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ACKNOWLEDGEMENT

The Indian Institutes of Technology 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 the Institutes. The Visitor's order appointing the present Review Committee is appended to the Report.

The Review Committee (henceforth referred to in the report as the Committee) is grateful for the opportunity given to it to carry out the review. The Committee wishes to place on record its grateful thanks to the Ministry of Human Resource Development, Government of India, for the support extended to it. The Directors of all seven Institutes took enormous trouble to host the visits to their Institutes by the Committee and organize meetings with their faculty, staff and students. The Committee is deeply appreciative of their efforts and sincerely acknowledges their wholehearted cooperation by way of ready response to the Committee's several queries and requests for information. The Registrars of the IITs extended their help, also provided information whenever contacted.

During the course of its several meetings and deliberations, the Committee has had the benefit of the views and suggestions of the Chairmen of the Boards of Governors of the IITs. Among them, Professor MGK Menon (IIT Delhi), Professor CNR Rao (IIT Kanpur), Dr. K. Kasturirangan (IIT Madras) and Shri Rahul Bajaj (IIT Bombay) spared their precious time and took the trouble personally to meet with the Committee. Shri Rahul Bajaj brought up very useful issues relevant to this Report for discussion by the Advisory Committee of IIT Bombay. As a member of this Committee, the Chairman (i.e the Chairman of the Review Committee) benefited from this meeting and discussion. Professor MGK Menon took the initiative to organize a discussion with the Chairmen and Directors of IITs. The Chairman and Members of the Committee wish to record their sincere gratitude to all of these eminent persons.

Some former Directors and several former Professors of IITs readily offered their valuable suggestions. Mention has to be made here of Dr. A. Ramachandran, Professor S.P. Sukhatme, Professor V.S. Raju and Professor K.A. Padmanabhan (all former Directors) and Professor E.C. Subbarao, Dr. S.C. Dutta Roy, Professor P.C. Kapoor, Professor H.K. Kesavan, Professor K. Srinivasa Raghavan, Professor P.N. Murthy and Professor V.P. Radhakrishnan (all former Professors) and Professor Vijay Gupta (when on lien in 2003). Several heads of agencies and other institutions, namely Dr. G. Madhavan Nair, Chairman, Space Commission, Dr. V.S. Ramamurthy, Secretary, Science and Technology, Dr. Anil Kakodkar, Chairman, Atomic Energy Commission, Dr. R.A. Mashelkar, DG, CSIR, Professor R. Narasimha, Director, National Institute of Advanced Studies, Dr. A. Nigavekar, Chairman, UGC and Professor R. Natarajan, Chairman, AICTE have generously given of their time to meet with the Committee. Among the other senior professionals, Dr. F.C. Kohli is to be thanked for having spoken to the Chairman on what the IT industry looks for from the IITs. Professors H.P. Khincha and S. Mohan provided

information on Society for Innovation and Development of IISc while Dr. G. Rangarajan did so on IISc-Toulouse Cyber University.

The Committee was also talked to by a large number of IIT alumni in person during the visits of the Committee to the IITs, via teleconferencing, via telephone or e-mail or by way of meetings with the Chairman. Special mention is made here of Shri N.R. Narayana Murthy, Shri Rajat Gupta, Shri Rajendra S. Pawar and Professor P. Balaram who were very considerate in sparing time for discussion with the Chairman. Shri Rajat Gupta kindly made available a Mckinsey report on *'Shaping the Knowledge Economy in India – The need to set up a National Mission for Technology Education'*, which was a project report on the IITs. Among the relatively younger alumni, Dr. V. Sudhir, Dr. K. Balasubramanian, Dr. S.V. Kamat, Dr. Pradip and Mr. Vipul Tuli need to be mentioned for their interest and help. Dr. V. Sudhir was particularly and enormously helpful and made himself available to the Chairman whenever needed. Being an expert in management cybernetics and systems engineering, he provided insightful concepts. The Chairman feels personally indebted to all of them and the Delhi Alumni Association (President Mr. Sudarshan Chawla), comprising several luminaries in various spheres, who invited the Chairman for a full day of presentations to a large gathering of several hundred alumni. They also prepared and furnished a report on their vision for the IITs in the coming decades. Their interest and work is gratefully acknowledged.

To all the distinguished persons seriously interested in the welfare of the IITs, who either spoke to the Committee members or communicated with them by e-mail, too numerous to mention by name, the Committee wishes to record its grateful thanks.

The Chairman gratefully acknowledges the award of a Professorship by the Indian Space Research Organisation which has helped him to perform his duties to the Committee. Also his sincere thanks to Dr. G. Sundararajan, Director, ARCI, Hyderabad and his office staff for all their assistance. ARCI has also provided partial financial support to this endeavour. This help is gratefully acknowledged.

In conclusion, the Chairman wishes most sincerely to record his enormous debt of gratitude to the members of the Review Committee who are all, being so senior and so eminent in their fields, busy professionals. It was their presence at the Committee meetings, their wholehearted participation in the deliberations and their continuous, substantial inputs that kept the Committee going. But for their powerful association, this Report would not have been possible.

EXECUTIVE SUMMARY

"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"

Pandit Jawaharlal Nehru
(1889-1964)

EXECUTIVE SUMMARY

INTRODUCTION

The Indian Institutes of Technology were established during 1950-2001 at Kharagpur (1950), Bombay (1958), Madras (1959), Kanpur (1960), Delhi (1961), Guwahati (1995) and Roorkee (2001). The last review of the five older institutes was performed by the Nayudamma Committee in 1984 (Report in 1986). Much has changed during the last two decades, in particular the economic environment to which technology and higher technical education are so tightly connected. Consequently, the IITs have become even more valuable as Institutes of National Importance. In the years that have gone by since their establishment, these Institutes have acquired unique strengths and have demonstrated their potential. These features are described in **Chapter 1** of the Report, titled: *Why IITs are Important to the Nation?* This chapter is an attempt to place the Committee's approach to the Review in a proper perspective, which is that in the IITs India can find a colossal resource of inestimable worth to tap and display the country's enviable richness in its knowledge-intensive human capital.

In **Chapters 2 and 3** that follow, the scope and the objectives of the Review and a bird's-eye-view of the total IIT System comprising the seven entities are presented. The Committee was handed down eleven terms of reference (listed in **Chapter 2**). These were divided into twelve elements and **Chapters 4 to 15** are devoted to each of the related twelve topics. Considerable effort has gone into prefacing these Chapters with relevant data obtained from the MHRD and the IITs themselves. It is possible that despite all care some numbers are erroneous and these can be corrected, once pointed out. The data are relevant not only to set the stage for making the observations but also as a record for the future, when in all likelihood another review will occur which will require tracing back to the present time. **Chapter 16** pertains to the case of IIT Guwahati which is in need of special attention.

While reviewing the performance of the IITs, the committee adopted a process of appreciative enquiry. Accordingly, the recommendations were conditioned by two guiding principles: a) not to be prescriptive in academic matters and b) not to make suggestions that may obstruct the freedom of any one of the IITs to pave its own desired academic path. Thus, although several observations have been made on academic issues, the final shape of things to be crafted has been left to the IITs themselves. It is only in matters that have to be necessarily handled with a commonality of approach that coordination at the apex level has been suggested.

OVERVIEW OF THE RECOMMENDATIONS

First the then Prime Minister Nehru, then the N.R. Sarkar and Y. Nayudamma Committees, thereafter the IITs themselves, have thoughtfully formulated their vision for the IITs. It is in the light of these expressed goals that the Committee has made its recommendations. The recommendations address a range of issues that the Committee has considered pertinent in light of

the terms of reference and for taking the IITs forward. Starting with the question of translating the IIT vision into concrete results (**Chapter 4**), the areas dealt with by the Committee in the Report are: (i) governance (**Chapter 5**), (ii) faculty matters (**Chapter 6**), (iii) research enhancement (**Chapter 7**), (iv) the education system (**Chapter 8**), (v) the JEE (**Chapter 9**), (vi) IPR issues (**Chapter 10**), (vii) linkage with industry (**Chapter 11**), (viii) technology in education (**Chapter 12**), (ix) non-faculty employees (**Chapter 13**), (x) funding policy and development (**Chapter 14**), (xi) expansion in the country and opening campuses abroad (**Chapter 15**), (xii) and the special case of IIT Guwahati (**Chapter 16**). The core theme addressed in each of these chapters and the key recommendations made therein are summarized below.

- **The Board of Governors (BOG) in each case may keep in view the direction their IIT has chosen to pursue (Chapter 4) and annually set up numerical targets related to key achievements in regard to a) out-turn of graduates, b) research and other scholarly publications and c) output of patents.** Targets, not necessarily numerical but in terms considered appropriate by the BOGs, may be defined for other areas relevant to the IIT system. BOGs are best placed to monitor progress by their IITs in this regard. The purpose of suggesting targets is not so much to clutter up the freedom of the academics but to indicate that such an approach is expected to help. **The Committee thus prefers to leave specifics in these matters in the respected hands of the Chairmen and members of the BOGs, of which the respective Directors are also members.**

- BOGs at the level of individual IITs, together with the IIT Council for the whole of the IIT system, constitute the apex elements of the Governance Structure (**Chapter 5**). These apex bodies are designed to function for the benefit respectively of the individual IITs and of the entire IIT system. The key recommendations are:

  1. **A standing committee of the IIT Council, called PAN-IIT Synergy Committee, Chaired by Secretary MHRD and Co-chaired by a distinguished non-official member of IIT Council to be chosen by Minister, MHRD, may be set up to provide inputs to the IIT Council.** Such inputs are to help the IITs, as a system of outstanding institutes, achieve higher academic outputs and make an impact in the world of research, on domestic economy and in regard to societal well-being. This committee could also take care of coordinating matters pertaining to non-teaching employees. Importantly the PAN-IIT Synergy Committee could prepare the ground for the IIT Council to work cooperatively with such Ministries as Ministry of S & T and Ministry of CIT to mobilise additional resources, in particular for IIT research projects, and for greater deployment of information communication technology (ICT).

  2. **A new procedure has been recommended for choosing Chairmen and Members of the BOG as well as the Directors.**

  3. The position of Deans needs to be formally recognised in the IIT statutes. A Dean dedicated to faculty matters has been suggested. He will head the HR (human resources) unit proposed in **Chapter 6**. The Committee has also suggested two more Deans: 1) to lead the effort in IPR matters (**Chapter 10**) and 2) to manage and enhance the capability and use of information and communication technology (**Chapters 5 and 12**).

- The stature of the IITs is intimately linked to the stature of their faculty members. **Chapter 6** addresses this core theme. How many of them are widely acclaimed stars in their respective disciplines is an important parameter. The faculty-mix in terms of such features as their disciplinary strength (science, engineering or interdisciplinary), where they were educated and trained, their age and their position in the institution are the other considerations. Keeping in view the importance of these aspects related to the faculty, the Committee has recommended as follows:

  1. **The service conditions of the IIT faculty, including their pay scales and allowances, need to be urgently reviewed, in view of the prevailing high demand for higher qualified technical personnel.** As for immediately implementable measures, the Committee suggests that the best performers among the IIT faculty may be retained beyond 62 years to the age of 65. Further, the pension scheme and medical facilities subsequent to retirement should be such as to encourage faculty to continue in the service of the IIT system.

  2. **Each of the IITs should create a dedicated Human Resources (HR) unit headed by a Dean.** The unit will constantly innovate strategies for attracting high calibre individuals to take up faculty positions, also for their retention and for providing opportunities for their professional growth. The HR Unit will also have to be concerned with genuine faculty needs such as housing and medical facilities.

  3. **A system akin to that prevalent in IISc for faculty induction as well as for faculty assessment and promotion has been recommended.** The IIT Statutes will have to be amended to make this happen.

  4. It is submitted that, at this juncture of development of the IITs, **MHRD should consider making provisions for enabling IITs to induct meritorious foreign nationals (to start with, those of Indian origin) to join their faculty.** This may be particularly desirable in certain frontier areas where advanced countries have a lead.

- **Chapter 7** deals with the major challenge that the IITs face, which is to intensify their research without in any way jeopardising their teaching programs, especially for the B.Tech. students. While encouragement to the faculty members is crucial, a key factor concerns the ability of the IITs to attract and motivate high calibre students in good number for research. Accessing funds for research needs also to be made easier and less time consuming. Accordingly, the key recommendations pertain to 1) Faculty 2) Research Scholars and 3) Support to Research and these are summarised below.

  1. **Outstanding performers in research among the faculty to be rewarded financially; Distinguished Research Professorships to be instituted; Funding to be provided for engaging Visiting Professors and Visiting Outstanding Scientists in larger number and for longer durations; Funding also to be provided for selected faculty members and selected research scholars to spend upto 3 months in a year (and successively for 3 years, if needed) for collaborative work with well-established researchers abroad.**

2. Instituting for the seven IITs put together **100 Golden Jubilee Research Fellowships with a monthly stipend of Rs.20,000/-;** setting up enabling mechanisms for bright candidates to complete Ph.D degree requirements by the age of 25. **A way to achieve this is by introducing research projects at the 2nd year B.Tech. stage and attracting the best performers directly to Ph.D programme after B.Tech.; Promoting and attracting students for Ph.D research from abroad, also as Post-doctoral Research Associates; Providing for 25 Post-doctoral fellowships in each of the IITs with a monthly stipend of Rs.25,000/-;** Providing for Ph.D work to be carried out by students engaged in collaborative projects with institutions in advanced countries; Expanding QIP and ensuring quality at the same time.

