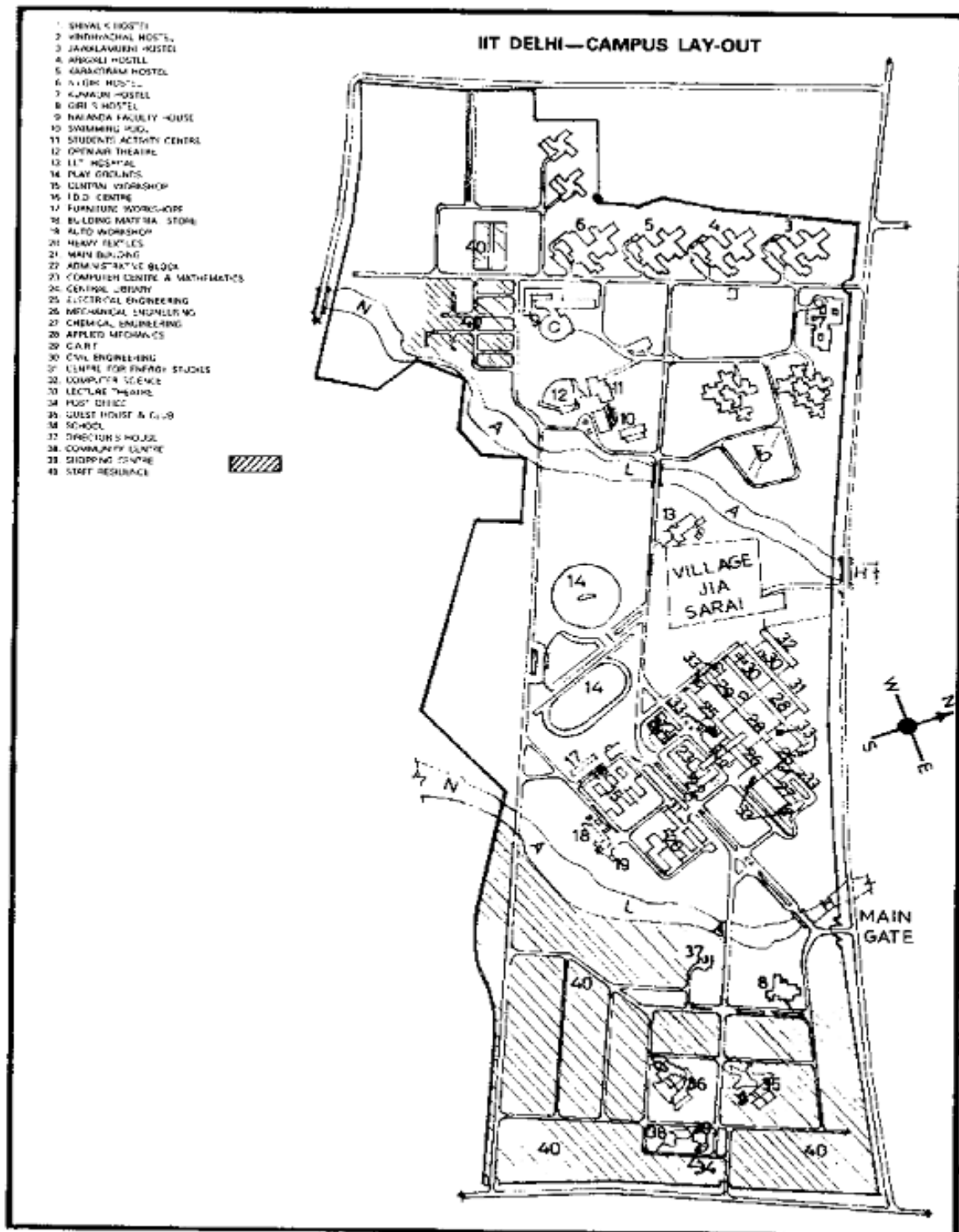


Figure 4.1.4 (V)

Postgraduate Programmes offered by IITs

IIT Kharagpur

M.Tech./M.Arch.

1. Aeronautical Engineering
2. Farm Machinery & Power
3. Soil and Water Conservation Engineering
4. Dairy & Food Engineering
5. Applied Botany
6. Water Resources Development & Management
7. Aquacultural Engineering
8. Chemical Engineering Plant Design & Fabrication
9. Coal Process Engineering,
10. Petroleum Refinery Engineering & Petrochemicals
11. Process Simulation, Optimisation and Control
12. Minerals Resources Development & Management
13. Water Resources Engineering
14. Highway and Traffic Engineering
15. Environmental Engineering and Sanitation
16. Soil Mechanics and Foundation Engineering
17. Structural Engineering
18. Control System Engineering
19. Machine Drives & Power Electronics
20. Power Systems Engineering
21. Instrumentation

22. Automation & Control Engineering
23. Microwave and Radar Engineering
24. Satellite Communication and Remote Sensing Engineering
25. Integrated Circuits and Systems Engineering
26. Computer Engineering
27. Industrial Management
28. Industrial Engineering and Operation Research
29. Systems Engineering and Management
30. Maintenance Engineering and Management
31. Foundry Engineering
32. Thermal Engineering
33. Machine Design
34. Machine Tool Engineering
35. Mechanical Handling Science and Technology
36. Production Science and Technology
37. Machine Dynamics
38. Metallurgical Engineering
39. Mine Planning and Mechanisation
40. Marine Technology
41. Cryogenic Engineering
42. Materials Science & Engineering
43. Post-Harvest Engineering
44. Microwaves and Optical Communication Engineering
45. Reliability Engineering
46. Rubber Technology

47. High Pressure Technology & Catalysis
 48. Applied Geology
 49. Exploration Geophysics
 50. Geochemistry
 51. Computer Science and Data Processing
 52. Computational Mechanics
 53. Industrial Physics
 54. Architecture
 55. City Planning
 56. Regional Planning
 57. Human Resources Development and Management
-

 **IIT Bombay**

 **M.Tech.**

1. Aeronautical Engineering
2. Chemical Engineering
3. Civil Engineering
4. Computer Science
5. Electrical Engineering
6. Mechanical Engineering
7. Metallurgical Engineering
8. Corrosion Science & Engineering
9. Energy Systems Engineering
10. Environmental Science & Engineering
11. Industrial Engineering and operations Research

12. Industrial Management
13. Material Science
14. Systems and Control Engineering
15. Reliability Engineering

 **M.Des.**

16. Industrial Design
17. Visual Communication

 **D.I.I.T.**

18. Dock and Harbour Engineering

 **M.Sc.**

19. Applied Geology
20. Chemistry
21. Physics
22. Mathematics (Pure Mathematics)
23. Mathematics (Statistics and Operations Research)
24. Mathematics (Computer Science)
25. Mathematics (Applied Mathematics)

 **IIT Madras**

 **M. Tech.**

1. Aeronautical Engineering
2. Engineering Mechanics
3. Industrial Tribology
4. Maintenance Engineering & Management

5. Chemical Engineering
6. Civil Engineering
7. Computer Science
8. Electrical Engineering
9. Industrial Management
10. Mechanical Engineering
11. Industrial Metallurgy
12. Ocean Engineering
13. Solid State Technology

M.Sc.

14. Chemistry 1
 5. Mathematics
 16. Physics
-

IIT Kanpur

M.Tech.

1. Aeronautical Engineering
2. Chemical Engineering
3. Civil Engineering
4. Computer Science
5. Electrical Engineering
6. Mechanical Engineering
7. Metallurgical Engineering
8. Industrial & Management Engineering

9. Materials Science

10. Nuclear Engineering & Technology

 **M.Sc. (5 yrs)**

11. Chemistry

12. Mathematics

13. Physics

 **M.Sc. (2 yrs)**

14. Chemistry

15. Mathematics

16. Physics

17. Statistics

 **IIT Delhi**

 **M.Tech.**

1. Applied Mechanics

2. Design Engineering

3. Process Engineering & Design

4. Modern Methods of Chemical Analysis & Control

5. Soil Mechanics & Foundation Engineering

6. Structural Engineering

7. Water Resources Engineering

8. Rock Mechanics

9. Building Science & Construction Management

10. Communication & Radar Engineering

11. Control Engineering & Instrumentation
12. Integrated Electronics & Circuits
13. Power Apparatus & Systems
14. Computer Technology
15. Behavioural & Social Sciences
16. Computer Science
17. Thermal Engineering
18. Production Engineering
19. Industrial Engineering
20. Design of Mechanical Equipment
21. Applied Optics
22. Solid State Materials
23. Fibre Science & Technology
24. Textile Engineering
25. Biochemical Engineering & Biotechnology
26. Energy Studies
27. Industrial Tribology & Maintenance*
28. Management & Systems"
29. Polymer Science & Technology
30. Opto-Electronics & Optical Communication

 **M.Sc.**

31. Chemistry
32. Mathematics
33. Physics

 **D.I.I.T.**

34. Naval Construction-for sponsored candidates from Indian Navy.

* This programme is run exclusively for sponsored Executives/Technocrats/Engineering Managers from Industry/Public Undertakings. The sponsoring organisation has to indicate the project of its interest of one-year duration with the name of the guide.

** This course is also run on part-time basis in the evening exclusively for the sponsored Executives of Public Sector Undertakings.

Table 4.3.1A

Intake and Out-turn of Postgraduates from all IITs

(1977-1983)

Institution	Sanctioned Intake	Actual Intake	Postgraduates Produced
1. IIT Kharagpur	3121	2811	1773
2. IIT Bombay	1559	1612	1082
3. IIT Madras	1760	1804	1336
4. IIT Kanpur	2819	2009	936
5. IIT Delhi	1742	2211	1004
Total	11,001	10,447	6,131

Table 4.3.1 B

An example of Yardsticks for Selection and Evaluation of Technological Research Reports

A. Background Information

1. Project Title

2. Name of Sponsoring/Supporting Institution:

The category to which the sponsoring/supporting institution belongs:

(a) IIT itself

(b) Government R&D; Institution

(c) Government Department or Ministry

(d) Public Sector Organisation

(e) Private Sector Organisation

Please give the name of the concerned department (s) or division (s) of the institution.

3. Estimated/Actual Project Cost

4. Method and Sources of Finance

5. Estimated/Actual Project duration

6. Project Focus:

(a) Basic Research includes research projects which represent fundamental investigations for the advancement of scientific knowledge and which do not have specific commercial objectives.

(b) Applied Research includes research projects which represent investigations directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either product or processes.

(c) Development Research includes technical activity concerned with non-routine problems which are encountered in translating research findings or other general scientific knowledge into marketable products or processes.

(d) Design Research includes evolving of new design approaches such as computer simulation and use of orthogonal arrays/finite element method etc. for design optimisation. Also to undertake theoretical and experimental studies which are not specific to a particular size or design and the results which can facilitate improved design for an entire range of product.

(e) Application Research includes studies in the areas of application engineering and systems engineering, cutting across specific product and processes areas as required.

B. Specific Benefits

7. Technological Benefits

7.1 Development of specific product/process

(a) Is it completely a new product/process? Specify the old technology it replaces and the technological and economic benefits derivable.

(b) Is it an improvement in an existing product/process? Please specify the improvement in quality, applicability, and cost of production.

7.2 Improvement in Product Design

Please specify the improvement in the following parameters:

a) Overall cost reduction per unit

(b) Size reduction

(c) Material content reduction-specify the material saved

(d) Substitution of critical materials/not-easily available materials

(e) Improvement in performance parameters applicable to the product

(f) Improvement in customer acceptance-Attach acceptance data or certificate

7.3 Improved Process Design Please specify the improvement on the following parameters:

(a) Simplification of the process

(b) Energy saving in the new process

(c) Saving in capital investment

7.4 Application know-how

(a) Better maintainability

(b) Ease of operation

8. Potential/Actual Economic Benefits

8.1 Lump sum and Royalty earnings

- 8.2 Import substitution-specify criticality
- 8.3 Foreign exchange saving-specify annual saving to the country
- 8.4 Export promotion
- 8.5 Foreign exchange earnings (per year)
- 9. Other benefits
 - 9.1 Patents-National and international
 - 9.2 Papers published in National/International journals
 - 9.3 Achievement of "industry-institute" cooperation
 - 9.4 Achievement of "inter-disciplinary team-work"
 - 9.5 Achievement of appropriate technology in national perspective

C. Project Monitoring and Review

Based on the planned time duration, cost estimates and the benefits anticipated, the project should be reviewed monthly/quarterly.

Linkage between Universities and Industries in Brazil

In the matter of linkage with Industry the strategy followed by Brazil to create an institutional framework for promoting indigenous S&T; development may be of interest and relevance considering the progress Brazil as developing country has made in self-sufficiency and competitiveness in industry. The institutions created are:

Apex Funding Agency

The FINEP (Studies and Projects Financing Agency) is a government enterprise created in 1967 with the objective of financing all phases of the creative process and knowledge absorption from basic research at academic institutions to the development and use of new technologies by industry. Among the varied responsibilities of FINEP are:

- Providing financial support to local enterprises (not controlled by foreigners) in such activities as setting up R&D; centres, purchase and absorption of indigenous technology, market tests, creation of products and processes and quality control.

- Financing the contracting of local consulting firms for feasibility studies, studies aimed at improving productive capacity and basic project formulation.
- Giving support to local consultancy firms for investments needed to improve their technical levels, establishing computer systems, training of personnel, execution of services requiring funds larger than normal and export of consultancy services.
- Granting financial support to universities and research institutions for their research projects, equipment purchase and the like.

The FINEP operates through a network of financing agents represented in the entire country of Brazil by a group of 12 development banks and 15 commercial banks.

Regulation of Know-how Imports

The INPI (National Institute of Industrial Property), formed in 1972, has been responsible for submission and approval of contracts regarding technology import, use of patents and technical services, and trademarks. The institute gives priority to foreign technology which may lead to import substitution or exports. Simultaneously, it tries to limit expenditure which results from the import of technology or the use of foreign industrial property (patents and trademarks) both through the reduction of such imports and the improvement of the bargaining power of Brazilian businesses. In this context, INPI limits the duration and volume of payments for technology and forbids restrictive clauses (like export restrictions, imports with strings, confidentiality after termination of a contract etc.)

The INPI tries to encourage Brazilian companies to broaden their technological activities and to use the domestic R&D; capabilities. In some cases, it may even require that investments in R&D; be made as a counterpart for technology imports and the use of Brazilian technology whenever available. The INPI also functions as an information bank for technologies which are not patented within the country and can be freely used.

Many of these measures were taken by the IN PI in recent years and the effect has been reflected in a noticeable decreasing trend in the expenditure on technology imports.

Fillip to Innovation

The technology innovation programme is an effort started in 1981 to promote and commercialise the technologies generated in the universities and research institutes. At the same time, the programme also intends to solve the technological problem of the small and medium scale industries by utilising the capabilities of the R&D; sector.

At the operative end of the programme are the nuclei for technological innovation (NITs) set up in the major universities and research institutes. The NITs are responsible for the coupling between the technological supply and demand in their respective areas. Fifteen such NITs have been set up so far.

Vendor Development

The NAIs (Centres for Linkage with Industry) were originally set up in government-owned corporations, back in the early seventies to increase the percentage of indigenous procurement of parts and components by these corporations. These centres were subordinated to a committee whose executive secretariat was the government funding agency, FINEP.

By the end of 1978 there were as many as 106 NAIs. Their record in technology import substitution and in promoting the technological development of the vendors to the State-owned corporations varies according to the sector involved. The success in areas such as telecommunications, electric power and oil are truly noteworthy. Significantly, these are the sectors wherein the State-owned corporations are investing more heavily in their own R&D; capability and in contracting outside research.

Table 4.5.3

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Courses Available at the Five Institutes						
S.No.	COURSE Duration and Name	INSTITUTE				Delhi
		Kharagpur	Bombay	Madras	Kanpur	
		G	B	M	N	D
B.Tech: 4 years						
1.	Aeronautical Engg.	GAE	SAE	MAE	NAE	
2.	Agricultural Engg.	GAG				
3.	Chemical Engg.	GCH	BCH	MCH	NCH	DCH
4.	Civil Engg.	GCE	BCE	MCE	NCE	DCE
5.	Computer Science	GCS	BCS	MCS	NCS	DCS
6.	Electrical Engg. (Power)			MEP		
7.	Electrical Engg.	GEE	BEE		NEE	DEE
8.	Electronics & E.C Engg.	GEC		MEC		
9.	Mechanical Engg.	GME	BME	MME	NME	DME
10.	Metallurgical Engg.	GMT	BMT	MMT	NMT	
11.	Mining Engg.	GMI				
12.	Naval Architecture			MNA		
13.	Textile Technology					DTX
14.	Engineering Physics		BPE			
15.	Energy Engg.	GEG				
16.	Instrumentation Engg.	GIE				
17.	Manufacturing Science & Engg.	GMF				
B. Arch.: 5 years						
18.	Architecture	GAR				
Integrated M.Sc.: 5 years						
19.	Chemistry	GMC	BMC		NMC	
20.	Mathematics	GMM			NMM	
21.	Physics	GMP			NMP	
22.	Applied Geology	GMG				
23.	Exploration Geophysics	GMX				
24.	Statistics				NMS	

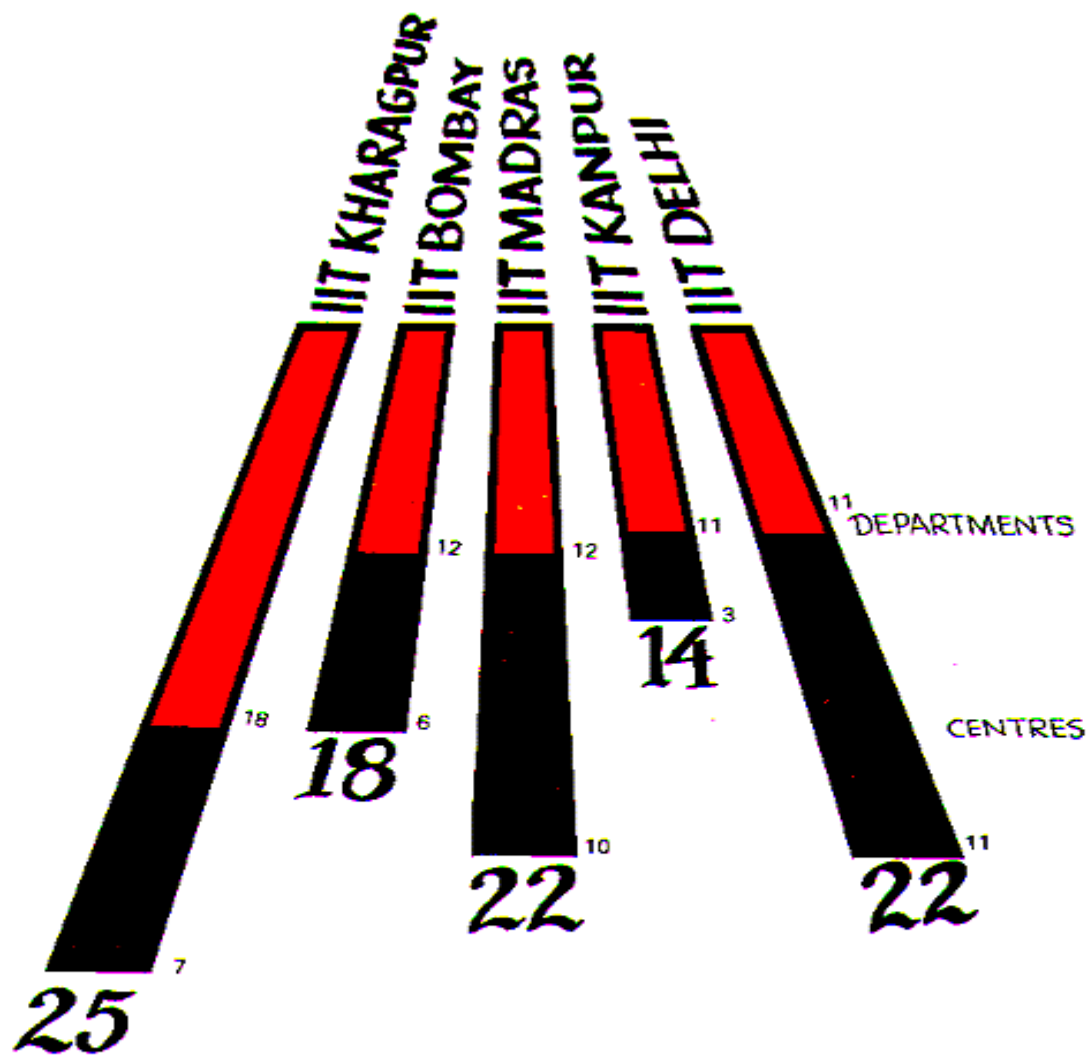
Table 4.6.1

Doctorate Produced by IITs

		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total
IIT Kharagpur	Engg./Tech.	25	24	26	27	25	33	24	23	27	33	23	290
	Science	31	31	28	17	33	18	36	44	53	36	27	351
	Total	56	55	52	44	58	51	60	67	80	68	50	641
IIT Bombay	Engg./Tech.	21	19	29	41	26	26	21	38	40	28	36	325
	Science	16	21	30	23	30	20	28	42	30	40	35	315
	Total	37	40	59	64	56	46	49	80	70	68	71	640
IIT Madras	Engg./Tech.	20	51	33	37	27	37	26	38	38	41	28	376
	Science	25	23	22	20	17	18	26	40	30	31	36	268
	Total	45	74	55	57	44	55	52	78	68	72	64	664
IIT* Kanpur	Engg./Tech.	—	36	21	38	5	54	28	30	29	15	—	258
	Science	—	41	21	26	6	51	46	30	36	30	—	267
	Total	—	77	42	64	11	105	74	60	65	45	—	543
IIT Delhi	Engg./Tech.	20	37	36	32	25	31	44	31	51	76	40	423
	Science	26	44	27	19	22	47	35	27	30	39	25	341
	Total	46	81	63	51	47	78	79	58	81	115	65	764