3. **Government to be persuaded to institute a new mechanism for assuring careers to highly talented IIT Post-graduates, also to offer tax incentives to industry if they hire Ph.Ds and research trained Post-graduates; MHRD to introduce a dedicated budget head for research support and to provide an amount to match IITs using upto Rs.10 crore from their earnings and donations; a few PAN-IIT grand challenge projects to be supported and thereby inter-IIT research collaboration promoted; IITs to work out alliances with national laboratories and to seek support from major science funding agencies, also to bid for major national experimental facilities in the IITs.**

- The Committee emphasizes the widely acclaimed strength of the IIT B.Tech. educational programmes. Going back to the period when the duration of the B.Tech. course was 5 years, the Committee raises two important questions (**Chapter 8**). One question is whether, as a consequence of the transition to the 4 year course, there has been a reduction in the content of science, mathematics, humanities and social sciences in the present B.Tech. programme. The value of liberal arts and science education cannot be overestimated when one recognises that leaders in the professions are rarely one dimensional persons. The other relevant question is whether there is room to effect a reduction in the actual teaching load and thereby release more time for the students to *learn to learn* as well as for faculty to gain more time for research. In this light should be viewed the recommendation to introduce research assignment in the B.Tech. course at the 2nd year stage. In the same light, the Committee has felt that a review of the Continuing Education Programmes is warranted, for such involvement, how-so-ever may be argued as necessary, means distraction from research for the faculty. **The Committee strongly suggests that a PAN-IIT Committee of Academics should be set up and be requested to pay attention to the Committee's observations made in Chapter 8.**

  - **This Committee of Academics should also examine a major key recommendation of the Committee to drop the 5-year B.Tech.-M.Tech. dual degree programme in favour of a new 4-year M.Tech. programme for the carefully selected (*a' la JEE*) B.Sc. graduates who are expected to have undergone substantial training in science subjects (the pros and cons with reference to the new M.Tech. course have been put down).** The sample size of B.Sc.s runs into several lakh of students in the country for whom education in engineering and technology in the IITs would present the prospect of a fine career. With a view to consolidating the educational programmes in terms of the 4-year B.Tech., 2-year M.Tech.and the new 4-year M.Tech. and avoiding increase to the

teaching burden carried by the faculty, some of the integrated Masters courses, which may have lost their attractiveness, may also have to be dropped.

- Conducting a JEE type examination for screening in meritorious B.Sc., graduates provides a means of selecting a few of them for the integrated Ph.D. programme in science, engineering and interdisciplinary areas, which has been recommended. This has been successful in the IISc where bright B.Sc.s were taken to Ph.D. in physics, chemistry, mathematics and biology.
- **The Committee has received a suggestion that IITs should also consider starting undergraduate science courses for reasons briefly stated in Chapter 8.** Three of the seven IITs have an ongoing B.Tech. (Engineering Physics) programme. This suggestion has also to be evaluated by the Committee of Academics suggested above.

- **In regard to the Joint Entrance Examination (Chapter 9)**, the flagship of the IITs, the Committee strongly recommends zealous preservation of the time-tested system, which has been in place for years for the ***conduct*** of the examination. **The key suggestion is for an IIT group to examine a) whether the level of the recommendation can be better related to a bright school leaving pupil, b) whether the screening test can be eliminated and c) whether a transition to an electronic web-based examination can be made operational in a 3-year time-frame.**

- **Chapter 10** is devoted to a discussion on expanding the IIT brand by gaining intellectual property rights (IPR). While there is a growing trend in securing IPRs, there is a long way to go for the IITs to make their mark. For this to happen, there are steps to be taken to motivate innovators. **The key recommendation in this regard is to instituionalise an IP system operated by a dedicated IP management centre which can take away from the inventor, once he makes his seminal contribution, the rest of the burden involved in applying for and getting a patent granted to him and maintaining the IP asset.** The IP management centre should be an empowered centre, but not embedded within those for ICSR (Industrial Consultancy and Sponsored Research). This centre should have separate staff and a separate budget, with autonomy in its utilization. **A separate budget allocation is called for because the cost of preparing and filing patents, in particular international patents, could be substantial. The budget should have a provision for financially rewarding the inventor.** This expenditure is to be regarded as an investment, just as the Government deliberately invests in education and training with the expectation that the educated and trained individuals would be successful and would generate worthy assets for the nation. The return on IPR investments can only be expected in the future and would be contingent upon the success of the patented idea, product or process.

  Engineering process is driven by innovation and, to encourage a culture of innovation, monetary rewards to the inventor are to be built into the IP system. The IP system should strive towards spreading the IP culture among not just the researchers but across the IIT community. The principle being emphasized is that innovation is a phenomenon dependent on individuals. The capacity to think and innovate creatively resides in every section of the

IIT community, not excluding the undergraduates, the non-teaching employees and the other residents on the campus. It is important to motivate and challenge them.

- The bridge between innovation and industry (read also business) poses substantial challenges and this is the subject matter of **Chapter 11.** The IIT-Industry interface has been largely managed by units, albeit with varying labels in the IITs, mandated to build up industrial consultancy and sponsored research. IIT Kharagpur was among the earliest in the country to venture into a science and technology entrepreneurship park (STEP). Some of the IITs (IIT Bombay and IIT Kanpur) have encouraged technology business incubators (TBIs) on their campus to help young entrepreneurs. Significant revenues have been earned by the IITs via these and other mechanisms now in place, e.g. IIT Delhi having invited industry to set up some of their operations on the IIT campus. However, all of this does not mirror the significant change witnessed in some of the world's leading academic institutions where the boundary between the academia and business has blurred. **To see a prosperous linkage with the industry, and a thriving entrepreneurial spirit, as notable features of the IIT system requires fresh approaches. Such fresh approaches have to pay particular attention to the following essential requirements:**

  a) Attracting experienced industry technical personnel to take full-fledged positions, even if it be for one to three years as visiting experts in the IITs (several means by which this can be done are mentioned in **Chapter 11**);

  b) Setting up physical facilities on IIT campuses for cooperative R & D;

  c) Allowing those graduates freshly selected by the industry to remain on campus as industry staff but to carry out their Ph.D degree research before they return to their industry job;

  d) Developing a clear understanding on sharing of IPRs;

  e) Instituting special fast-track procurement procedures for industry projects;

  f) Establishing a framework in the IITs to encourage, assist and reward entrepreneurship and

  g) Formulating enabling policies, including tax incentives, for industry to invest in industry-IIT partnership programmes

  In the Committee's view, all of the above to be attended to needs a system, like an autonomous society within the IITs, not as a replacement for the present ICSR, to invest in industry–IIT partnership programmes and to discharge functions that go beyond the present ICSR responsibilities.

- Knowledge systems are critically dependent on information communication technology (ICT). The use of modern ICT is far more advanced in the IITs than in most academic institutions in the country (**Chapter 12**). MHRD has liberally funded the IITs in several ways to enhance internet connectivity, access to technical journals, digital libraries, distance education and allied activities related to e-learning. A national programme for technology enhanced learning has been launched. In this programme, inter-alia, the seven IITs and IISc are expected to together develop web and video-based material for basic undergraduate science and engineering courses. Another major development in this area is the Indo-French Cyber University in which, as a first project, IISc and Toulouse University are working out lecture programmes on selected topics. The successful launching and placement of the educational satellite (EDUSAT) is yet another milestone.

The Committee recommends that, at this stage, when the various elements have been put in place and financially supported, a group consisting of experts drawn from IITs, IISc and the Department of Space should review key aspects related to technology infrastructure, training of mentors, content generation & delivery and research collaboration.

The review by the expert group should focus on the effectiveness of these programmes and suggest what further investments and other support may be necessary to ensure sustained growth in these and related projects.

- **An important component of the IITs,** like that of any academic institution, is the group of **non-teaching employees** (**Chapter 13**). Their commitment to the work environment in the IITs has been commendable. The issues pertaining to this group have been briefly stated in this chapter. The strength of the supporting (8026) and the project staff (1848) put together is more than four times the faculty strength (2375) and this calls for a review. Given the high technical nature of the IIT work portfolio, these institutes require a larger number of staff with higher technical qualifications. Although IITs are better endowed than most academic institutions in the country with regard to IT tools, much more needs to be done to achieve a higher level of automation and online operations in the IIT environment. IITs also need to install and maintain a robust management information system. Keeping such advances in view, the Committee has set out to make their observations in respect of non-teaching employees. Apart from their cadre structure and pay scales, staff development and regular training have been emphasized. Training has to be viewed across the board. Senior staff training in management, workshop and technical staff training in the use of modern power tools and automated machinery and office staff training in the daily use of IT tools are to be organized and financially supported. Higher Productivity in the IITs is closely linked to the efficiency and effectiveness of this group of employees. **A coordinated approach for addressing matters pertaining to them should be possible through the PAN-IIT Synergy Committee recommended in Chapter 5.**

- The funding policy is discussed in **Chapter 14**. It is pointed out at the outset that the Government has been a benevolent supporter of the IITs. A block grant system was introduced during the early 1990s for non-plan funding. This system, with built-in incentives for resource generation, led to the spectacular success of IITs attracting significant donations from their alumni. More recently performance-based funding was experimented with. **In the Committee's view, the MHRD is in a position to decide, depending on their experience with the past approaches, on the best course for funding. To the annual funding meant for salaries, maintenance and development, the Committee has recommended additionalities:**

  1) An allocation for each IIT of Rs.20 crore over the next 5 years for improving upon undergraduate student laboratories and workshops and the associated infrastructure. The task in this respect is much beyond repair and rejuvenation. The IITs need to put in place a world class infrastructure in their academic as well as non-academic spaces. If more than Rs.20 crore is needed in any given year in specific instances, MHRD could look at the same favourably.

2) Additional dedicated budgetary provision for a) Research b) IP Management Centre c) Visiting Chairs, Visiting Scientists and for inviting industry technical experts d) Distinguished Professorships, Post Doctoral Fellowships and initiation grants to the newly inducted faculty. These items have been explained in **Chapters 6, 7, 10** and **11**.

3) The Committee reiterates, as suggested in **Chapter 5**, that MHRD could invite cooperative funding from the Ministry of Science and Technology for research and major experimental facilities and from the Ministry of Communication Information Technology for augmenting IT infrastructure.

- The demand in the country for IIT education is immense. Consequently, expansion of the present intake into the IITs and expanding the IIT system by setting up more IITs in the country have been widely advocated. **The need for increase in intake at the B.Tech level has been underscored by the Committee (Chapter 15).** The cost implications of catering for more students have been briefly analysed. While some more expansion is possible, this chapter presents the constraints coming in the way of large-scale expansion of the IITs as they are situated at present. In the case of some of the IITs which have substantially utilized space in their present campuses, satellite campuses would be required to meet the needs of expansion. **The way forward seems to lie in creating more IITs at a steady pace.**

  Chapter 15 also discusses export of IIT brand by setting up campuses abroad. Reference has been made to the most recent indication arising from the reported interest of eminent foreign universities in extending their activities by setting up campuses in India. Thus, a new challenge is likely to appear at the door-step of the IITs. Such a development will bring with it added pressure on the IITs to think and perform competitively in an international sense in order to retain their status as the most preferred destination by the students and faculty alike. **The Committee has recorded a few of its immediate inputs in this regard for the consideration of the IIT Council.**

- The sixteenth and the last Chapter (**Chapter 16**) pays attention to IIT at Guwahati. The Committee points out the locational disadvantages of this IIT, especially for attracting and retaining meritorious faculty. The industrial growth in the region has been inhibited and this also has an impact on the various aspects of IIT endeavours. **The key recommendations are in terms of providing incentives to the faculty of IIT Guwahati and setting up in its campus major national facilities. These and other measures to be articulated by the Director, IIT Guwahati may receive special consideration by the MHRD.**

CONCLUDING REMARKS

Members of the Committee were no doubt familiar with the IITs, but "*familiarity is not accurate knowledge*". In a sense, therefore, the review was a voyage of discovery, not only of the Institutes the Committee was involved with but also of its own thoughts as to how best to propel the IITs into their promising future. The Report is a record of the Committee's findings and of its well-intentioned thoughts.

IITs have undoubtedly displayed several outstanding attributes and demonstrated significant capabilities which mark them out as India's excellent institutions for teaching and research in engineering and technology. It is good to remember that "*excellence is a journey and not a destination*" and this is a dictum followed by universities and institutions the world over. Stanford University underwent a massive change during 1940-60 to transform itself from being a peer of Ohio State University to a world-class university and is now ranked among the top ten in the world. Beijing Transcentury Project has been undertaken to make ten universities in China truly world-class and Seoul National University, Korea has initiated a transformation program in 1999 to be a global research major. Given their talent, energy and enthusiasm, IITs of India should at this juncture feel inspired to attempt a similar transformation. The IIT Faculty, their scholarly pursuits and accomplishments and their stature in the academic world hold the key to bringing about such a transformation. All else will follow. The Committee would therefore urge all those who have a stake in these institutions, in particular the Government which has invested heavily and will continue to do so, that they should do all they can to help IITs attract high caliber individuals to join their faculty. It would also be necessary to ensure that the faculty time is zealously guarded so that their core functions, namely teaching, research and building bridges with those who could be engaged in the application of products of their research, are discharged with the minimum of other distractions.

The Committee hopes that this Review Report, coming as it does after two decades since the last one, receives due consideration by the Government of India, the IIT community, by the Indian industry and by the numerous alumni who have in recent times displayed exemplary interest in the welfare of their *alma mater*. None of the recommendations made in this Report warrant any amendment to the IIT Act. Some of the Statutes will need to be amended and this requirement has been clearly indicated where necessary. While the full set of recommendations and the rationale for making them have been documented in the Report, some of the major and key recommendations have been brought together in this Summary. The Committee earnestly hopes for these to be accepted and implemented by the Government. Acceptance of the recommendations in some cases would need specific additonalities to annual financial allocation by the MHRD. Hopefully, such allocation will be appreciated as necessary at this point in time and made available to these institutions, which have, among the hundreds that have come into existence in the country, the best chance to get into the big league of the world's leading universities.

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CHAPTER ONE

WHY IITs ARE IMPORTANT TO THE NATION?

"The best higher education is a model and a source of pressure for creating a modern civil society. This is an ideal not often realized but is nevertheless a standard against which to measure national systems"

WORLD BANK TASK FORCE REPORT:

"Higher Education in Developing Countries: Peril and Promise 2000"

CHAPTER ONE

WHY IITs ARE IMPORTANT TO THE NATION?

The resurgence of India as a nation competitively endowed in science, technology and higher technical education can be traced to the vibrant currents of 1947 when, to India's great fortune, Jawaharlal Nehru took charge as the country's first Prime Minister. Among his several pioneering initiatives designed to accelerate India's development through education and research in scientific and technology disciplines, several specific projects have stood out with extraordinary success and have achieved global reach and stature. Among them is his visionary venture to set up a group of institutions called the Indian Institutes of Technology. From Kharagpur in 1950 to Roorkee in 2001, there are now seven potentially world-class institutions in the family. Their consistent performance assiduously kept up in the last fifty years has attracted not only nation-wide acclaim for them but provided them international commendation, which they so richly deserve. What are those features associated with the IITs that have contributed to their *brand* as institutes of excellence?

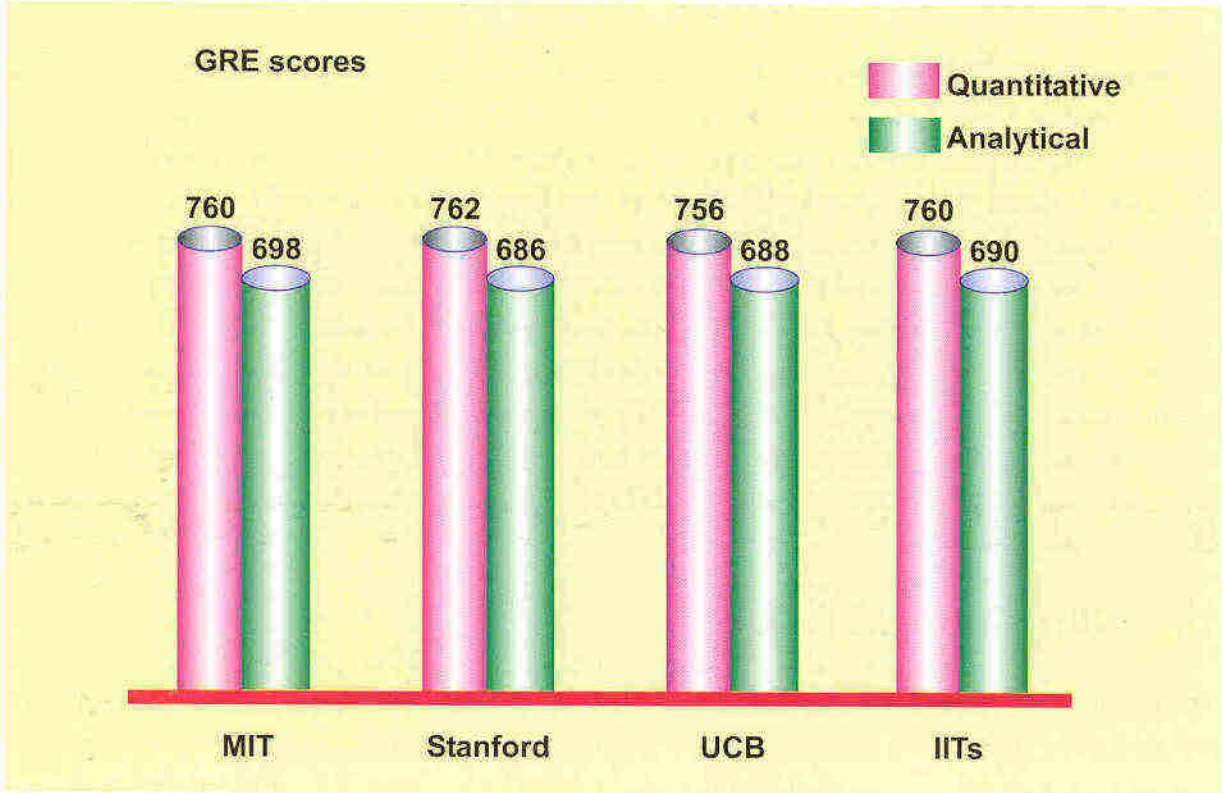
1.1 OUTSTANDING INTAKE

The nation-wide examination that the IITs conduct to select the most deserving for admission has proved to be a significantly effective filter. At one time the ICS and, later on, the IAS examinations conducted for *graduates in any discipline* throughout the country enjoyed a great reputation. Such a reputation was based on transparency and rigour of the selection process. No wonder those that withstood the pressure and succeeded in the selection, from among the several thousand that attempted, shone as visionary builders of our institutions. They stood apart as exemplary guardians of the nation's stability and committed their indefatigable energy and contribution to India's economic and social development. It may not be an exaggeration to state that the JEE, *held for the 12th grade students*, in recent times has perhaps eclipsed these and a myriad other competitive examinations in its ability to pick the most outstanding from a very large gene pool. In nurturing the IIT system with the ablest in this way, the JEE is singularly responsible for accomplishing the brand image to India. The IITs have thus emerged as a cradle for India's future leaders.

1.2 WORLD CLASS PERFORMANCE OF THE B.Tech. GRADUATES

The International competitiveness of the IIT undergraduates is reflected in their performance at the Graduate Record Examination (GRE) of the USA, an examination for graduates from all over the world. A comparison of the performance levels at the GRE between the IIT B.Tech.s and those of the three of the best institutions in the world is shown in Figure 1.1. In no other sphere have any of our Universities and Institutes of higher education come anywhere near MIT, Stanford University and University of California at Berkeley, USA, – Institutions which rank among the world's top ten Universities. (A global consultancy firm, Mckinsey, has reported that they have more IIT graduates in their

worldwide work force than those from any other University in the world). It is this kind of topnotch performance of IIT graduates that, *inter alia*, has infused self-esteem and self-reliance in the Indian mind.



Source: IIT Delhi Alumni Report 2004
Figure 1.1: IIT undergraduates are comparable to the best

India today boasts of over 1200 engineering colleges with an intake that has presently risen to about 4,00,000. An impressive figure of around 3,00,000 students graduate from these colleges every year (incidentally, this is 4 times the number of engineering graduates in the USA). In this sizeable population of colleges and engineering graduates, the small number of seven IITs and their 2300 graduates each year stand out in their accomplishments. The IITs have, therefore, been justifiably hailed as islands of excellence in India's engineering education. Apart from the outstanding intake, the following IIT characteristics place them apart from the rest of the hundreds of engineering colleges:

- Nearly all of IIT faculty members have Ph.D.s. Their research interests impact their teaching, govern their consultancy methods and enable their continuing education.
- In the engineering field, the IITs together account for over 60% of the Ph.D.s from India.
- The faculty members at IITs enjoy full academic autonomy and are able to update their curricula to keep pace with the modern developments.
- The continuous assessment of students, with particular emphasis on tutorials, leads to continuous learning.

- Student evaluation of teaching is an established norm among the IITs.
- Much academic activity occurs in their libraries, around their laboratories and computing facilities, which are made available to students till late hours in the evening.
- Students have the opportunity to interact with post-graduate and Ph.D. research scholars.
- Their campus-centred ambience has magically contributed to personality building at an impressionable age.

1.3 EXEMPLARY ALUMNI AND FACULTY

The alumni of IIT today number more than 1,35,000 and constitute an asset of inestimable worth. Alumni data in Table 1.1 brings out two less-known features:

- Over 70% alumni are working in India
- It is notable that 28% (IIT Kanpur) to 62% (IIT Kharagpur) of IIT Faculty are IIT alumni

Table 1.1 Approximate number of IIT alumni in India and abroad*

	IITB	IITM	IITD	IITK	IITKGP
Total number graduated till 2003	~27,000	~26,111	~25,485	~20,000	~34,649
Alumni abroad	~7,000	~7,000	~6,500	~5,400	~6,000
Alumni in India	~20,000	~19,111	~18,985	~14,600	~28,000
IIT Faculty with at least one degree from any of the IITs	~170 (44%)	~190 (60%)	~270 (61%)	~90 (28%)	~275 (62%)

*The total turnout of graduates from the IITs, as of March 2003, is about 1,33,245.
** % figure in the brackets reflects % of total faculty.

In the present day technology-intensive times, the performance of IIT alumni has had a definitive impact on the national and international professional scene. An illustrative list of celebrated achievers among the alumni demonstrates their impressive spread across industry, academia and entrepreneurship in India and abroad, as well as in Government establishments in India (please see Table 1.2 at the end of this chapter). One should not lose sight of the fact that quite a few of these achievers and others, who are professionally engaged in India, are post-graduates from the IITs.

Nothing succeeds like success. This adage comes true in the manner in which the alumni of the IITs, whose success is so phenomenal, are now returning to their *alma mater* with gratitude. The PAN-AMERICAN IIT Alumni Association has grown into a colossal body catalyzing a comprehensive approach to maintaining the alumni link. The Association has formed an authentic conduit for the flow of funds and other kinds of support; it has provided a much needed platform for the alumni to come together to discuss and determine how best to advance and propel the IITs into a league of the world's best universities. It is with these aims that thousands of the old IIT students already gathered twice in a common forum in the distant California, in the US. The tangible outfall of this passionate wave to give, which has no parallel in India's educational

institutions, is reflected in the impressive corpus funds, physical assets and invaluable contacts now made available to the IITs. **This alumni gesture of gifting with gratitude is yet another special IIT asset.**

Just as the IIT alumni have done the nation proud, so also the IIT faculty. Many of the former faculty members are in the lead roles today as Vice-Chancellors of leading Universities, heads of eminent institutions and valued advisers to Government and, above all, honoured as famed academics.

1.4 DEMONSTRATED POTENTIAL

Our endeavour from now on should be to address the question as to whether the IITs have realized their full potential. Suffice it to say at this stage that, if we have to pick a dozen technical institutions in the country which have the highest potential to become the dominant players in a knowledge intensive society, the seven IITs will easily figure among them.

Why do we say that the IITs have the potential? It is because, whether in original research or in product design or product development, IITs have often clearly demonstrated their high level of competence. We mention here a few examples:

(a) Institute of Scientific Information, Philadelphia, USA, has put out a list of most cited authors during 1981-1999. Of these, 8 are from India, out of whom 3 are from the IITs. These are Soumitro Banerjee (in Engineering) and Sadhan Kumar De (Material Science) of IIT Kharagpur and K.L. Chopra (Material Science) from IIT Delhi. The fourth is V.K. Gupta (Ecology and Environment) from the then Roorkee University, now IIT Roorkee.

(b) The work from IIT Kanpur gave the first deterministic polynomial-time algorithm for the primality testing problem, i.e. given a number, test if it is prime, a major breakthrough in the area of computational number theory.

(c) IIT Delhi, in conjunction with the Central Electronics Ltd. (CEL) and Solid State Physics Laboratory (SPL), developed the dual mode reciprocal (both to receive and transmit operations) phase shifter at X Band, also at C Band, with integrated antenna elements and driver. With respect to these microwave ferrite phase shifter modules, as they were denied to our country, all of their elements had to be designed, developed and produced in hundreds by the IIT Delhi-SPL-CEL team. Without the collaborative pooling of the three institutional resources in which IIT Delhi had a lead role, a major technological achievement of making the phased array radar, capable of acquiring a target with total flexibility in terms of multibeam electronic scanning, would not have been possible in the country.

(d) The CorDECT Wireless in Local Loop (WLL) telecommunication system has been designed, developed and commercially deployed by the TeNet group of IIT Madras. The TeNet Group consisted of faculty members of the Departments of Electrical Engineering and Computer Science and Engineering. They co-opted nine IITM alumni who formed the company Midas Communications. TeNet, together with Midas Communications, constituted a powerful consortium to work for a common goal.

(Midas Communications won this year's CSIR Technology Award). This is a remarkable demonstration of how the costs of even the so-called high technology products, when they are indigenously researched, developed and produced, can be drastically cut and consequently their deeper penetration can be facilitated. It is no surprise, therefore, that the WLL telecommunication system is reaching out to the less endowed villages in the country. Further, unprecedented export possibilities could be realized.

(e) The modern rice-mills that were set up in Andhra Pradesh and the rest of India were based upon the design of international manufacturers. But it was IIT Kharagpur, which brought about the required design changes and contributed to testing, and propagated the modern rice mills. IIT Kharagpur has also significantly contributed to the design and development of paddy-husk-fired fixed bed and fluidized bed combustors and allied equipment that form an integral part of the rice milling plant. It is noteworthy that IIT Kharagpur is the only Institution offering educational and research programmes in Agricultural and Food Engineering at the undergraduate and post-graduate levels.

(f) IIT Bombay has made a mark in the important role they played in the development of technologies for India's prestigious Light Combat Aircraft (LCA), *Tejas (Brilliance)*. Their wide-ranging contributions included the development of aeroservoelasticity analysis software (not available commercially anywhere in the world) and computational fluid dynamics (CFD) packages, besides their work on controls for LCA and the maintenance-training simulator.

(g) Indigenous development of earthquake engineering goes to the credit of IIT Roorkee. Beginning with the development of experimental tools to study the dynamic behaviour of various types of structures, IIT Roorkee's work was basic to the reconstruction programmes following the Latur earthquake in Maharashtra and in Gujarat in the aftermath of the Bhuj earthquake.