* Data in respect of IIT Kanpur is based on the Convocation held and hence the gap in the years 1974 and 1984

Table 4.5.3



NO. OF DEPARTMENTS AND CENTRES IN IITs

Fig. 4.7.1

Results of GATE 1985 and 1986

Institution	Year	Appeared	Successful	Percentage success
IIT Kharagpur	1985	342 (37)	302 (34)	88.30 (91.89)
	1986	240 (12)	164 (7)	68.33 (58.33)
IIT Bombay	1985	318 (15)	288 (15)	90.57 (100.00)
	1986	219 (8)	186 (7)	84.87 (87.50)
IIT Madras	1985	231 (8)	207 (7)	89.61 (87.50)
	1986	142 (4)	107 (3)	75.35 (75.00)
IIT Kanpur	1985	242 (32)	223 (30)	92.15 (93.75)
	1986	172 (5)	139 (4)	80.81 (80.00)
IIT Delhi	1985	245 (26)	207 (23)	84.49 (88.46)
	1986	191 (19)	157 (15)	82.20 (78.95)
Total	1985	1378 (118)	1227 (109)	89.04 (92.37)
	1986	964 (48)	752 (36)	78.00 (75.00)

Figures in brackets represent the results of SCST candidates

Table 4.8.2

SC/ST Candidates Registered for Admission to JEE and Seats Reserved for them

Year	Name of I.I.T.	Total registration for adm. incl. SC/ST	No. of registered reserved seats for SC/ST				No. of students qualified without relaxation				No. of students qualified with relaxation				No. of SC/ST candidates admitted		Reserved seats kept vacant	
			SC	ST	SC	ST	SC	ST	SC	ST	SC	ST	SC	ST	SC	ST		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				
1979-80	Bombay (West)	8989	266	90	38	16)					7	5	31	11				
	Delhi (North A)	6917	147	18	41	12)					12	2	29	10				
	Kanpur (North B)	11127	421	52	37	13)	*	*	88*	11*	23	2	14	11				
	Kharagpur (East)	14911	574	188	60	20)					34	2	26	18				
	Madras (South)	9592	233	36	38	12)					5	-	33	12				
		51536	1641	384	214	73					81	11	133	62				
1980-81	Bombay (West)	10250	415	103	41	13)					18	2	23	11				
	Delhi (North A)	13146	413	47	41	12)					20	2	21	10				
	Kanpur (North B)	14557	493	61	35	10)	6	1	161	26	24	3	11	7				
	Kharagpur (East)	10789	537	212	60	20)					50	6	10	14				
	Madras (South)	10879	254	31	41	14)					21	4	20	10				
		59621	2112	454	218	69					133	17	85	52				
1981-82	Bombay (West)	7067	318	76	46	16)					7	3	39	13				
	Delhi (North A)	9683	341	39	35	10)					5	-	30	10				
	Kanpur (North B)	10603	444	36	34	10)	8	1	47	4	10	-	24	10				
	Kharagpur (East)	11931	628	248	58	20)					23	-	35	20				
	Madras (South)	10119	378	38	41	13)					7	-	34	13				
		49403	2109	437	214	69					52	3	162	66				
1982-83	Bombay (West)	7776	338	70	51	18)					8	-	43	18				
	Delhi (North A)	11216	352	56	40	11)					11	2	29	9				
	Kanpur (North B)	12102	576	42	51	17)	8	1	49	8	5	1	46	16				
	Kharagpur (East)	11844	465	45	69	24)					17	1	52	23				
	Madras (South)	11406	600	232	43	15)					4	3	39	12				
		54,344	2331	445	254	85					45	7	209	78				

Notes:

- (1) Figures in column (3-5) are zone-wise and not institute-wise, as the candidates registered in a zone at a particular Institute can get admission to any of the five Institutes and the Institute of Technology, Banaras Hindu University, if merit listed at JEE.
- (2) Figures given in column (8-11) are for all the zones together, since only the figures for total number of SC/ST students qualified with and without relaxation in each zone are available whereas figures for qualified SC/ST students without relaxation are available for all the zones together.
- * For the year 1979-80 the figures in column (10-11) give the total (with and without relaxation) for all zones; no separate figure of SC/ST candidates qualified without relaxation either zone-wise or total, is available.
- (3) The difference between the total number of qualified SC/ST candidates (columns 8-11) and the total number actually admitted (col 12-13) is due to: (a) some candidates did not turn up for counselling, (b) some joined Institute of Technology, BHU, and (c) the others did not join after they were offered admission.

Table 4.8.4A

The Following Statement Indicates the Number of Scheduled Caste/Scheduled Tribe Students who were Offered Admission and the Number who Actually Joined Each of the Five Indian Institutes of Technology During the 5 years Between 1978-82

IIT	1978		1979		1980		1981		1982	
	Offered	Joined	Offered	Joined	Offered	Joined	Offered	Joined	Offered	Joined
Delhi	21	20	14	12	24	21	5	5	13	12
Madras	30	30	5	5	26	26	7	7	7	7
Kanpur	24	22	26	25	28	27	10	10	6	6
Bombay	21	20	13	11	23	23	10	10	8	8
Kharagpur	72	68	59	52	95	40	24	22	18	18
Total	168	160	117	105	196	137	56	54	52	51

Table 4.8.4B

Sanctioned Strength of Students at U.G. Level
(as on 1983)

IIT Kharagpur	410
IIT Bombay	248
IIT Madras	300
IIT Kanpur	286
IIT Delhi	255
Total	1499

Table 4.8.4C

Seats Reserved for SC/ST Candidates for Admission to Undergraduate Programmes at IITs

Year	IIT Kharagpur			IIT Bombay			IIT Madras			IIT Kanpur			IIT Delhi		
	R	F	(%)	R	F	(%)	R	F	(%)	R	F	(%)	R	F	(%)
1974	84	81	96	72	37	51	NA	34	—	50	45	90	52	41	79
1975	71	63	89	58	28	48	NA	34	—	50	43	86	52	39	75
1976	95	71	75	49	27	55	NA	38	—	50	37	74	53	32	60
1977	61	58	95	60	42	70	NA	42	—	50	28	56	53	28	53
1978	41	37	90	54	20	37	NA	29	—	55	24	44	53	21	40
1979	38	38	95	50	11	22	48	5	10	55	26	47	53	14	26
1980	80	56	70	54	23	43	50	17	34	48	28	58	53	24	45
1981	78	23	29	62	10	17	54	8	15	45	10	22	45	5	11
1982	84	24	29	69	8	12	51	7	14	64	6	9	51	13	25
1983	88	41	47	71	14	20	81	20	25	64	26	41	57	27	47
1984	93	37	40	71	20	28	68	12	18	64	20	31	57	20	35
Total	813	527		670	240		352	246		595	293		579	264	

R—Seats reserved for SC/ST. F—Filled by SC/ST. %—Percentage of seats filled by SC/ST

Table 4.8.4D

Faculty Strength of IITs

IIT Kharagpur											
Year	Director		Professor		Asstt. Professor		Lecturer		Total		
	S	P	S	P	S	P	S	P	S	P	
1974	1	1	93	76	178	161	176	151	448	389	
1975	1	1	127	87	178	159	159	131	465	378	
1976	1	1	127	100	196	168	155	136	479	405	
1977	1	1	131	103	228	178	132	131	492	413	
1978	1	1	132	102	229	187	131	123	493	413	
1979	1	1	131	106	231	196	131	109	494	412	
1980	1	1	131	108	231	209	128	111	491	429	
1981	1	1	134	124	234	211	131	115	500	451	
1982	1	1	141	128	252	228	140	107	534	464	
1983	1	1	143	124	252	200	141	106	537	431	
1984	1	1	143	128	250	223	140	102	534	454	

Category of Professor includes Deans & Dy. Director and category of Lecturer includes Associate Lecturer.

IIT Bombay

1974	1	1	74	77	135	102	175	103	385	283
1975	1	1	74	77	135	106	175	98	385	282
1976	1	1	96	83	150	134	138	104	385	322
1977	1	1	96	84	150	138	138	88	385	311
1978	1	1	96	95	150	154	138	75	385	325
1979	1	1	96	92	150	162	138	67	385	322
1980	1	1	131	119	185	167	68	52	385	329
1981	1	1	131	118	185	166	68	47	385	332
1982	1	1	131	117	185	170	68	47	385	335
1983	1	1	191	172	170	121	65	40	427	334
1984	1	1	191	174	170	123	65	41	427	339

Category of Professor includes Dy. Director and Associate Professor. Category of Lecturer includes visiting faculty.

IIT Madras

1974	1	1	63	55	123	100	156	139	343	295
1975	1	1	63	51	123	111	156	133	343	296
1976	1	1	63	51	123	112	156	124	343	291
1977	1	1	74	63	147	115	159	121	381	300
1978	1	1	94	60	169	108	162	146	426	315
1979	1	1	101	62	169	112	162	159	433	334
1980	1	1	101	87	169	131	162	119	433	338
1981	1	1	105	123	210	140	104	101	420	365
1982	1	1	105	123	210	161	104	78	420	363
1983	1	1	105	116	210	156	104	78	420	351
1984	1	1	167	145	147	133	104	67	419	346

Category of Professor includes Dy. Director & Associate Professor.