(h) The newest IIT at Guwahati has taken a pioneering initiative in starting a Bachelor's course in Design. Their design of bamboo products for use in local institutions, such as hospitals and schools, in the north-eastern region holds considerable promise.

1.5 THE NEW FRONTIER

Times have changed and "*we stand today on the edge of a new frontier*". The world has transited from industrial revolution and from industrial economy to knowledge revolution and toward knowledge economy. In this changed scenario, global economies are getting integrated. R&D is crossing national borders. India, with its large pool of technical graduates, is confronting new challenges. They are indeed of a kind that suits India's genius. There is, therefore, a new opportunity for India to seize upon. The nature of products of immeasurable economic worth will henceforth be knowledge-based, requiring minimal capital unlike the conventionally manufactured industrial products that guzzle huge capital. Here is where the IITs must have their prominent presence.

How can one define knowledge economy? A good definition could be that knowledge economy is characterized by the highest number of the best-trained, productive individuals. In other words, **highly educated, research-oriented human capital of the creative class would be the bedrock of the knowledge economy**. It has been forecast that, before the middle of the century, BRICs (Brazil, Russia, India and China) could become a much larger force in the world economy and India could be the third largest economy. Indian companies in the pharma, software and automotive sectors have shown their strength in knowledge-based commercial operations and some of them have been recognized as potential world leaders.

New technologies in the field of bio-technology and pharmaceuticals, advanced materials and nano-technology, information and communication technology are likely to be the key drivers of growth in the near future. All of this should make it clear that the next phase of development of India and the growth of the Indian economy will primarily be technology driven. There are real opportunities for India to be in the forefront of the new technology-based development and application in diverse areas.

In the emerging scenario, the IITs have a glorious opportunity to play their role in the cutting-edge fields of science and technology. For this to become a reality, IITs have to rank *paripassu* with the best in the world. The IIT brand has, therefore, to be moved up the value ladder from the undergraduate to the post-graduate and Ph.D. rungs and even beyond post-doctoral level to more mature heights of research.

1.6 IITs ARE A RESOURCE TO ENHANCE INDIA's SCIENTIFIC IMPACT

There are two recent publications, which have attracted much attention here in our country, and elsewhere in the world. These are: (1) A feature article by David A. King in *Nature* (vol.430, July 2004) in which nations have been ranked in accordance with their research publications and the related citation analysis and (2) A publication by the Shanghai Institute of Education of a list of the top 500 world Universities (http://ed.sjtu.edu.cn/ranking.htm).

In the list published in the *Nature*'s article, among the 31 countries assessed, which accounted for 98% of the world's highly cited research papers, India's rank is 23. The parameter chosen by David King for this ranking is not to be trivialized as he has shown a striking correlation between the citation intensity of publications and wealth intensity of these 31 countries.

In the Shanghai rankings of 500 Universities, based upon 5 parameters described in their publication, only 3 Indian academic institutions figure. While IISc appears in the band 251-300, two IITs, namely IIT Delhi and IIT Kharagpur, weigh in at 451-500. (There are more recent rankings in which IITs figure at significantly higher places).

When IITs gear up to compete among the world's top institutions, even as their vision statements aver their intention to be world-class, **IITs are bound to move up in their own rank and thereby India's ranking among the world's top research-intensive countries will rise**. IITs can and should be in such an orbit and advance further. A whole range of accomplishments,

a sample of which has been listed in 1.4 (a) to (h), will flow from such calibre and commitment across the IIT network for the benefit of our technological progress and in the service of our societal needs. And herein lies the answer to the question: Why IITs are important to the nation?

Our task, then, is to envision how best to empower these IITs, with their remarkable capability in generating world-class undergraduates, so that they can shine as the top-most institutions for outstanding researchers. What additional resources are needed to take them up the hill of creative knowledge without jeopardizing in any way their performance in undergraduate education? The report will analyse the status of IIT research and the various elements of their present resources and suggest ways and means by which the IITs can be further endowed to enable them to advance their research and extension activities.

While the following chapters will consider these issues, it should be clear that the importance of the IITs to India is only further accentuated by their potential to become world leaders in a knowledge-rich regime. How then is their potential to be harnessed? While the Committee will suggest along the lines indicated above, **the key to release and channel this potential, in the ultimate analysis, lies with the faculty, staff and students that compose the IITs.**

Table 1.2: An Illustrative list of prominent IIT alumni

INDIA - GOVERNMENT AND R&D
Dr. Kiran Bedi, Former Joint Commissioner, Delhi Police (IIT Delhi)
Dr. A.K. Balyan, Director, ONGC (IIT Delhi)
Mr. Vijay Mahajan, BASIX India (IIT Delhi)
Mr. Pradeep Kumar, Ambassador of India in Cambodia (IIT Delhi)
Dr. Mahesh Sharma, Chairman, KVIC (IIT Delhi)
Vice Admiral A.S. Krishnan, Indian Navy (IIT Delhi)
Dr. D. Banerjee, Chief Controller R&D, DRDO (IIT Madras)
Dr. G. Sundararajan, Director, ARCI, Hyderabad (IIT Madras)
Dr.C.G.K. Nair, Former Chairman, HAL, Bangalore (IIT Madras)
Mr. M. Natrajan, Scientific Adviser to Raksha Mantri (IIT Madras)
Mr. B.S. Sudhir Chandra, Member Railway Board (IIT Madras)
Mr. N.R. Dave, Under Sheriff, Madras (IIT Madras)
Mr. P. Damodaran, Secretary, Govt. of Tamil Nadu (IIT Madras)
Mr. R. Ganesan, Secretary to Government of India, Dept. of Posts (IIT Madras)
Mr. M.S. Srinivasan, Joint Secretary, Ministy of Commerce & Industry, Govt. of India (IIT Madras)
Dr. S. Banerjee, Director, BARC, Mumbai (IIT Kharagpur)
Dr. K. Sekhar, Director, DRDE, Gwalior (IIT Kharagpur)
Mr. V.P. Sandlas, Chief Controller R&D (Electronics), DRDO (IIT Kharagpur)
Dr. S. Sivaram, Director, NCL, Pune (IIT Kanpur)
Dr. H.S. Maiti, Director, CGCRI, Kolkata (IIT Kanpur)
Dr. S.P. Mehrotra, Director, NML, Jamshedpur (IIT Kanpur)
Dr. K. Vijayraghavan, Director, NBC, Bangalore (IIT Kanpur)
Dr.K. Balasubramanian, Director NFTDC, Hyderabad (IIT Kanpur)
Dr. Ashoke Sen, FRS, Mehta Institute, Allahabad (IIT Kanpur)
Mr. Sudhir Vyas, IFS, Ambassador (IIT Kanpur)
Mr. T. Ravi Mathur, Joint Secretary, MHRD (IIT Kanpur)
Mr. Rahul Asthana, formerly BEST, now DAE (IIT Kanpur)
Dr. Kota Harinarayana, Ex. Director, ADA, VC, Hyderabad Central University (IIT Bombay)
Dr. R.K. Bhandari, Ex-Director, Natural Disaster Mitigation Centre, Chennai (IIT Bombay)
Mr. P.L. Bongirwar, Former CEO, MSRDC, Mumbai (IIT Bombay)
Dr. S. Agnihotri, Secretary Women & Child Dept., Govt. of Orissa (IIT Bombay)
Mr. Pradeep Baijal, Chairperson, TRAI, (IIT Roorkee)
Mr. R.K. Singh, Chairman, Railway Board, Ministry of Railways (IIT Roorkee)
Mr. P.C. Parekh, Secretary, Govt. of India, Ministry of Coal & Mines (IIT Roorkee)

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Professor Prem Vrat, Director, IIT Roorkee (IIT Delhi, IIT Kharagpur)	Professor A.J. Paulraj, Dept. of Electrical Engineering, Stanford University, USA (IIT Delhi)
Professor Trilochan Sastry, IIM, Bangalore (IIT Delhi)	Professor Madhu Sudan, Computer Science, MIT, USA (IIT Delhi)
Professor Devang Khakkar, Ch. E, IIT Bombay (IIT Delhi)	Professor G.P. Agarwal, Institute of Optics, University of Rochester, USA (IIT Delhi)
Professor R. Manickasavagam, Former V.C., Anna University (IIT Madras)	Professor Raghuram Rajan, Director (Research) and Economic Counsellor, ITF, World Bank, USA (IIT Delhi)
Professor P. Radhakrishnan, V.C., Vellore Institute of Technology (IIT Madras)	Professor S. Suresh, Dept. of Materials Sci. & Eng., Massachussetts Institute of Technology, USA (IIT Madras)
Professor A. Subrahmanyam, Head of Physics, IIT Madras (IIT Kharagpur)	Professor S. Sundaresan, Dept. of Chemical Eng., Princeton University, USA (IIT Madras)
Professor P.P. Chakraborty, Head VLSI Centre, IIT Kharagpur (IIT Kharagpur)	Professor J. Baliga, Distinguished Professor, ECE, North Carolina State University, USA (IIT Madras)
Professor M.N. Faruqi, Ex. V.C., Aligarh Muslim University (IIT Kharagpur)	Professor K.R. Rajagopal, Mech. Engg., Texas A&M Univ., USA (IIT Madras)
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Professor Surendra Prasad, Deputy Director, IIT Delhi (IIT Kharagpur)	Professor Meera Chandrapal, Physics, University of Missouri, USA (IIT Madras)
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Professor P. Balaram, Chemistry, IISc., Bangalore (IIT Kanpur)	Professor K. Pingli, Cornell University, USA (IIT Kanpur)
Professor K.J. Rao, Materials Science, IISc., Bangalore (IIT Kanpur)	Professor Arvind, CSE, MIT, USA (IIT Kanpur)
Professor H.R. Krishnamurthy, Physics, IISc., Bangalore (IIT Kanpur)	Professor J. Narayan, Materials Science, North Carolina State University, USA (IIT Kanpur)
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Professor D.V. Singh, Former Vice Chairman, AICTE and Former Vice Chancellor, University of Roorkee (IIT Roorkee)	

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INDUSTRY

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Mr. S. Srinivasan, Chairman & MD, SRA Systems Ltd., (IIT Madras)	Mr. Gururaj Deshpande, Chairman, Sycamore Networks, USA, (IIT Madras)
Mr. P. Mallick, MD, Wartsila India Ltd., (IIT Madras)	Dr. R. Ramaswami, VP Xros/Nortal Networks, USA (IIT Madras)
Mr. K.V. Rangaswamy, Executive VP, L&T, (IIT Madras)	Dr.C. Mohan, IBM Fellow, IBM, USA (IIT Madras)
Dr. R. Mahadevan, Director, India Pistons (IIT Madras)	Mr. A. Subu, Director, Almex, USA (IIT Madras)
Mr. B. S. Kamath, Chairman & MD, Laser Soft Infosystems, (IIT Madras)	Mr. Arun Sarin, CEO Vodafone, USA (IIT Kharagpur)
Dr. V. Sumantran, Executive Director, Tata Motors (IIT Madras)	Mr. Rononjoy Dutta, Former President, United Airlines, USA (IIT Kharagpur)
Mr. R. Gopalkrishnan, Executive Director, Tata Sons (IIT Kharagpur)	Mr. Vinod Gupta, Chairman and CEO, Info USA Inc., USA (IIT Kharagpur)
Mr. B.K. Syngal, CMD, VSNL (IIT Kharagpur)	Mr. Rakesh Gangawal, Former President, US Airways (IIT Kanpur)
Dr. S.K. Kaura, CMD, Samtel Colour (IIT Kanpur)	Mr. Sanjay Mittal, CTO, Selectica, USA (IIT Kanpur)
Mr. Som Mittal, CEO, Digital Global Soft (IIT Kanpur)	Dr. Arindam Bose, President, Pfizer, USA (IIT Kanpur)
Mr. Suresh Pandey, MD, Bokaro Steel (IIT Kanpur)	Dr. Rakesh Agarwal, President, Air Products, USA (IIT Kanpur)
Dr. B.N. Singh, Former CEO, RINL and now Jindal (IIT Kanpur)	Dr. Rajendra Singh, CEO, Telecom Ventures, USA (IIT Kanpur)
Mr. Devasis Chowdhury, CMD, Midhani (IIT Kanpur)	Mr. Muktesh Pant, Reebok (IIT Kanpur)
Dr. Pawan Kumar Goenka, COO, Mahindra & Mahindra Ltd. (IIT Kanpur)	Mr. Victor Menenzes, Vice President, Citigroup, USA (IIT Bombay)
Mr. Parag R. Rele, Managing Director, Aplab (IIT Bombay)	Mr. Ravi Tilak, Director, Almex, USA (IIT Bombay)
Mr. Ravi Venkatesan, Chairman, Cummins India (IIT Bombay)	Mr. Rajiv L. Gupta, Chairman and CEO, Rohm & Haas, USA (IIT Bombay)
Dr. S. Rama Iyer, Managing Director, Kvaerner Powergas India Ltd. (IIT Bombay)	Mr. S.S. Kakade, President & CEO, US Aeromotive Inc., USA (IIT Bombay)
Mr. Deepak Satwalekar, Managing Director, HDFC Standard Life Insurance Ltd. (IIT Bombay)	Dr. Arun Netravali, President, Lucent Technologies, USA (IIT Bombay)
Mr. R.M. Pandia, MD Herdilia Chemicals Ltd. (IIT Bombay)	Mr. V. Kasturirangan, Chairman & CEO, Unilever, Phillipines (IIT Bombay)
Dr. Badri Prasad, Joint MD, Furnace Fabricia (I) Ltd. (IIT Bombay)	Dr R. Ayer, Chairman & CEO, Hartford Financial Services Group Inc., USA (IIT Bombay)
Mr. S.N. Mathur, Chairman, IBP-Balmer Lawrie Group of Companies (IIT Bombay)	Dr. - Ing, B. Balasubramanian, Sr. VP, Daimler Chrysler AG, Germany (IIT Bombay)
Mr. Atul Vijaykar, Intel Asia (IIT Bombay)	Mr. A. Manudhane, Advisor & Former Managing Partner, Goldman Sachs, USA (IIT Bombay)
Mr. A. Godbole, CEO, L&T Information Technology Ltd. (IIT Bombay)	Mr. Jitendra Goel, California(CA), USA (IIT Roorkee)
Mr. J.K. Tandon, MD and CEO, Jindal Vijaynagar Steel Ltd. (IIT Bombay)	Dr. Ajay Kumar, Director (AAAC) NASA Langley Research Centre, Virginia (VA), USA (IIT Roorkee)
Sri Subodh Bhargava, Chairman, Wartsila India Ltd. & Former Chairman & CEO, EICHER Group (IIT Roorkee)	Dr. Jai Hakhu, Vice President, Intel Corporation (Santa Clara), California, USA (IIT Roorkee)
Mr. S.K. Gupta, CMD, VSNL (IIT Roorkee)	
Mr. S.G. Awasthi, Ex-CMD Daewoo Motors Ltd. (IIT Roorkee)	

CHAPTER TWO

SCOPE AND OBJECTIVES OF THE REVIEW

"The conquest of the technical frontier, like the conquest of the geographical frontier, requires a varied initiative by millions of individuals"

MILTON FRIEDMAN, NL

(Consultant to India's Ministry of Finance 1955)

CHAPTER TWO

SCOPE AND OBJECTIVES OF THE REVIEW

The terms of reference given to the Committee and the methodology adopted by the Committee in its review work are presented in this chapter.

2.1 CONTEXT OF THE IIT REVIEW

Three factors are relevant to the IIT Review 2004.

First, the review is occurring at the turn of a new era, at the beginning of the 21st century coinciding with the dawn of the third millennium. Rapid and global changes in technological, economic, social, political and ecological dimensions at this time are not only creating opportunities for growth, but also posing developmental challenges for the nation. India has emerged as one of the five largest economies in the world (in terms of purchasing power parity). However, India's standing in terms of per-capita income (World Bank index), human development (UNDP index) and the global competitiveness survey (involving more than 60 countries) is low. This is a matter of serious concern for the world's second largest populous nation. While the nation has taken strides to embrace the increasingly knowledge intensive and global economy, it faces immense challenges in terms of poverty, social security, and environmentally sustainable development. How then can India achieve development that is more inclusive?

Second, this review comes at a time when there is an increasing realisation among national and international agencies that higher education and R&D are critical for development in this region, to address prevalent problems of poverty reduction, facilitate sustainable human and social development and improve competitiveness of the country to participate effectively in the emerging knowledge economy. Science and technology have traditionally been a critical component of the knowledge infrastructure. India started, soon after independence, providing a strong thrust to development of human capital and R&D in science and technology from early 1950s through the establishment of several government departments such as the Department of Atomic Energy, the Department of Defence Research, the Department of Space, the Departments of Science and Technology, Scientific and Industrial Research, Biotechnology and Ocean Development, Ministries of Non-Conventional Energy Sources and Information Technology, the premier Indian Institutes of Technology and a large number of engineering colleges, both public and private. These initiatives have led to visible improvement in the technology scenario in areas piloted by the respective agencies. So also in agriculture, the country experienced the green revolution and increased food security. However, India's position on the technology achievement index[1] is still behind that of several other countries. One could argue that such indices are fallacious. However, it cannot be denied that India has not made a mark, commensurate with its size and stature, in internationally competitive R&D based manufactured products. How is this lacuna to be corrected?

[1] Technology Achievement Index is a composite index of four criteria: (a) technology creation (patents and receipts of royalty and licence fees from abroad), (b) diffusion of recent innovations (ICT and exports of higher and medium technology products), (c) diffusion of old innovations (telephones and electricity), and (d) human skills (average years of schooling and gross tertiary enrolment in Science, Mathematics and Engineering).(See Human Development Report 2001)

Third, this review is taking place alongside a national initiative to improve the quality of technical education in the country. The initiative seeks to improve the quality of undergraduate engineering education in a number of institutions. Government colleges that are at a level below IITs are being identified as lead centers for focused improvement through measures such as greater autonomy in academic, financial and administrative aspects and increased funding, as has happened in the conversion of erstwhile Regional Engineering Colleges into National Institutes of Technology. Improvement of engineering education across the country is expected to address shortage of qualified faculty and good quality students for post-graduate education. The onus on the IITs is then to generate high calibre PGs and Ph.D.s and cater to the nation's dire need for quality technical manpower. IITs have also to excel in research, innovation and extension activities in a way as to be counted among the world's best research universities. What strategy may result in such excellence being accomplished?

It is in the context delineated above that the present review has been undertaken.

2.2 TERMS OF REVIEW (2004)

The Terms of Reference (TOR) handed down to the IIT Review Committee (2004) (herein after referred to as the Committee) are shown in Table 2.1

Table 2.1: Terms of Reference for the IIT Review Committee

1.	To review the **Vision**, **Mission**, and **Goals** of the IITs, and the strategies needed for achieving them, taking into consideration the current & future national priorities and emerging global scenario. In particular, whether there is need to reorient their entire thinking so that they are geared to solving the manpower & research problems pertaining to the critical sectors of the Indian Economy, especially those that have impact on the lives of our rural population & disadvantaged sections.
2.	To review the **performance of the IITs in relation to their Vision**, Mission and Goals, both in quantitative and qualitative terms. This will include the performance in manpower development in terms of capacities, levels and disciplines, as well as provision of Continuing Education for teachers and working professionals. The Committee should also give their recommendations on **increase in intake**, opening **new campuses** within the country and outside and possibility of operating two-shifts by optimum utilization of their physical infrastructure and faculty resources. The services and recommendations may also include academic and sponsored research, in terms of national priorities, thrust areas, and new and emerging areas of technology.
3.	To review the extent and intensity of **interaction with industry** for technology development & consultancy, as well as alliances with carefully chosen partners, both nationally & internationally.
4.	To review the management structures and **governance mechanisms** as also **financial management** and make recommendations on potential improvement.

5. To review the nature & scope of academic offerings in the context of emerging technology requirements such as bio-technologies, nano-technologies & new energy technologies and assess the responsiveness of the causes & **curricula** to the changing demands of the profession. The issue of inclusion of diversified inputs in **Physical and Biological Sciences, Social Sciences and Humanities** in the preparation of students may also be examined and recommendations made thereon. The Committee may also review the pedagogical approaches and suggest modifications, if any, that should be made in order to produce autonomous learners who are flexible, adaptable and possess the skill of **'learning to learn'**. Further, it may also make recommendations on the potential of, and actions needed for, **technology enhanced learning**.

6. In particular, the Committee should suggest ways and means of creating a mindset among the students that is based on human values of truth, good conduct, peace, non-violence and love. The IITs should produce students who are patriotic and think mainly of India and its problems. The tendency to look westwards in everything needs to be eschewed.

7. To review the contributions of IITs in serving as role models for other technical institutions in the country, and in providing leadership and playing a pro-active role in setting benchmarks for the national technical education system. The Committee may also review the extent to which IITs have succeeded in establishing **networking partnerships** and other educational & research institutions for resource sharing and academic partnership, and make recommendations for the future.

8. To review and make recommendations on faculty recruitment, retention and development processes in order to **induct high quality faculty, retain it and motivate it** to perform consistently at high levels of excellence. The Committee may also review and make recommendations on recruitment criteria in order to provide healthy participation of SC/ ST communities in the IIT faculty.

9. To review the procedures of students admission to different programmes and assess how effective they have been in **admitting high quality diversified student body while maintaining the constitutional provisions for SC/ST** and providing adequate access to disadvantaged weaker sections of society. The Committee may wish to review the **methodology of JEE** and recommend improvements that can be made therein in the light of proliferation of coaching industry.

10. To review the **state of physical infrastructure** of the IITs in order to make recommendations relating to their modernization, removal of obsolescence and future development consistent with their anticipated role at national and international levels.

11. To review the position regarding number of **IIT Undergraduates enrolling themselves for Post graduation/Research Studies** and those opting for other professions.

2.3 ANALYTICAL FRAMEWORK

The eleven terms of reference for this review cover multiple dimensions of the IIT system and also point to many pressing concerns/expectations from IITs as institutes of national importance. This aspect is different from that of the previous reviews. In the past, mostly individual IITs were reviewed. The first PAN-IIT Review (review of all the IITs together) was by a committee chaired by Professor Y. Nayudamma. Shri Hiten Bhaya was the Vice-Chairman and Professor C.N.R. Rao, Shri Nanubhai Amin, Shri J.A. Kalyanakrishnan, Shri M.S. Padmanabhan and Shri Jagdish Narain were members, apart from the officials of the Ministry. The report of the Nayudamma Review Committee, submitted in 1986, was used in formulating the present Committee's approach to review the progress since registered by the IITs in the last seventeen years and to consider possible directions for their future growth and enhanced performance.

In order to ensure that the richness of the IIT system is fully appreciated at multiple levels and all the key concerns are clearly addressed, this review uses an analytical framework as shown in Figure 2.1.

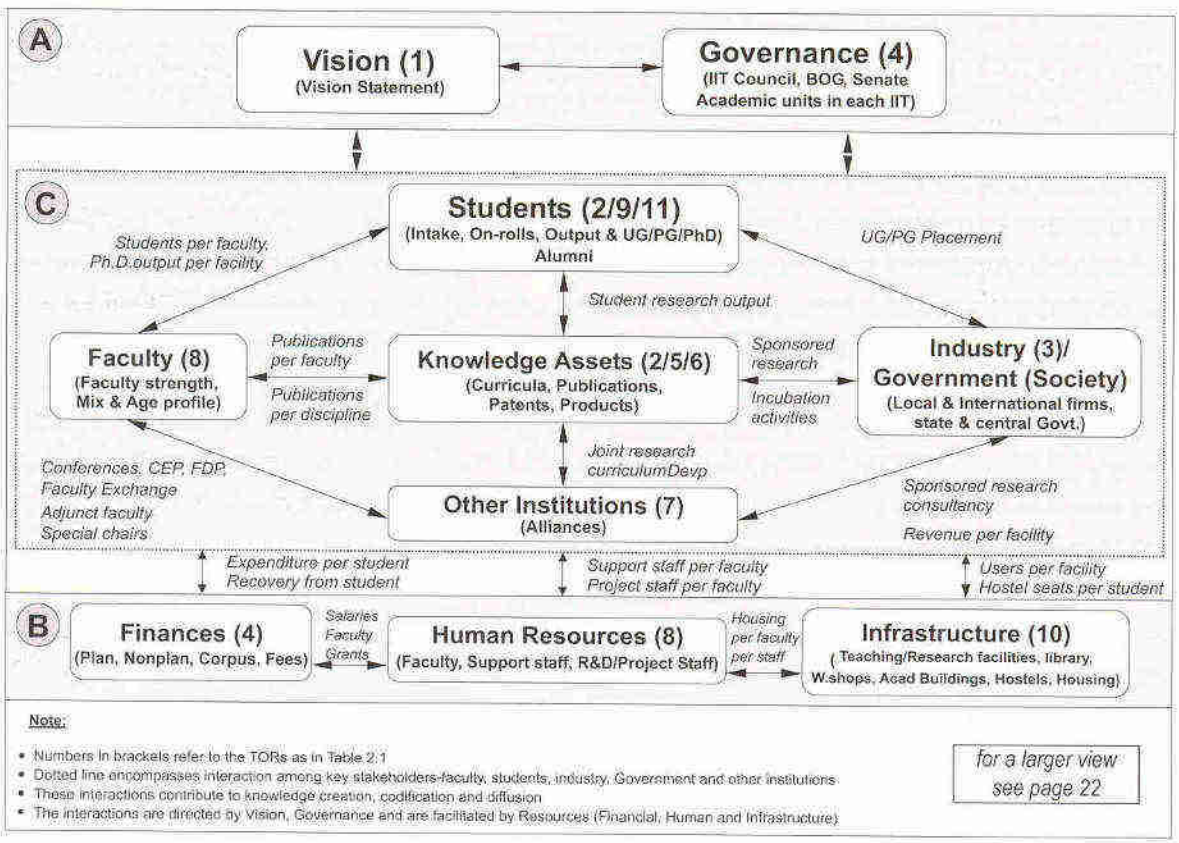


Figure 2.1: Framework for IIT Review

The framework classifies the TOR elements into three broad categories as indicated in the box below:

A. AT THE APEX:

Vision and **Governance** that provide the necessary authority, support and direction to performance