IIT Kanpur

Year	Director		Professor		Asstt. Professor		Lecturer		Total	
	S	P	S	P	S	P	S	P	S	P
1974	1	1	136	81	203	142	68	40	408	264
1975	1	1	136	81	203	145	68	40	408	267
1976	1	1	136	90	203	146	68	34	408	271
1977	1	1	136	84	203	145	68	33	408	263
1978	1	1	136	102	203	144	68	26	408	273
1979	1	1	136	120	203	125	68	35	408	281
1980	1	1	136	126	203	122	68	30	408	279
1981	1	1	136	125	203	124	68	26	408	276
1982	1	1	136	142	203	111	68	27	408	281
1983	1	1	136	141	203	116	68	23	408	281
1984	1	1	136	136	203	120	68	27	408	284

IIT Delhi

1974	1	1	41	39	129	108	100	87	271	235
1975	1	1	47	44	138	121	128	82	314	248
1976	1	1	50	48	144	126	132	80	327	255
1977	1	1	62	56	159	131	141	84	363	272
1978	1	1	71	65	166	144	141	81	379	291
1979	1	1	71	83	166	142	148	91	386	317
1980	1	1	74	88	172	159	153	86	400	334
1981	1	1	111	107	173	157	110	87	395	352
1982	1	1	116	114	174	162	118	94	409	371
1983	1	1	151	119	194	165	92	88	438	373
1984	1	1	159	117	205	169	96	85	461	372

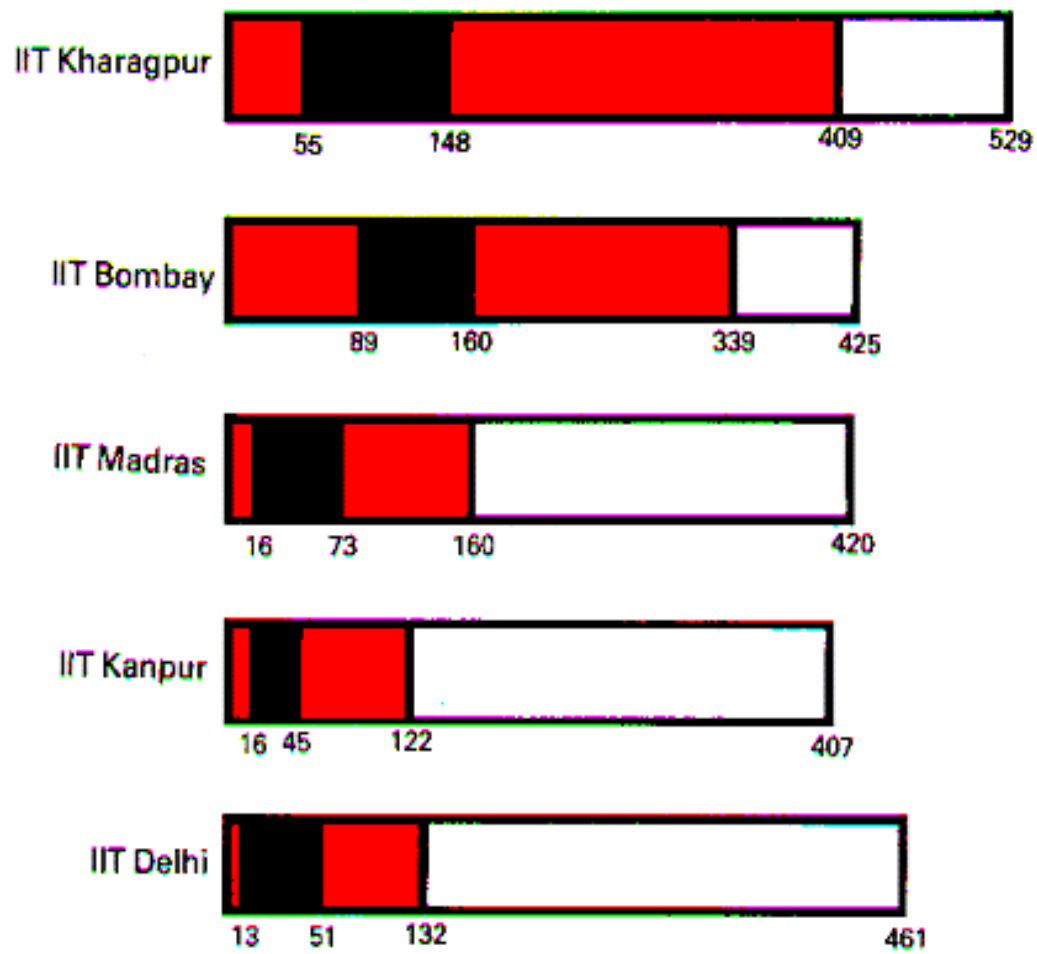
S—Sanctioned. P—In position

Table 4.9.1

Number of Faculty Retiring in the Next 5, 10 and 15 Years

	Sanctioned as on 1985	Retiring in next 5 years	Retiring in next 10 years	Retiring in next 15 years
IIT Kharagpur	529	55 (10.40%)	148 (27.98%)	409 (77.32%)
IIT Bombay	425	89 (20.94%)	160 (37.64%)	339 (79.76%)
IIT Madras	420	16 (3.81%)	73 (17.38%)	160 (38.1%)
IIT Kanpur	407	16 (3.93%)	45 (11.06%)	122 (29.98%)
IIT Delhi	461	13 (2.82%)	51 (11.6%)	132 (28.63%)

Table 4.9.2



IIT FACULTY RETIRING IN **5** **15** YEARS

Fig. 4.9.2

Pay Scales of IIT Teachers Existing Prior to 1.1.1973 and Thereafter

Post	Prior to 1.1.1973	After 1.1.1973
Lecturer	400-40-800-50-950	700-40-1100-50-1600
Assistant Professor	700-50-1250	1200-50-1300-60-1900
Professor	1100-50-1300-60-1800	1500-60-1800-100-2000-125/2-2500
Professor (Senior scale)	1600-100-1800	

Table 4.9.3A**Pay Scales of Persons in Different Positions.**

Rank in IIT	IIT	IAS	LIC	Bank
Lecturer	700-1600	700-1300	700-1300	700-1800
Assistant Professor	1200-1900	1200-2000	1000-1675	1200-2000
Professor		2000-2200	1250-2000	1800-2250
Professor (Sr. Scale)	1500-2500	2500-3500	1600-2250	2000-2400
Professor of Eminence	3000 fixed	3500 fixed	2000-2500 2500-3000 3250 fixed	2500-3000 3000-3250 3250-3500 3500 fixed

Table 4.9.3B**Pay Scales and Gross Salary Income**

Current Prices		Real value in 1983 at constant prices			
1973		1983		1973-74	
On mini. Basic	On max. Basic	On mini. Basic	On max. Basic	On mini. Basic	On max. Basic
1096	2218	1667	3020	779	1412
1755	2563	2507	3440	1179	1660
1178	2875	3132	4675	1344	2137

Table 4.9.3C

Shortage of Faculty Housing

Category	Sanctioned as on 1985	In position in 1984	No. of appropriate houses available	Shortage against sanctioned strength
IIT Kharagpur				
Director	1	1	1	-
Professor incl. Dy. Director	138	124		140
Asstt. Professor	250	223	248	
Lecturer	140	102	120	20
Total	529	450	369	160
IIT Bombay				
Director	1	1	1	-
Professor incl. Dy. Director & Assoc. Professor	190	176	19	171
Asstt. Professor	170	125	110	60
Lecturer	65	42	150	85 (Excess)
Total	426	344	280	146
IIT Madras				
Director	1	1	1	-
Professor incl. Dy. Director & Assoc. Professor	169	141	40	129
Asstt. Professor	147	133	54	93
Lecturer	104	67	72	32
Total	421	342	167	254
IIT Kanpur				
Director	1	1	1	-
Dy. Director	1	1	-	1
Professor	135	135	60	75
Asstt. Professor	203	119	131	72
Lecturer	68	27	70	2 (Excess)
Total	408	283	262	145
IIT Delhi				
Director	1	1	1	-
Professor incl. Dy. Director	159	117	40	119
Asstt. Professor	205	169	117	88
Lecturer	98	85	62	34
Total	461	372	220	241

Table 4.9.3D

Number of Faculty Positions Filled During 1974-84

Category	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total
1	2	3	4	5	6	7	8	9	10	11	12	13
IIT Kharagpur												
Professor												
(a) No. of posts filled	2	23	12	7	10	11	15	9	5	1	9	104
(b) No. Selected from IIT Kharagpur	1	21	9	3	8	9	10	7	3	1	7	79
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	-	-	-	-
(d) No. selected from outside	1	2	3	4	2	2	5	2	2	-	2	25
Asstt. Professor												
(a) No. of posts filled	22	36	12	24	14	29	23	23	15	2	19	219
(b) No. selected from IIT Kharagpur	22	29	8	19	13	26	15	13	10	-	13	168
(c) No. selected from other IITs	-	-	-	-	-	-	1	-	-	-	-	1
(d) No. selected from outside	-	7	4	5	1	3	7	10	5	2	6	50
Lecturer												
(a) No. of posts filled												
(b) No. selected from IIT Kharagpur												
(c) No. selected from other IITs												
(d) No. selected from outside												
												- NA -

IIT Bombay

Professor												
(a) No. of posts filled	2	-	12	10	14	2	32	3	-	18	1	94
(b) No. selected from IIT Bombay	-	-	11	8	10	2	31	2	-	18	1	83
(c) No. selected from other IITs	-	-	-	1	1	-	-	-	-	-	-	2
(d) No. selected from outside	2	-	1	1	3	-	1	1	-	-	-	9
Associate Professor												
(a) No. of posts filled	5	-	-	-	-	-	-	-	-	43	5	53
(b) No. selected from IIT Bombay	3	-	-	-	-	-	-	-	-	43	3	49
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	-	-	-	-
(d) No. selected from outside	2	-	-	-	-	-	-	-	-	-	2	4

Asstt. Professor

(a) No. of posts filled	10	10	40	10	27	8	27	11	10	13	9	175
(b) No. selected from IIT Bombay	5	7	32	8	17	7	16	7	7	7	6	119
(c) No. selected from other IITs	-	-	1	-	-	-	-	-	-	-	-	1
(d) No. selected from outside	5	3	7	2	10	1	11	4	3	6	3	55

Lecturer

(a) No. of posts filled	3	3	24	9	18	10	6	5	6	5	11	100
(b) No. selected from IIT Bombay	-	-	3	-	9	5	1	-	1	-	-	19
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	-	-	1	1
(d) No. selected from outside	3	3	21	9	9	5	5	5	5	5	10	80

IIT Madras**Professor**

(a) No. of posts filled	9	25	1	16	9	22	21	-	-	23	-	126
(b) No. selected from IIT Madras	8	24	1	14	8	18	14	-	-	20	-	107
(c) No. selected from other IITs	-	1	-	-	-	-	-	-	-	-	-	1
(d) No. selected from outside	1	-	-	2	1	4	7	-	-	3	-	18

Assoc. Professor

(a) No. of posts filled	-	8	3	-	-	-	13	-	-	33	-	57
(b) No. selected from IIT Madras	-	7	3	-	-	-	10	-	-	32	-	52
(c) No. selected from other IITs	-	-	-	-	-	-	1	-	-	1	-	2
(d) No. selected from outside	-	1	-	-	-	-	2	-	-	-	-	3

Asstt. Professor

(a) No. of posts filled	32	17	23	15	8	46	37	-	27	27	-	232
(b) No. selected from IIT Madras	18	14	22	6	5	38	21	-	17	12	-	163
(c) No. selected from other IITs	-	1	-	-	-	-	2	-	1	2	-	6
(d) No. selected from outside	14	2	1	9	3	8	14	-	9	13	-	73

Lecturer

(a) No. of posts filled	21	37	25	9	5	3	13	-	22	1	8	144
(b) No. selected from IIT Madras	13	20	7	2	5	1	8	-	6	-	1	63
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	1	-	-	1
(d) No. selected from outside	8	17	18	7	-	2	5	-	15	1	7	80

IIT Kanpur

Professor

(a) No. of posts filled	4	28	-	34	10	-	21	20	2	-	-	119
(b) No. selected from IIT Kanpur	3	28	-	31	10	-	20	19	2	-	-	113
(c) No. selected from other IITs	-	-	-	2	-	-	-	-	-	-	-	2
(d) No. selected from outside	1	-	-	1	-	-	1	1	-	-	-	4

Asstt. Professor

(a) No. of posts filled	22	11	28	27	29	1	32	31	2	33	-	216
(b) No. selected from IIT Kanpur	12	2	9	14	10	1	16	6	1	4	-	75
(c) No. selected from other IITs	-	1	1	1	-	-	3	-	-	1	-	7
(d) No. selected from outside	10	8	18	12	19	-	13	25	1	28	-	134

Lecturer

(a) No. of posts filled	4	15	12	18	21	2	18	21	-	44	-	125
(b) No. selected from IIT Kanpur	-	2	-	-	-	-	1	-	-	-	-	3
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	-	-	-	-
(d) No. selected from outside	4	13	12	18	21	2	17	21	-	14	-	122

IIT Delhi

Professor

(a) No. of posts filled	3	8	4	9	14	10	20	17	7	-	10	102
(b) No. selected from IIT Delhi	2	5	3	7	13	8	19	16	6	-	9	88
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	-	-	-	-
(d) No. selected from outside	1	3	1	2	1	2	1	1	1	-	1	14

Asstt. Professor

(a) No. of posts filled	11	12	15	29	17	26	18	26	13	8	10	185
(b) No. selected from IIT Delhi	4	8	9	20	10	21	14	22	11	6	5	130
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	1	-	-	1
(d) No. selected from outside	7	4	6	9	7	5	4	4	1	2	5	54

Lecturer

(a) No. of posts filled	24	15	16	21	23	19	13	23	9	2	2	167
(b) No. selected from IIT Delhi	-	-	-	1	-	1	2	1	1	1	1	8
(c) No. selected from other IITs	-	-	-	-	-	-	-	-	-	-	-	-
(d) No. selected from outside	24	15	16	20	23	18	11	22	8	1	1	159

Table 4.9.3E

Seventh Plan Requirements of IITs

(Rs. in crores)

Budget head	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi	Total
Equipment	27	29	28	27	22	133
Building/Infrastructure	32	7	22	10	14	85
Recurring	8	2	15	8	7	40
Total	67	38	65	45	43	258

Table 5.1.1A

Amount Provided for Replacement of Equipment and Computer Facilities
(Rs. in lakhs)

Year	IIT Kharagpur		IIT Bombay		IIT Madras		IIT Kanpur		IIT Delhi	
	E	C	E	C	E	C	E	C	E	C
1974-75	-	-	-	-	-	27.31	-	-	-	6.43
1975-76	-	-	-	-	-	10.32	-	-	-	45.75
1976-77	-	-	4	-	-	13.53	-	-	-	16.14
1977-78	5	-	6	-	-	15.58	6	-	6	9.03
1978-79	-	-	6	-	0.10	14.80	6	-	6	8.50
1979-80	4	-	6	-	6.56	24.58	6	-	6	6.70
1980-81	4	-	6	25	12.64	37.35	7	-	6	16.70
1981-82	2	-	6	25	5.66	19.7	7	-	6	16.50
1982-83	-	-	8	-	3.80	24.37	7	-	6	21.20
1983-84	20	-	25	25	39.85	26.75	29	-	15.2	14.25
1984-85	55	-	75	25	30.96	28.71	NA	NA	55	17.50

E - Equipment
C - Computer

Table 5.1.1B

Space Built in IITs
(in Sq.m)

	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi
Laboratory/Workshop	43,926	11,548	2,870	8,400	71,467
Others	79,359	20,400	12,510	600	9,679
Total	1,23,285	31,948	15,380	9,000	81,146

Table 5.1.1C

Shortage of Space in IITs (as on 1985)
(in Sq.m.)

	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi	Total
Laboratory/Workshop	15,650	10,600	5,600	5,000	6,850	33,100
Others	13,100	14,300	53,250	5,500	14,334	41,734
Total	28,750	24,900	58,850	10,500	21,184	74,834

Table 5.1.1D

Grants Released to IITs for Emerging Areas

(Rs. in lakhs)

Name of IIT	Emerging Areas	Amount of grant released		
		1981-82	1982-83	1983-84
IIT Kharagpur	Micro-Processor	10	10	8
	Remote Sensing	-	-	15
	Reliability Engg.	-	15	15
	Micro-Electronics	-	-	40
	Computer Science	-	-	10
IIT Bombay	Micro-Processor	10	10	8
	Remote Sensing	-	10	-
	Environmental Engg.	-	15	-
	Micro-Electronics	-	-	25
	Computer Science	-	-	10
	Product Development	-	-	10
	Bio-Conversion	-	-	-
IIT Madras	Micro-Processor	10	10	8
	Information Sciences	-	10	20
	Computer Aided Design	-	20	-
	Computer Science	-	-	12
IIT Kanpur	Micro-Processor	10	10	8
	Laser Technology	-	20	-
	Computer Science	-	-	10
	Water Resources Management	-	-	10
IIT Delhi	Atmospheric Sciences	20	20	-
	Micro-Processor	10	10	8
	Laser Technology	-	10	-
	Bio-Conversion	-	10	-
	Micro-Electronics	-	10	29
	Computer Science	-	-	10

Table 5.1.1E

Sixth Plan (1980-85) Amount Allocated to IITs

(Rs. in lakhs)

Year	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi
1980-81	133.00	172.50	142.12	140.00	134.00
1981-82	195.00	175.00	150.00	130.00	150.00
1982-83	140.00	140.00	160.50	140.02	157.52
1983-84	168.82	165.00	160.00	140.00	140.00
1984-85	202.62	199.50	179.50	172.00	167.50
Total	839.44	852.00	792.18	722.02	749.02
Total Sixth Plan allocation for IITs					3954.66

Table 5.1.2**Non-Plan Provisions Made in the Budget of IITs**

(Rs. in lakhs)

Year	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi
1974-75	220.64	238.90	207.60	266.00	186.36
1975-76	293.05	313.63	282.00	319.95	231.25
1976-77	331.90	364.72	269.28	351.28	294.40
1977-78	349.33	399.30	293.67	385.51	322.23
1978-79	367.93	441.75	278.58	409.78	339.27
1979-80	396.38	467.60	344.91	433.91	401.45
1980-81	398.60	520.10	361.75	443.52	465.57
1981-82	462.00	585.04	441.44	506.07	547.96
1982-83	539.46	719.06	525.96	548.21	623.09
1983-84	699.03	834.36	629.90	680.51	753.70
1984-85	827.86	1004.38	790.74	837.12	900.25

Table 5.2A

NON-PLAN PROVISIONS MADE IN THE BUDGET OF IITs

(Rs in Lakhs)