C. AT THE CENTRE:

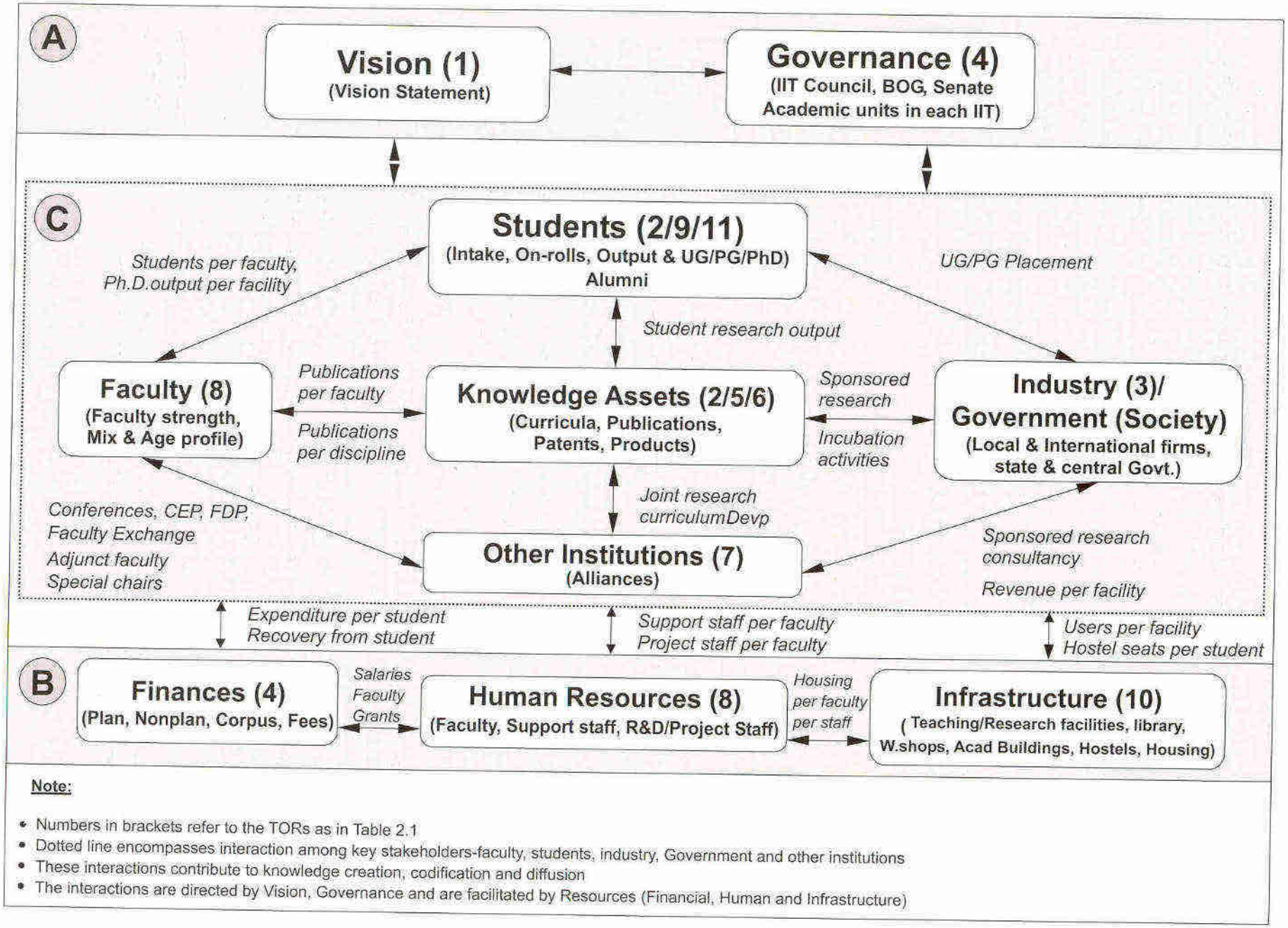
The mechanisms to facilitate interactions among the key stakeholders – **Faculty, Students, Industry** (within and outside the country), **Government** (in the States and at the Centre and the National Laboratories) and **other institutions** (academic as well as non-academic, here and elsewhere) - around core **knowledge assets** such as **curricula, publications, patents and knowledge intensive products.**

B. AT THE BASE:

The **Financial, Human** and **Infrastructure** resources required to facilitate performance of the IIT system

The framework provides a backdrop to appreciate the impact, present and potential, of the IIT system (as institutions of national importance) in the emerging knowledge society. It is more comprehensive than the traditional as well as the more recent models of the educational system, as brought out below.

The traditional model regards faculty as the centre of a university system (von Humboldt model). More recent models argue in favour of a learner-centric model. However, both these models require presently to take into account the fact that learning, knowledge and innovation are becoming far more pervasive and involve many other institutions such as industry, government, and society at large. IIT products (alumni) are participating and shaping different spheres of human activity (industry, government, NGOs). Industry is investing a lot more in R&D and training. Governments are concerned about life-long learning. The framework is designed to connect the discussion on IITs to these changes happening in different dimensions. The framework when applied recursively at multiple levels can reveal the unique characteristics of individual IITs, their contribution to the brand of the IIT system, and the contribution of the IIT system to the wider innovation system.



Note:

- Numbers in brackets refer to the TORs as in Table 2.1
- Dotted line encompasses interaction among key stakeholders-faculty, students, industry, Government and other institutions
- These interactions contribute to knowledge creation, codification and diffusion
- The interactions are directed by Vision, Governance and are facilitated by Resources (Financial, Human and Infrastructure)

Figure 2.1: Framework for IIT Review

2.4 METHODOLOGY

The system framework has been applied through a methodology involving three broad steps (shown in Figure 2.2):

- Step 1: Discover the present scenario of IITs and assess the degree of interaction with key stakeholders
- Step 2: Diagnose the key issues of concern that are inhibiting desired interactions, especially those arising out of vision, governance and resources
- Step 3: Design strategies for enhanced performance

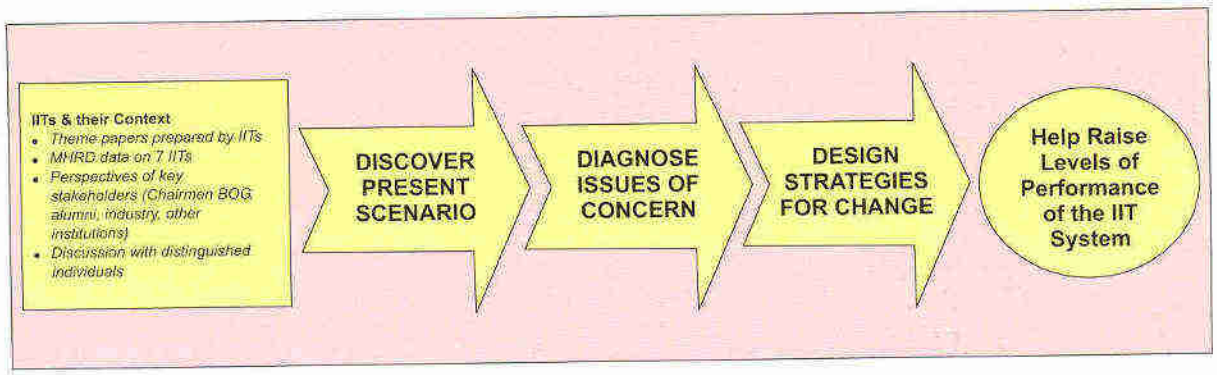


Figure 2.2: Methodology for the Review

Both qualitative and quantitative data were collected for analysis:

- Data provided by the MHRD was supplemented with specific questionnaires sent out to IITs; additional queries were posed during the visits and in correspondence with the Directors, interactions with other interest groups such as alumni (within the country and abroad), industry captains, past Directors and former professors.
- Visits to the 7 locations where IITs are situated to obtain a first hand feel for the facilities, to listen to the faculty, the students, the non-teaching employees and alumni.
- Distinguished academics in the country, Chairmen of the Boards of Governors, DG CSIR, Secretary to Government of India, Science and Technology, Secretaries to Departments of Space and Atomic Energy have all been most gracious in providing inputs to the work of the Review Committee.
- The Terms of Review were divided into 10 themes. Eight of the themes were assigned to the IITs and the remaining 2 to Chairman, AICTE and Indian Institute of Science (See Table 2.2). The ten theme papers constituted an input to the Review Committee.

Table 2.2: Theme papers prepared by IITs

Theme paper No.	Subject	Prepared by
Theme: 1	Vision, Mission, and Goals	IIT Kharagpur, IIT Delhi
Theme: 2	Increase in intake/new campuses both within and outside the country	Chairman, AICTE
Theme: 3	Special thrust on Post-graduate education and research	IIT Kanpur, IIT Bombay
Theme: 4	Partnership with industry and national and international linkages	IISc, Bangalore
Theme: 5	Management structure and Governance Mechanisms	IIT Kanpur
Theme: 6	Academic Offerings – Curriculum and Pedagogic issues, human values and use of technology for on-campus programmes	IIT Delhi
Theme: 7	Networking with other technical and research institutions – Distance & web-based education issues	IIT Delhi IIT Madras*
Theme: 8	Faculty related issues	IIT Bombay
Theme: 9	Admission and Fee related issues	IIT Roorkee
Theme: 10	Infrastructure Related issues	IIT Kharagpur

* subsequently assigned.

2.5 STRUCTURE OF THE REPORT

The rest of the report is organized as follows. Chapter 3 presents a macro-view of the IIT system. The remaining chapters discuss the issues pertaining to the various elements of the framework and suggest areas of improvement.

- Chapter 4 probes the vision of the IIT system and that of the individual IITs
- Chapter 5 analyses the governance structure
- Chapters 6 and 13 discuss issues pertaining to faculty and non-faculty staff
- Chapters 7 and 10 analyse research performance and IPR issues
- Chapters 8, 9, 12 and 15 discuss issues related to education, JEE, technology in education and expansion in India and overseas campuses
- Chapter 11 discusses industry interactions
- Chapter 14 discusses funding policy for IITs
- Chapter 16 refers to the special case of IIT Guwahati

CHAPTER THREE

A MACRO-VIEW OF THE IIT SYSTEM

"The great untapped resource of technical and scientific knowledge available to India for the taking is the economic equivalent of the untapped continent available to the United States 150 years ago"

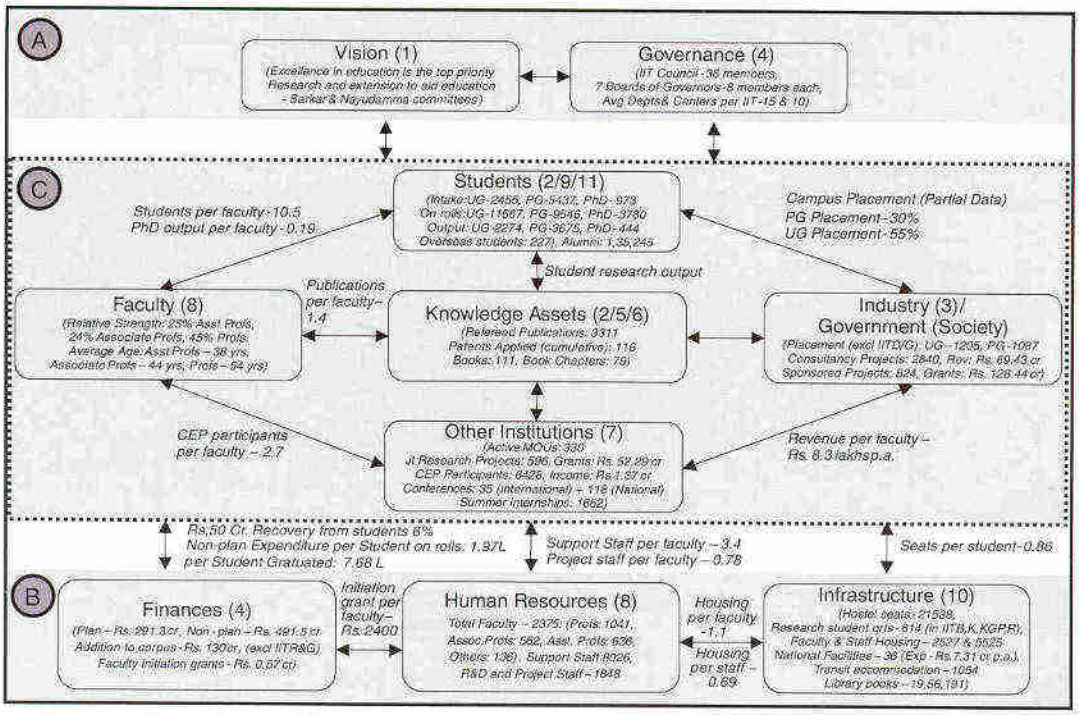
MILTON FRIEDMAN, NL

(Consultant to India's Ministry of Finance 1955)

CHAPTER THREE

A MACRO-VIEW OF THE IIT SYSTEM

This chapter presents a view of the IIT system as of 2002-03 with reference to the framework defined in Figure 2.1. The key attributes of the IIT system have been depicted in Figure 3.1.



for a larger view see page 28

Figure 3.1: State of the IIT system at the end of the academic year 2002-03

3.1 KEY FEATURES OF THE IIT SYSTEM

Some of the key features of the IIT system (scale, resources, ratios) are highlighted below:

- **Student Output:** In 2002-03, IITs produced 2274 UG (incl. Preparatory), 3675 PG (incl. Dual Degree) and 444 Ph.D. graduates and had about 25000 students on rolls. Higher PG output suggests that IITs may be focusing more on post-graduate education. However, it may be noted that only 30% of non-UG students are absorbed by campus recruitment compared to 53% of UG students. On the other hand, a higher percentage of UG students goes abroad after graduation than that of non-UG students.
- **Faculty Strength & Productivity:** The seven IITs put together have 2375 faculty members. In 2002-03, every IIT faculty member on an average produced 2.70 students (0.96 UGs, 1.55 PGs, 0.19 Ph.D.s), 1.4 research publications and generated Rs. 8.3 lakh per annum through consultancy and sponsored research and managed 10.5 students (UG + PG + Ph.D. students on rolls). There are 4.18 staff members (3.4 administrative and support staff and 0.78 R&D and project staff) for every faculty.
- **Financial Resources:** For every rupee spent by government (plan and non-plan), the IITs are