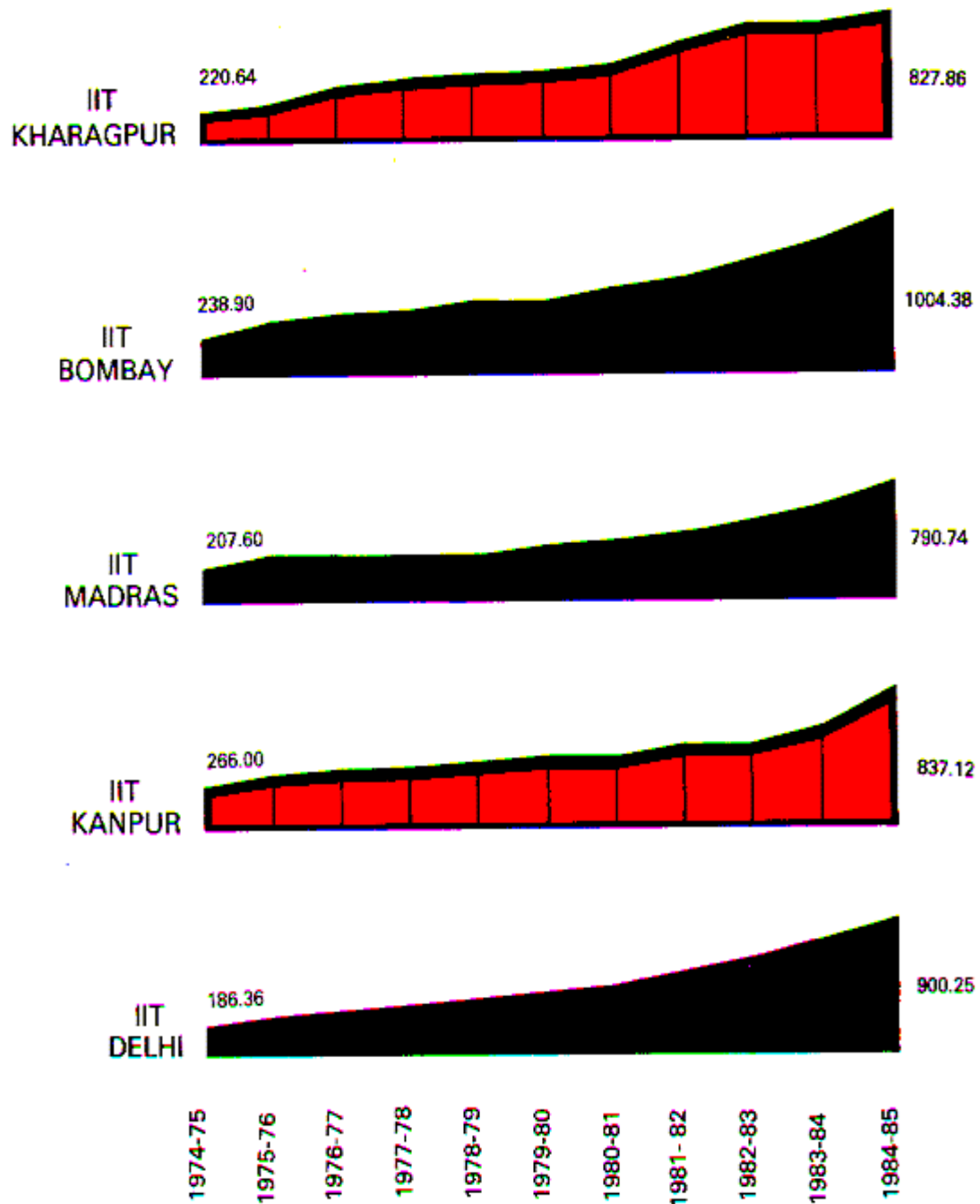


Fig. 5.2

Income Generated During 1984-85

(Rs. in lakhs)

Source	IIT Kharagpur	IIT Bombay	IIT Madras	IIT Kanpur	IIT Delhi
Academic fees	6.09	5.88	14.95	6.92	7.92
Other income from students	2.40	3.39	3.07	2.31	2.23
Miscellaneous consisting of Application fee for advertised posts, fines, sales of tenders leave salary contribution, JEE, GATE, Testing & Computer charges, licence fee for residential houses, sales of unserviceable item etc.	52.15	108.57	123.91	85.25	72.73
Income from sources other than G.O.I.	60.64	117.84	141.93	94.48	82.88
Non-plan & Plan grant from G.O.I.	919.13	969.12	857.25	920.60	900.08
Gross	979.77	1086.96	999.18	1015.08	982.96
% of income to the gross	6	11	14	9	8

G.O.I.—Government of India

Table 5.2B

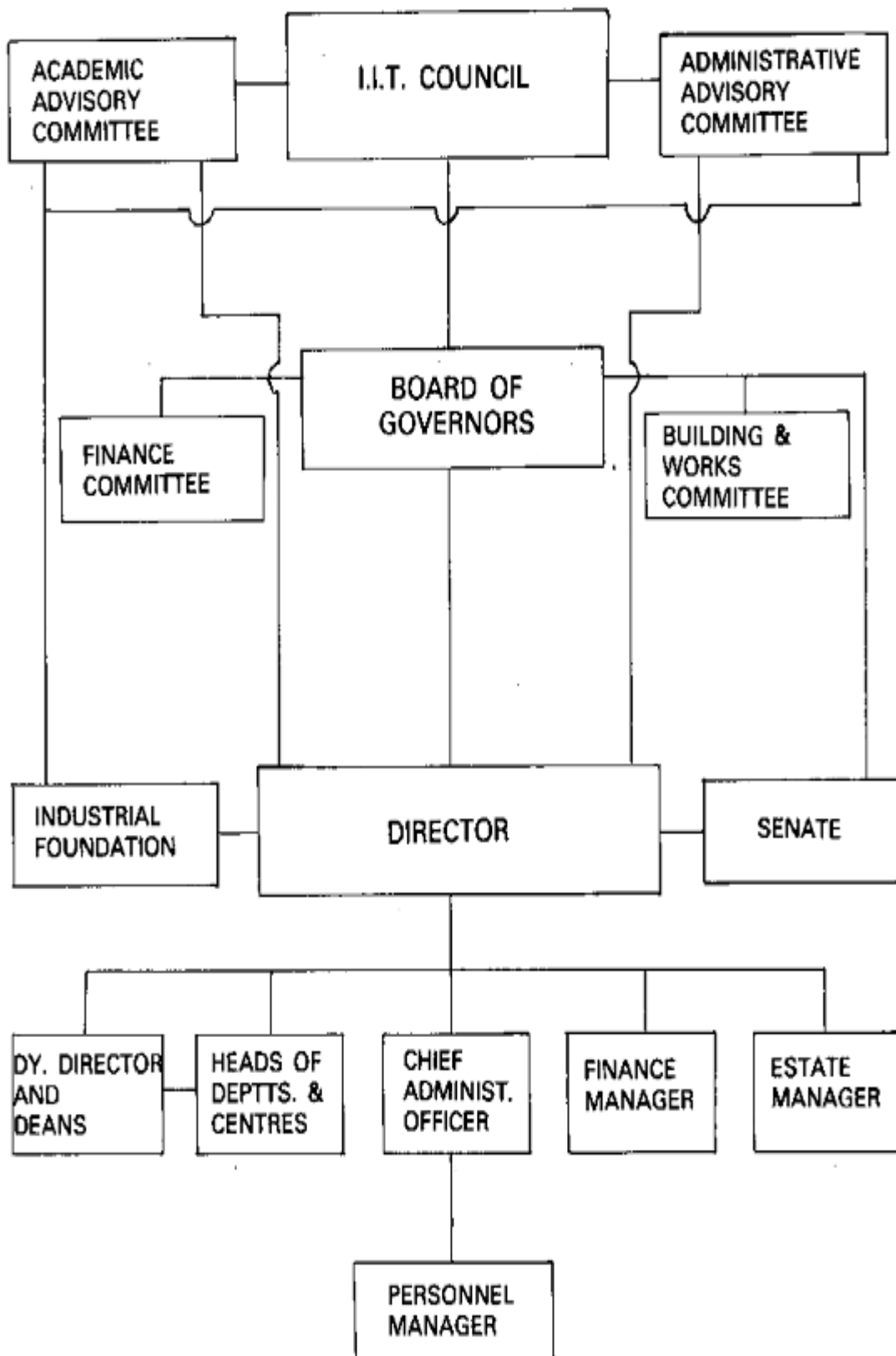


FIG. 6.8.1

RECOMMENDATIONS OF THE IIT REVIEW

COMMITTEE

PERFORMANCE REVIEW

1 The Indian Institutes of Technology were established with the objective which is best described in the words of the late Prime Minister Pandit Jawaharlal Nehru- "to provide scientists and technologists of the highest calibre who would engage in research, design and development to help building the nation towards self- reliance in her technological needs". There is a more elaborate statement of objectives in the Sarkar Committee Report and in the statutory charter of the IITs. These are comprehensive and hold good even today though it may be necessary to re-emphasise some, to remove ambivalence in some others and to set the priorities more clearly to meet the changing needs. (Pars 2.1)

2 The IITs were set up inspite of the recognition that some colleges of engineering had "attained a quality with age". IITs have completed nearly a quarter of a century of existence. This is the first time that a single common committee was appointed to review all the IITs together. They have acquired a degree of excellence in their facilities and faculty with the help of industrialised countries and as liberal a funding as was possible by the central government. The IITs have evolved an exclusive system of attracting good calibre students. They also evolved sound systems pertaining to courses of study and evaluation and oriented towards helping students to learn at their pace, choosing a load and picking electives with flexibility in the choice of subject. Their performance is evaluated not by chance achievements in a single examination but continuously through varied methods. (Para 2.1)

3 These measures have enabled the IITs to produce B.Tech. engineers of excellent quality comparable to the best in the world. (Para 2.2)

4 During the last decade, the IITs have also contributed to the upgradation of engineering education in the country. Considerable investment and effort has gone in to increase of research activities, developing some centres of advanced research to give technological leadership and diversifying and expanding post-graduate engineering education. (Para 2.2)

5 One cannot, however, overlook the fact that output from the IITs may not have been commensurate with the inputs and expectations. One can question the degree of impact of IITs on national, industrial, eco- nomic and social development, on their attaining excellence and leadership in research and education and in motivating the students and teachers to be pioneers and job-generators. Of late, there are indications that the undergraduate programmes themselves tend to be less flexible than originally envisaged. Experimental research and design and fabrication of sophisticated instruments are on the decline. IITs do not seem to be able to motivate the students and teachers sufficiently in regard to their commitment to the nation to give their best and to achieve excellence. (Pars 2.3)

6 In fairness to the IITs, their performance audit should take into account the internal and external environmental factors, obsolescence in institutes set up two to three decades ago, and lack of coordinated manpower and technology policies posing challenges that hinder efficiency and productivity. (Pars 2.4)

GOALS AND OBJECTIVES

7 Technological manpower production is admittedly the basic function of the IITs. The product has to be excellent in quality, relevant to the technological needs of the country, motivated to give of its best and have a commitment to the country. (Para 3.1)

8 The goals and tasks of these institutes in their process of development have to relate continuously to:

- Significant and notable changes that are taking place in the socioeconomic development of the country; and

- Rapidly exploding universe of knowledge in science and technology. (Para 3.1)

9 To preserve IITs' character as institutes of national importance and to maintain their leadership and pacesetter function in technological education, research and extension and to be able to produce the kind of technological manpower set out above, their goals must be:

- To excel in teaching, research and in all aspects of academic activity and produce a high quality science-based engineering student;

- To survive on specialisation, work increasingly in front line areas that transcend disciplines;

- To have a perception and a value system appropriate to the pursuit of high engineering science to meet the critically evaluated needs of the society;

- To programme into their activities emerging technological needs with a futuristic outlook;

- to accept extension and public service as a third dimension to their role in addition to education and research;

- To attain a stature that enables them to provide leadership with credibility. They should be the "thinktank" for higher technological education;

- To aim at preparing more of creative engineers, innovative thinkers and engineer entrepreneurs;

- To develop a special nexus with rural development mainly by way of involvement in technology-based solutions for problems in rural areas;

- To maintain and foster interactive linkages with leading technological institutions and centres of research in India and abroad. (Para 3.2)

10 It is against this broad conceptual background that the recommendations of this Committee are based. It is expected that if the recommendations are accepted and acted upon, changes will be clear and visible in five years' time. (Para 3.3)

ACADEMIA

11 IITs should continue to offer both undergraduate and postgraduate programmes. (Para 4.1.2)

12 The student strength of undergraduate and postgraduate courses should be aimed to be maintained at 1:1 ratio. (Para 4.1.3)