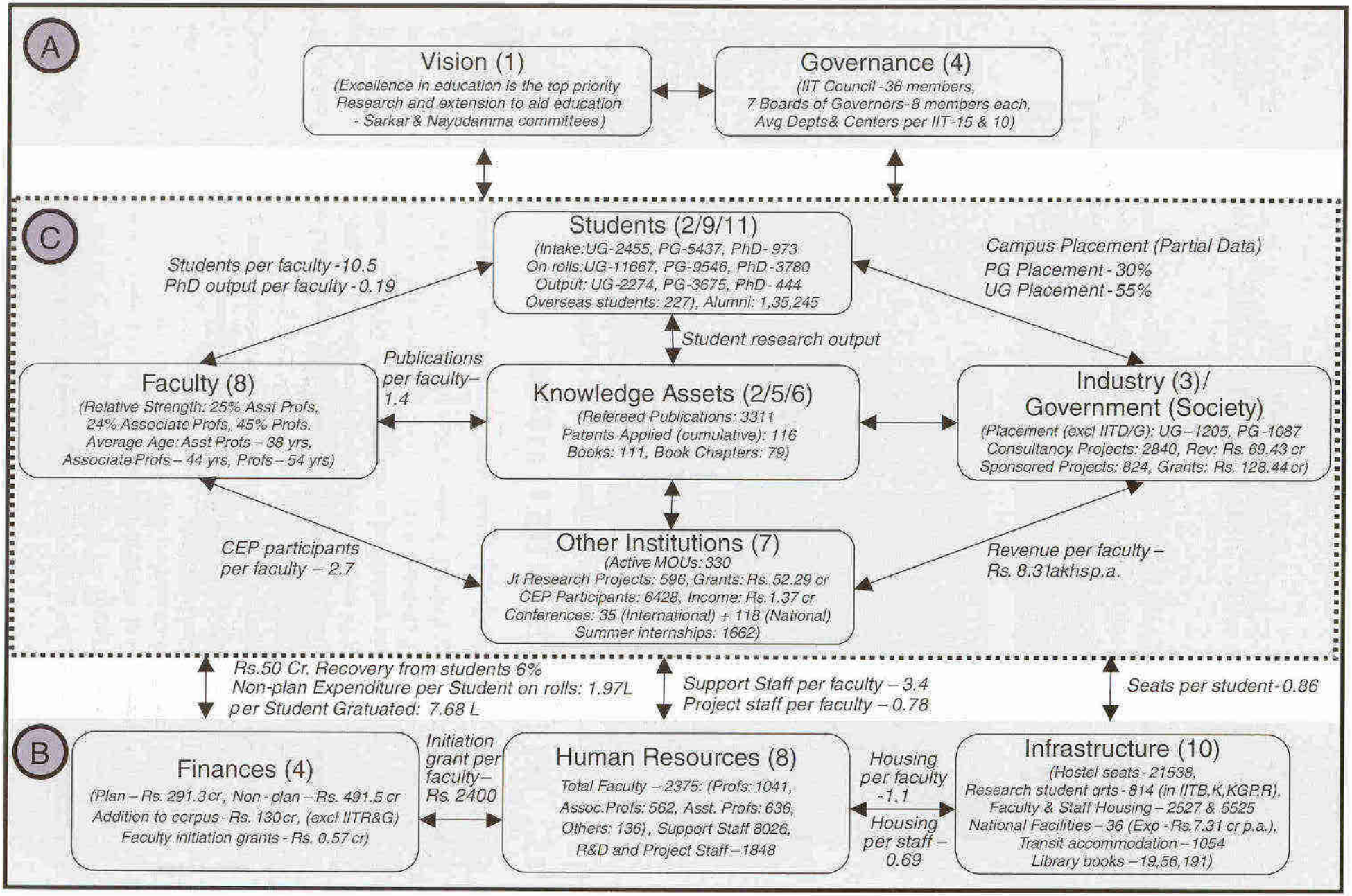


Figure 3.1: State of the IIT system at the end of the academic year 2002-03

able to generate an additional Re.0.24, through sponsored research and consultancy and make a net addition of Re.0.16 to the corpus. Recovery from students by way of fees is Re.0.06.

- **Research Infrastructure:** IITs have also accumulated a significant amount of infrastructure over time. Some of the national facilities installed in the IITs are shown in Table 3.1.

Table 3.1: Some of the national facilities in IITs

IIT	National Facility
IITD	• National Centre for Upgradation of Textiles Education • National Resource Centre for Value Education Engineering • Biotechnology Information Sub-centre • Indo-French Unit for Water and Waste Technology • NISSAT's Windows to Information Support Services for Entrepreneurs • Educational Technology Service Centre
IITM	• Regional Sophisticated Instrumentation Centre • Centre for Computational Fluid Dynamics • Ocean Engineering Centre
IITK	• National Information Centre of Earthquake Engineering • National Wind Tunnel Facility • Atomic Force Microscope • Advanced Centre for Materials Science • Advanced Centre for Electronic Systems • Flight Lab • Facility for Ecological and Analytical Testing
IITKGP	• Post Harvest Technology Centre • LSI Design Centre • Centre for Education Technology • National Facility in Medical Technologies • National MEMS Design Centre • Rubber Technology Centre
IITB	• Geotechnical Centrifuge Facility • Sophisticated Analytical Instrumentation Facility • Centre for Software Validation and Verification • National Facility for Photo Labeling & Peptide Sequencing in Biomolecular Systems • National Facility for Single Crystal X-ray Diffractometer • National Facility for Texture and Orientation Imaging Microscopy
IITR	• Thermal Ionisation Isotope Studies • Electron Probe Microanalysis • Shake Table Facility • Wind Tunnel Facility • Strong Motion Facility Network • Instrumentation and Analytical Facilities

Besides substantial experimental facilities for teaching and research, IITs today possess a wealth in terms of library resources (Table 3.2).

Table 3.2: IIT library resources as of 2002-03

	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Books	200745	215812	230024	214680	204211	237858	36841
Periodicals	1096	672	1541	1160	894	658	568
Back Volumes of Periodicals	98229	88880	155025	97538	79934	44933	17576
CD/video/Microfilms	125	4576	2420	10076	2761	3400	910
Total	**300195**	**313940**	**389010**	**323499**	**287800**	**285849**	**55895**

Note: IITD and IITK have access respectively to 4000 and 5300 electronic journals

The rest of the discussion focuses on interactions among the key players: faculty, students, industry, government and other institutions. The interactions will be analyzed to understand the characteristics of the IIT system. This will be done at three levels:

- Level 1 will present the current state of the IIT system as a whole and changes in key attributes over the past few years.
- Level 2 will tease out the similarities and differences among the individual institutes of the system. Much of the comparison will be restricted to the five older IITs (IITB, IITD, IITK, IITKGP and IITM). IITR is a relatively new entrant and IITG is a young institute.
- Level 3 will seek to extract the similarities and differences across major disciplinary categories-engineering, science, and humanities & social sciences.

The results of the data analysis at the three levels will provide the backdrop for the presentation of the Committee's recommendations on important aspects pertaining to the following key components that matter so much for the IITs' ability to reach up to higher levels of performance:

1. Vision
2. Governance
3. Faculty
4. Research
5. Education
6. Joint Entrance Examination
7. IPR
8. Industry interactions
9. Technology in Education
10. Non-Faculty Employees
11. Funding Policy and Development of IITs
12. Expansion within the country and Campuses Overseas
13. IIT Guwahati.

The following chapters 4 to 16 will deal with the above thirteen issues, respectively.

CHAPTER FOUR

VISION FOR THE IIT SYSTEM

"It's not what the vision is,
it's what the vision does....."

Peter M Senge
(1947 -)

CHAPTER FOUR

VISION FOR THE IIT SYSTEM

A key question to answer is whether IITs have comprehensively fulfilled their purpose or for that matter whether IITs have achieved their potential in full measure? The answer is an emphatic yes insofar as it relates to the calibre of the UG entrants, the quality of their education and their subsequent achievements. In regard to the other aspects like research output, effectiveness of their work with the industry or their contribution in the service of societal needs, there is no clear quantitative benchmark for the IIT system as a whole and for the individual IITs. Comparison of IITs against international benchmarks, while useful, may not be entirely appropriate because IITs are institutes of national importance created for a specific purpose, and operate in a particular societal context. In the absence of quantitative benchmarks, a qualitative model is suggested to analyse the extent to which IITs have achieved the vision, first articulated by the Sarkar Committee.

4.1 MODEL OF THE IIT VISION

The core elements of the IIT vision, expressed in Nehru's words (page *ii*) and the Sarkar Committee and Nayudamma Committee (1961) Reports, are

- The basic function of IITs is production of scientists and engineers of the highest calibre through **education (1).** It should be tightly integrated with **research (2)** and **extension (3).**
- Goals & tasks of the institutes should relate continuously to changes taking place in the **socio-economic development of the country (4)** and … rapidly exploding **universe of knowledge in science & technology (5).**
- IITs should embody the student with values, enthusiasm and ability to engage in research, design and development to help building the nation towards self-reliance in her technological needs

To facilitate *prima facie* analysis, the above statements have been translated into a simple influence diagram comprising the five elements and their relationships (see figure 4.1).

The model suggests that the priority of the IIT system is clearly on education, followed by research and extension. Research and extension have a very specific purpose-they are expected to aid absorption of new developments in science and technology, facilitate appreciation of societal issues and problems in technology management, and help translate these into excellence in education. It also suggests that public funding of IITs should result in students willing to take on problems of national interest. The model has sufficient feedback loops to ensure that the IIT system and individual IITs can adapt to changes in the environment.

However, a comparison of the vision statements of the IITs (Figure 4.2) against the model of the IIT vision shows that the match is not perfect. While educational excellence is reflected in all the

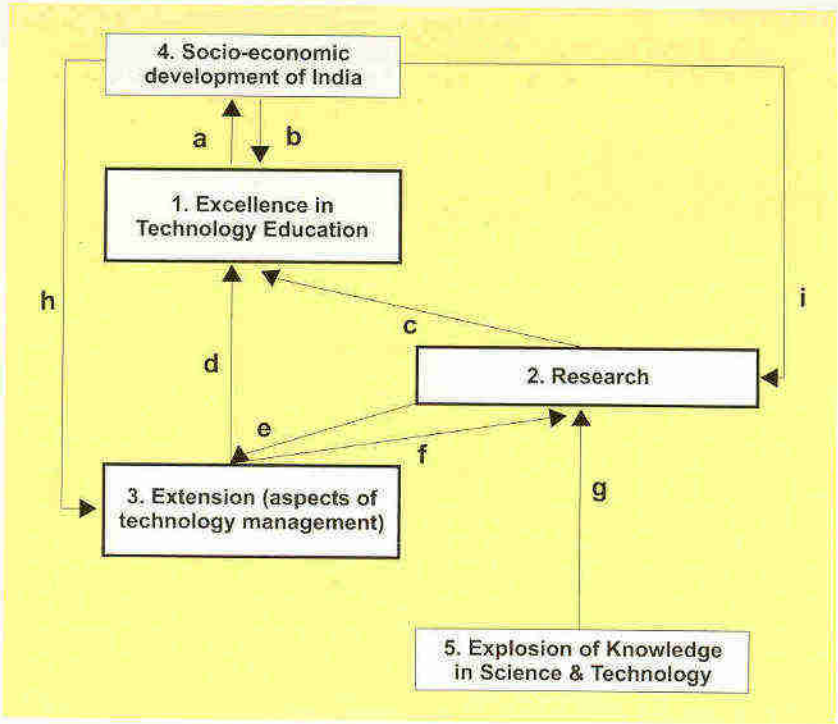


Figure 4.1: Model of the IIT vision

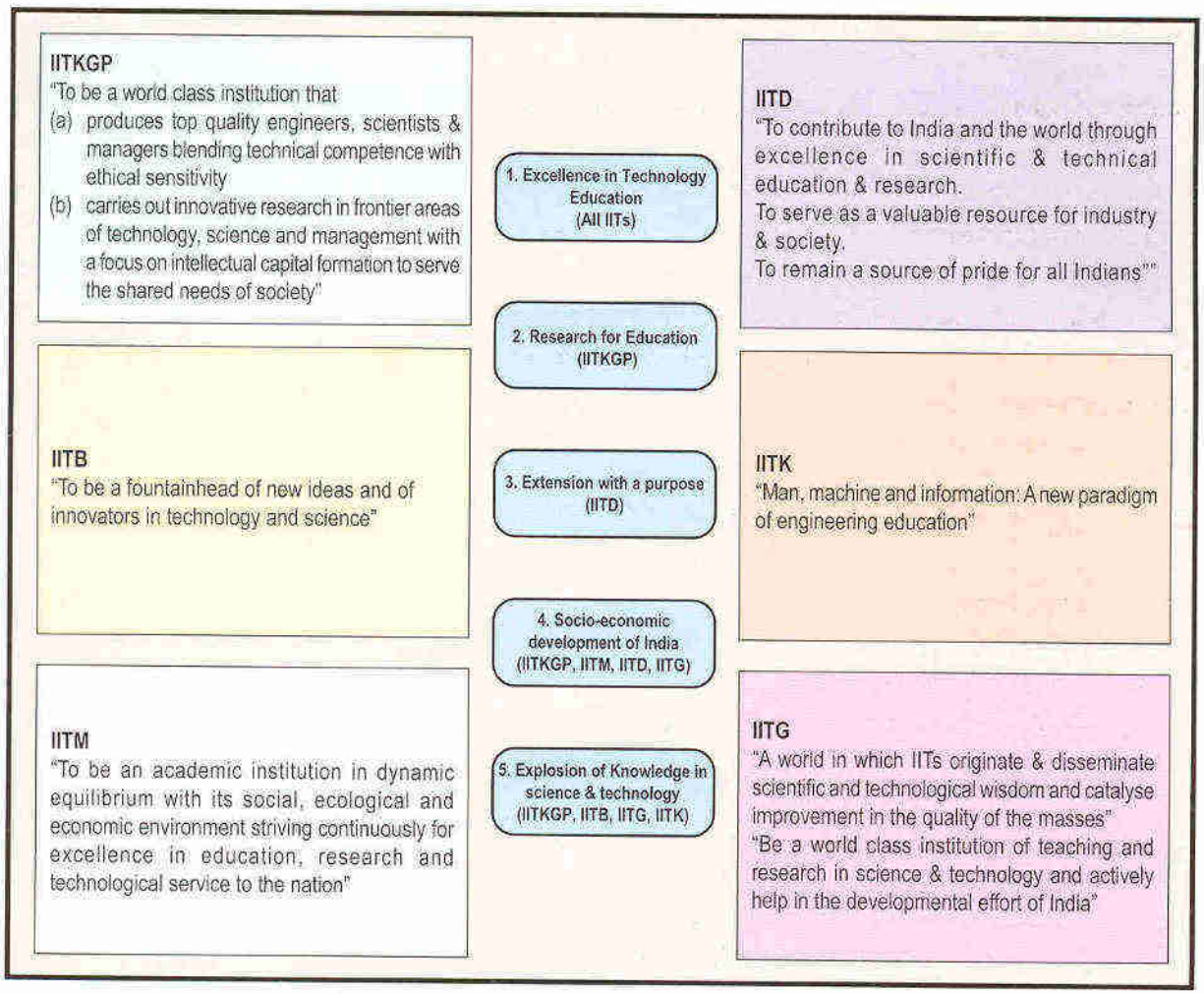


Figure 4.2: Alignment of vision of individual IITs to the overall vision

CHAPTER SIX

FACULTY MATTERS

"It is not the strongest of the species that survive, not the most intelligent, but the one most responsive to change"