13 The overall student strength at any one campus should not ordinarily exceed 2500. (Para 4.1.4)

14 Instead of starting new IITs, wherever higher technical manpower is needed, support to Departments/Engineering Colleges/Centres who have done well, is recommended. (Para 4.1.5)

15 B.Tech. Level programmes in the IITs should aim at: - greater flexibility and actual availability of a wide choice of electives;

- New technology and system involving cross-disciplinary perspectives;

- Experimental and innovative programmes to foster creativity;

- maintaining a science-based engineering curriculum. (Paras 4.2.2 to 4.2.4)

16 M.Tech. programmes must be carefully chosen and designed to serve the following objectives: - prepare teachers for engineering education; - provide, trained manpower to industry with the capability to influence up gradation and absorption of technology and setting up of new high-technology industries. (Para 4.3.1)

17 We endorse the recommendation of the Postgraduate Committee that the M.Tech. degree be prescribed as a minimum qualification for recruitment to many positions in the engineering profession in industry, R&D; organisations, Electricity Boards, PWDs, Post and Telegraphs, Railways etc. The present policy and practice of recruiting graduate engineers at the lowest levels (single point entry) to many services should be modified to allow for lateral entry at higher levels. As an incentive and mark of recognition it should be mandatory to give not less than two advance increments wherever postgraduate degree holders are recruited. (Para 4.3.2)

18 Conscious and concerted effort is needed to excel in research activities so as to be in the forefront of research in at least a few of the emerging areas, and to build competent research groups of international standing. (Para 4.4.1)

19 The impact of the IITs through research and development activities has not been conspicuous for varied reasons, including the unpreparedness of industry, policy support for technology imports and foreign collaboration and non-involvement with development-oriented projects. Conscious and positive steps should be taken to make the presence of IITs felt in this area. It is recommended that:

- An Industrial Foundation independent in its normal day-to-day functions, may be set up in each IIT. It should work as a commercial corporate body with its own budget and Plan for marketing its research and consultancy capability (CSIC of the Indian Institute of Science, Bangalore is one example);

- IITs may get involved in setting up innovative centres, S&T; parks, industry owned research centres etc., adjacent to the campuses;

- Faculty members may be encouraged to become entrepreneurs taking three year leave following the CSIR pattern. (Paras 4.4.2 to 4.4.6)

20 IITs either directly or preferably through the proposed Industrial Foundation should compete for and get plan assistance from Department of Science and Technology (SERC and GRS), Department of Electronics, Department of Defence Research, Department of Energy and others to do research and consultancy work in identified "thrust areas" in the national S&T; plan. (Para 4.4.7)

21 A number of "thrust areas" have been identified and a synoptic view given on them by faculty of IITs. These should be examined by the Academic Advisory Committee of the IIT Council. Internal and external funding of these projects is recommended. (Para 4.4.8)

22 IITs should have greater interaction between themselves and with outside educational institutions, universities, CSIR and other research laboratories, taking a lead in technology missions of national priority. Industry-Research-Education should become a closely linked triad. (Para 4.4.9)

23 Besides the newer areas of high technology in the emerging fields, IITs should also take up research and development activities related to the environment in which they are located. If successful, the impact will be more visible and the role of these higher seats of learning will be well appreciated by the community. It will also condition the student to relate to his surroundings. It is recommended that:

- Public service in some meaningful form should be organised for participation both by the teachers and the taught;

- The IITs should diagnose problems/needs of nearby rural community and work on their solutions through application of technology;

- The IITs should enlarge their interaction with other technical institutions and colleges in the region. The interaction can take varied forms. A periodical review of the above functions should be carried out. (Para 4.4.10)

24 Industry-IIT linkages have to be strengthened considerably. There are now a number of technology-oriented industries who are appreciative of the importance of the linkages and inclined to cooperate fully in giving access to the facilities and resources available with them. It is recommended that IITs (through Industrial Foundation, as and when it is formed), take more positive steps in this direction to remove the shortcomings. (Para 4.5.1)

25 To promote greater linkages between IITs and Industry and IITs' involvement in national development projects, it is recommended that:

- Faculty should spend compulsorily one of their sabbaticals in industry;

- IITs should invite competent persons from industry to be adjunct professors;

- IITs should be involved in technology missions connected with national development projects;

- the government may extend tax concessions for contributions made by the industry to IITs. (Para 4.5.2)

26 IITs should also undertake technology surveys. IITs should have some association with bodies like DGTD, DOE etc. who regulate import of technology. (Para 4.5.3)

27 It is recommended that IITs use their facilities more intensively to spread education. Some of the suggestions are:

- Evening classes in some specialised subjects for employed persons;

- Continuing education through seminars and other programmes. (Para 4.5.4)

28 A large number of programmes at undergraduate and postgraduate levels are being offered by the academic departments and school of studies. While this is as it should be, some important points have to be borne in mind:

- Programmes should be reviewed periodically and updated and modified to match with the needs of the country, and the developments in Science & Technology. New programmes (like Bio-science) may have to be introduced as interlocking/supporting ones to produce doctoral manpower to work on "thrust areas" and leading edge of technology.

- Doctorate degrees may be offered on work relating to developmental projects, hardware, experimental work, instrumentation etc.-areas in which the IIT faculty seem to have an ambivalent attitude.

- Programmes be shifted from the traditional areas towards inter- disciplinary ones like Materials Science, Energy System, Instrumentation etc. These should be normally offered as postgraduate programmes. Over the years separate undergraduate programme's in these areas be evolved, giving up the traditional areas. In the early stages, these postgraduate programmes of inter-disciplinary subjects can be based on elective course structure instead of starting a separate department/centre for it. Innovative ideas should be attempted such as starting of integrated five year course leading to M.Tech. degree; and modular courses to give students greater flexibility in transfer between institutes and to change disciplines.

- Modern teaching aids like audio-visual, computers etc. to be increasingly used. (Paras 4.6.11 to 4.6.7)

29 Academic departments in the IITs handle both teaching and research. The number of departments vary from IIT to IIT-largest at Kharagpur and smallest at Kanpur. It is recommended that such departments whose load is below an optimum level and not likely to build up in the near future, should be either closed or merged with another department. This will help utilisation of scarce resources, better elsewhere. (Para 4.7.1)

30 Departments should have more autonomy delegated to them and run them with their own committees of management. (Para 4.7.1)

31 'Centres' were started as nodal points to foster research and become peak points in some selected areas of importance, generally inter-disciplinary in character, drawing talent from other departments, other IITs and from outside organisations. The tendency for Centres to function like any other academic departments has to be curbed. An immediate review and evaluation of all Centres is necessary to ensure proper focus and character. New centres may be established only after proper assessment of the need by outside expert groups. An inbuilt mechanism for periodical evaluation of every centre is also suggested. (Para 4.7.2)

32 Students are inducted into undergraduate courses through the Joint Entrance Examination (JEE) barring a very small number who are either Foreign Nationals, or Indian Nationals residing abroad. While this test has been well-developed and is able to pick up high calibre students, it has been noticed that some of them do not have any marked inclination for a profession in engineering/technology. It is recommended that this entrance examination scheme should be refined by evolving and introducing an aptitude test. (Para 4.8.1)

33 For inducting into postgraduate courses, recently a Graduate Aptitude Test in Engineering (GATE) has been introduced. Though this is being organised by IITs, it is not exclusively for entrance to IIT postgraduate courses; nor, is it compulsory that all should come through this test. It is necessary only for those who want scholarship from government. Sponsored candidates normally do not take this test. It is recommended that this method of multi-entry should be watched for some more years for its efficaciousness. (Para 4.8.2)

34 Both JEE and GATE are being conducted at present by the IITs. There are both scope and need for a specialised national testing agency. The task of selection by IIT authorities to their B.Tech./M.Tech. Programmes could become lighter and more meaningful if restricted to a smaller number from among those qualifying in the national test. (Para 4.8.3)

35 Special dispensations is being given to SC/ST candidates admitted at the entrance through JEE. In this context, it is recommended that:

- this be continued while at the same time ensuring that positive and effective steps are taken to coach them up before the start of the very first semester;

- While every attempt should be made to fill the reserve quota fully, entry standards should not be further lowered;

- concrete and positive steps should be taken by bodies/agencies outside IITs to coach such of those SC/ST students who show promise, so that they can take JEE and get entrance on their own competitive merit without the aid of special dispensation. This can be undertaken by specialised agencies/institutions. (Para 4.8.4)

36 Steps are required to reduce the incidence of migration abroad of fresh graduates from IITs. This may be done through conscious career development planning for bright students, their involvement in technology missions and rural development schemes rather than rely on restrictive measures alone. The Department of Humanities and Social Sciences in the IITs must emphasise in the curriculum the socioeconomic ethos in which technology development is taking place in India, so as to inculcate distinct Indian values. (Para 4.8.5)

37 Faculty is the back-bone of these institutes. Necessarily they have to be highly competent and committed to teach, conduct and guide research, and interact with industry and society. It

is recommended that conscious efforts be continuously made to maintain an environment where excellence will be sustained and even enhanced.

The ambient conditions are:

- Reasonable facilities for work;
- Absence of hindrance by any section, specially the supporting staff;
- motivating factors i.e. recognition of good work and posing of challenges;
- Continual communication of stimulus and response from other institutions in the country and elsewhere in the world and easy mobility between Education, Research and Industry;
- Involvement in national development programmes in the realm of high technology;
- Exposure to challenges in technology missions and development projects of national priority;
- close coordination of technology imports, technology policies and technology manpower needs with education and research;
- Opportunity for extension/consultancy/research for both industrial and rural development;
- Encouragement of risk-taking in an atmosphere of trust. (Para 4.9.1)

38 At the start, IITs attracted an excellent faculty team, well qualified and committed. But with passage of time gerontocracy is likely to be established. Added to it, is the deteriorating environment with increasing indiscipline, constraints on resources, etc. It is time; steps are taken to arrest this trend. These steps are:

- A strict and objective assessment of all faculty against well-laid norms: mechanism and criteria needs to be developed by the IITs themselves with expert assistance, if necessary;
- give special status and additional 'perks' to highly merited people and at the same time 'ease out' those who continue to perform poorly. (Para 4.9.2)

39 IITs are not able to attract, retain and motivate high calibre young entrants for the teaching profession. Bright students are not coming to study M.Tech. and Ph.D. courses. A large number of faculty members are due for retirement. All these will reflect on the future of IITs. It is, therefore, recommended that:

- Salary scales and attached 'perks' be made more attractive, maintaining a differential between IITs and other related institutions;
- introduce a clear personnel policy;

- Steps are taken to ensure faculty residential accommodation. If it is not feasible to build new flats, alternative arrangements like leasing to estate developers should be made. Lack of accommodation discourages new entrants;

- At the undergraduate level, bright students who show aptitude for teaching should be spotted and groomed for service. They should be specially trained to Ph.D. level, sponsored for specialization abroad and during the senior studentship phase, be given a teaching assistantship;

- The present method of selecting faculty by advertisement alone should be supplemented by active, search' for talents; as is done by some corporate bodies, with a determination to induct fresh blood into the system. (Para 4.9.3)

40 The Committee recommends that a Ph.D. from the same IIT should not become a member of faculty till he has served outside for a period of not less than five years. Similarly lecturer in an IIT should be encouraged to go out to other IITs or institutions before he is taken in the same institute. (Para 4.9.3)

41 IITs should have the cadre of Associate Professor in the three-tier system of Assistant Professor, Associate Professor and Professor. Lecturers will comprise of Research Scholars/Associate Scholars and will not be part of the faculty cadre. They could be employed on contract for a trial period of two to three years and in no case exceeding five years. (Para 4.9.4)

42 Mobility of faculty, between IITs, R&D; organisations, other engineering institutions, and industry needs to be deliberately fostered. Impediments to such a mobility need to be identified and steps taken to remove them by introducing measures like National Pension Scheme, carrying the privileges, seniority, pension etc. wherever a person moves. (Para 4.9.5)

FINANCE AND ITS MANAGEMENT

43 The IITs will need to be supported by provision of substantial Plan Funds by the Human Resource Development Ministry to cater for:

- removing obsolescence and modernising of the laboratories and workshops;

- filling up critical gaps in campus facilities more particularly faculty housing, hostel, library and laboratory space;

- upgrading computer facilities and central instrumentation facilities;

- establishing facilities for new thrust areas on project basis. (Para 5.1.1)

44 The provision of Rupees 50 crores suggested by the Steering Group on Education for the Seventh Five Year Plan would appear to be a subcritical investment. Broad estimates presented to the Review Committee by the IITs indicate the need for an investment of about Rupees 258 crores. The Committee would recommend that the Plan Funds to the IITs in the Human Resource Development Ministry's Seventh Plan should be atleast of the order of Rupees 100 crores. The IITs must be able to earn and attract substantial funds to support a

major part of their research activities, through sponsored projects and consultancies. This is a corollary to the need for strengthening the linkages with industry and R&D; funding agencies. (Para 5.1.2)

45 The Committee recommends that the Ministry's support to the IITs through Non Plan budgetary support must be contained. Each IIT will need to critically examine the Non Plan expenditures and adopt zero based budgetary principles. A closer internal scrutiny of cost of administration services and its effectiveness is necessary. Avenues for augmenting the income of the IITs needs to be explored. The Committee recommends that approximately a third of the operating cost should be met by their own generations. In relation to the cost of education in the IITs, the tuition and academic fees charged is negligible. The Committee recommends that these fees should bear more reasonable relationship with the cost of imparting education in the IITs. The students who would be unable to meet this enhanced fees, should be helped through bursaries created out of endowments from the government as well as from other sources. Loan schemes from banks should also be introduced to help students meet cost of their education. The existing scheme for provision of scholarship will need to be appropriately reviewed. (Para 5.2)

46 The Non Plan budgetary support to the IITs may be determined on a five year grant basis, on realistic estimates of projected gaps between income and expenditure. Adjustments should be annually made only to compensate for increase in wage-bill due to liability for additional emoluments on account of government decisions. (Para 5.2)

47 The principles and practices of professional financial management should be adopted in the IITs to serve as meaningful tool for relating performance to budgeting and mobilising and channelizing resources in a scientific way. It is necessary to introduce modern methods of management accounting. It is also necessary to simplify and rationalise procedures relating to purchase, stores and inventory, municipal services, bills and disbursements etc. (Para 5.3)

GOVERNANCE AND MANAGEMENT STRUCTURE

48 The Committee does not recommend any change in the composition or functions of the Council. However, there is a need for the Council to be assisted by two advisory committees, one for academic matters and the other for administrative matters. The Chairman of the Council will nominate the Chairmen of these committees from among the Council members. The Secretary of the Council will act as Member-Secretary of both these committees. (Para 6.1.2)

49 The Academic Advisory Committee will have in addition three Directors on rotational basis, five eminent men from industry, economic departments/agencies of government and from leaders in- science, technology and higher education. (Para 6.1.2)

50 The Administrative Advisory Committee will have in addition three management experts from outside, the Financial Adviser to the Ministry of Human Resource Development and the senior most officer of the Ministry of Human Resource Development dealing with the IITs. All the five Directors of IITs will be members of this Committee. (Para 6.1.2)

51 The Council shall meet twice a year. The Advisory Committees shall meet four times a year. Whenever the Chairman is not present, a member will be temporarily elected to the chair and the meetings held. (Para 6.1.2)

52 The agenda for these meetings will include subjects proposed by various Boards of Governors, Directors and the Secretariat of the Council. (Para 6.1.2)

53 The Chairman of the Board of Governors should ordinarily be a non-official and a person of eminence. He should not be involved in matters of day-to-day nature in the running of the IIT. Where necessary, the Act and Statutes should be amended to ensure this. (Para 6.2)

54 Other members from outside, nominated to the Board by the Council and State Governments should be from among outstanding well-reputed industrialists, technologists, scientists and educationists. Such nominations should not be on an ex-officio basis. As far as possible, one distinguished alumni should find a place on the Board. (Para 6.2)

55 Agenda for the meetings should not be crowded with routine administrative matters. The Board should set up a committee to assist them in such matters. The Board should devote more time on items concerning growth, academic performance and linkages with outside bodies like industries, research and development institutes and other academic institutions. (Para 6.2)

56 The Board should meet at least four times in a year with a gap between any two meetings not exceeding 90 days. (Para 6.2)

57 The Finance Committee of IIT should also examine and recommend methods of resource-generation; examine and advise on proposals for financial support for students, faculty and other employees. (Para 6.3)

58 The Committee does not recommend any change in the composition of the Senate but it should appoint more committees to assist its work effectively. The Senate must review periodically and in a systematic manner the work of the Departments and Centres and present their appraisal to the Board. (Para 6.4)

59 Radical changes in the management structure are recommended. These will necessitate amendment of the Act and Statutes. (Para 6.5)

60 The Director shall be the Chief Executive as at present having a dual role—an academic head and an administrator. The post of Director shall be on contract as at present. (Para 6.6)

61 There should be no gap between the retirement of one incumbent and joining of another in the post of Director and the Search Committee should initiate its work well in time. The Director will be assisted by Deans in academic matters, students affairs, planning and research & consultancy. (Para 6.6)

62 The rank and requirements of the Deputy Director should be such that in the absence of the Director, he will act as Director. (Para 6.6)

63 The tenure of Deputy Director as well as of all Deans should be preferably co-terminus with that of the Director. (Para 6.6)

64 The setup of the Heads of the Department/Centre should continue. The principle of rotation of headship may be followed but with some flexibility. They will work in close cooperation with Deans and the Deputy Director but will be accountable to the Director. (Para 6.7)

65 The statutory position of the Registrar is incompatible with the management structure needed today in the IITs. All functions other than those connected with campus administration and finance, presently dealt with by Registrar, will be performed by the Chief Administrative Officer. The Chief Administrative Officer will also be in charge of personnel functions in which he will be assisted by a trained Personnel Manager. (Para 6.8.1)

66 The campus and township management will be in the charge of an Estate Manager, finance and all matters connected with funds will be looked after by a Finance Manager, both professionally qualified. (Para 6.8.1)

67 The proposed structure is intended to facilitate a transformation in the style of management of the IIT and move to a cluster type of management structure from the present hierarchical and vertical one, and

- To derive optimal advantage of the degree of autonomy statutorily conferred on the IIT system;
- To decentralise decision making powers while ensuring conformity with corporate policy and goals;
- To ensure that administrative support system subserves the academic activities of the institute;
- to develop a greater sense of participation in management of the IIT, of all interested and concerned groups like the students, faculty, researchers and other employees. (Para 6.8.2)

PERSONNEL MANAGEMENT

68 There is a need for the IITs to have clear-cut personnel policies which include provision for career development, in-service training for vertical, and horizontal mobility and enhancement of skills. (Para 7.1.1)

69 It is recommended that IITs improve their personnel management practices especially with regard to non-faculty employees.

These include:

- Method of recruitment;
- Method of evaluating them for purpose of career development and promotion against a well set visible promotion policy;
- Methods of rewarding and punishing them;

- A sound grievance procedure. (Para 7.1.2)

70 In handling of the affairs of the institute, the IITs have to shift their perception from one of administration to one of management. For this purpose it is necessary that all key personnel should have exposure to management training. (Para 7.1.3)

71 There is a need to increasingly resort to contracting for services rather than building-up permanent staff establishments. Gradually such an approach would help in reducing the burdens of administration and enabling the IIT to devote more time and energy to its primary functions. Students can also be given the opportunity to earn by doing some of the campus work part-time. (Para 7.2)

72 Some of the problems faced in the IITs in relation to deficiencies noticed in work-ethos and discipline have their roots in the external environment for which the IITs cannot be faulted. (Para 7.2)

73 Staff for instrumentation, maintenance, upkeep and repair of equipment should be given every encouragement and status to ensure the effective maintenance and use of high cost equipment and a central division be created in each IIT for this purpose. (Para 7.2.1)

74 The Committee recommends that IITs should have a core of competent scientific staff on permanent basis with all service benefits for sponsored projects. Expenses on account of the core staff should be suitably covered as overheads, charged to the projects. Other temporary staff recruited for a project must be terminated at the end of the project. (Para 7.2.2)

ACKNOWLEDGEMENT

75 The Committee could not cover some aspects of interest for lack of data and time. It is recommended that IITs take up or sponsor studies relating to some of these aspects viz.

- cost/benefit analysis of IITs;
- The locational advantages, if any of each IIT;
- The advantages gained by the IITs through technical collaboration with different countries;
- Whether JEE preferentially helps the urban elite;
- Data on placement of IIT graduates in India and abroad;
- IITs' contribution to industrial, economic and social development and to the store of fundamental knowledge as well as its position as a leader;
- Technical manpower planning relating to technology development;
- Technology and the future. (Para 8)