Charles Darwin
(1809-1882)

CHAPTER SIX

FACULTY MATTERS

The pun in the title is intended. Faculty matters a great deal! Faculty members and their academic stature constitute the core calibre of the IIT system. It is their intellectual value that drives output. The IITs over the years have been able to attract a number of bright faculty members. They have in turn contributed to building and sustaining the IIT brand. Their stature and work have contributed significantly to the name and fame that the IITs have acquired. The important place of faculty members in the scheme of IIT human resources, besides that of the students and the graduates, deserves to be emphasized far more than what has been done. Some of the IIT faculty members of the earlier years have moved out of the IIT system and migrated to institutions abroad or to high positions within the country.

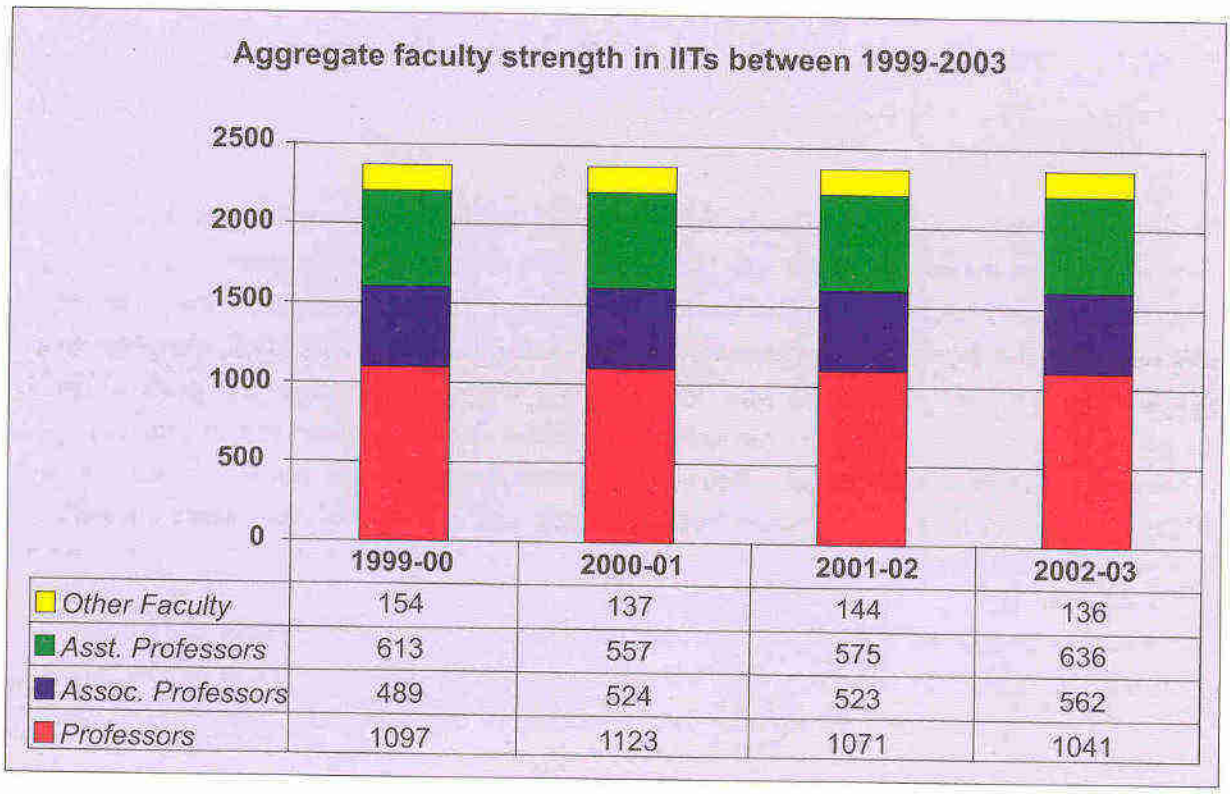
The questions to raise are the following: Do recent data suggest a continuation of the past trend of inducting star faculty? Is the faculty strength increasing? What does the current faculty profile in terms of age or discipline point to? The data pertaining to the faculty are presented first and the Committee's observations and recommendations follow.

6.1 FACULTY STRENGTH IN IITs DURING 1999-2003

Figure 6.1 shows the total IIT faculty strength in the period 1999-2003. It is clear that the total strength has not increased much during the recent years. The total strength of faculty in all the IITs in 2002-03 (2375) was 27% less than their total sanctioned strength (3263). It is also observed that more than 80 Professors have retired since 2000-01 (7% drop). New recruitments at Associate and Assistant Professor levels have just about managed to plug this gap. The quality of younger faculty attracted to IITs needs a closer study.

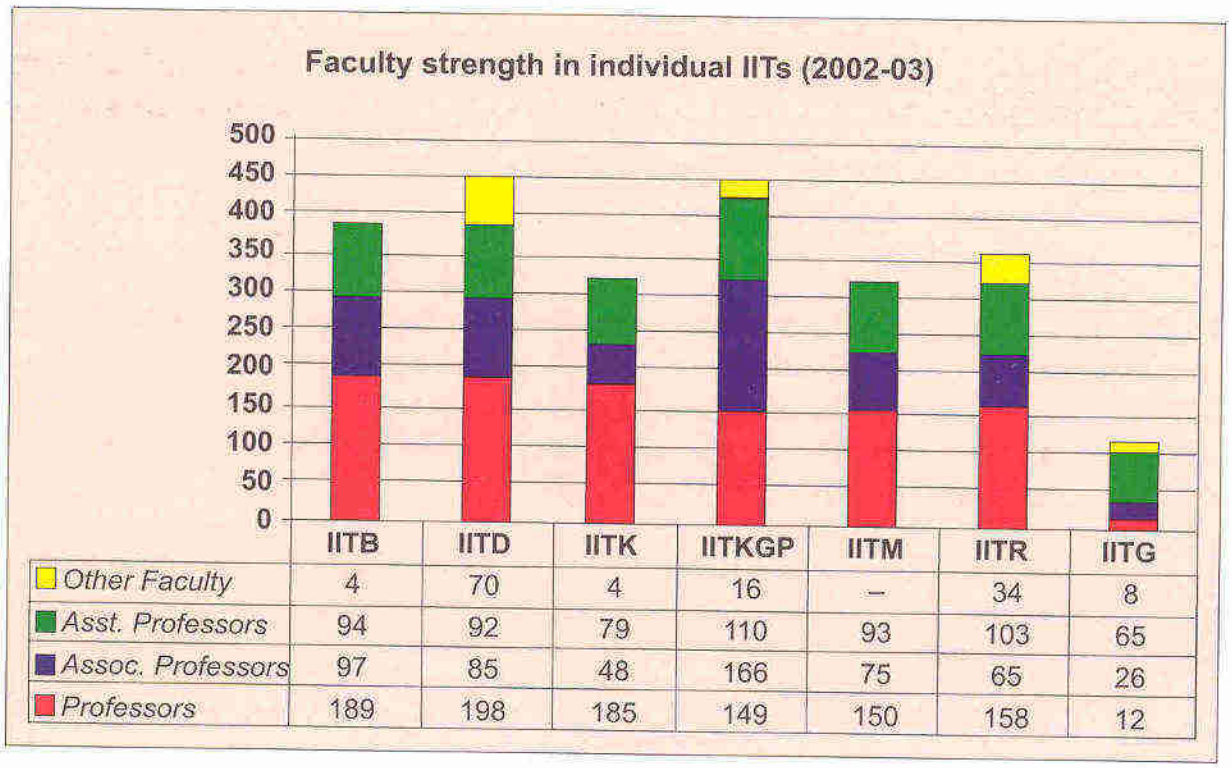
The faculty mix (in Figure 6.1) suggests that the IITs have an inverted pyramid structure (more Professors compared to Assistant Professors). The number of (Professors + Associate Professors) is about 2.5 - 2.9 times the number of Assistant Professors at an aggregate level. While this suggests a greater fraction of experience, and is perhaps inevitable in a mature system, the outputs should be commensurate with the greater number of senior staff. Whether this is so is not clear from the output data, as pointed out subsequently in this chapter.

In Chapter 7 (Section 7.4.1), it has been suggested that a balance between science, engineering and inter-disciplinary faculty strength is desirable. With increasing emphasis being placed on science-based engineering, there is a case for renewed attention to the faculty mix from this viewpoint.



	1999-00	2000-01	2001-02	2002-03
Other Faculty	154	137	144	136
Asst. Professors	613	557	575	636
Assoc. Professors	489	524	523	562
Professors	1097	1123	1071	1041

Figure 6.1: Aggregate faculty strength in IITs between 1999-2003



	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Other Faculty	4	70	4	16	–	34	8
Asst. Professors	94	92	79	110	93	103	65
Assoc. Professors	97	85	48	166	75	65	26
Professors	189	198	185	149	150	158	12

Figure 6.2: Faculty strength in individual IITs (2002-03)

The faculty strength in individual IITs is shown in Figure 6.2.

- IITD has the highest number of faculty while IITK has the lowest number (among the older IITs).
- IITKGP has a relatively large number of Associate Professors, while IITR has relatively more number of Assistant Professors.
- IITD has a large number of 'other faculty' suggesting flexibility in hiring 'other faculty'.

Table 6.1: Faculty shortage in IITs as of 2002-03

	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Sanctioned Strength	425	624	406	510	443	575	280
Total Faculty (incl others)	384	445	316	441	318	360	111
Faculty Shortage	10%	29%	22%	14%	28%	37%	60%

The number of faculty positions that have remained unfilled is significant and averages 127 per IIT (~27% of the average sanctioned strength - Table 6.1). The number of vacant positions in IITB is least at 41 (10% of its sanctioned strength) and is highest in IITD at 179. The recently established IITG is yet to fill 169 positions (i.e., 60% of its sanctioned strength); the location may have proven to be a drawback in this case.

Table 6.2: Age profile of IIT faculty as of 2002-03

	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Professors	51	56	52	54	55	56	54
Associate Professors	42	48	40	45	48	49	42
Assistant Professors	36	33	36	40	40	44	38

Table 6.2 shows the age profile (average age in each case) of faculty across the IITs. Most of the IITs have similar faculty profile in terms of age. (IITD has somewhat younger Assistant Professors compared to the other IITs). Notably,

- **Most of the Professors in IITD, IITM, IITKGP and IITR would retire in the next 5-6 years.**
- **The number of faculty members below the age of 35 years is a low fraction of the total faculty strength.**

6.2 FACULTY OUTPUT

The outputs per faculty are an important indication of the performance of the IITs. The aggregate performance of IITs has not changed significantly in recent years, although there are subtle differences in performance across IITs. These are represented in Table 6.3.

Table 6.3: Output of IIT faculty on key parameters in 2002-03

	IITB	IITD	IITK	IITKGP	IITM	IITR
Ph.D. output per faculty	0.19	0.19	0.12	0.24	0.15	0.19
Patents per faculty (cumulative)	0.05	0.05	0.15	0.04	0.01	0.01
Publications per faculty	1.50	1.69	1.53	1.54	1.23	1.03
Awards per faculty	0.09	0.09	0.16	0.11	0.09	NA
Grants & consultancy per faculty (Rs. Lakh)	8.1	8.5	9.5	13.3	5.5	6.14

As pointed out (Table 6.1), the average faculty shortage per IIT is 127 (about 27% of the sanctioned strength). Filling these vacancies may not by itself provide the solution for enhancing the research output per faculty. This is the inference one draws from the fact that available data do not suggest a strong correlation between increase in faculty strength and research output in terms of publications per faculty. This is surprising because one would normally expect large strength to not only reduce faculty workload, but also provide a critical mass to spur research. One reason for this may be that the number of high calibre research students is not sufficiently large.

The relationships between faculty mix and publications per faculty (Figure 6.3) and research grants and consultancy revenues per faculty (Figure 6.4) have been examined. A correlation is observed between the proportion of Associate Professors and the publications per faculty and revenue realization per faculty (it may be noted that the data set is limited to the last four years).

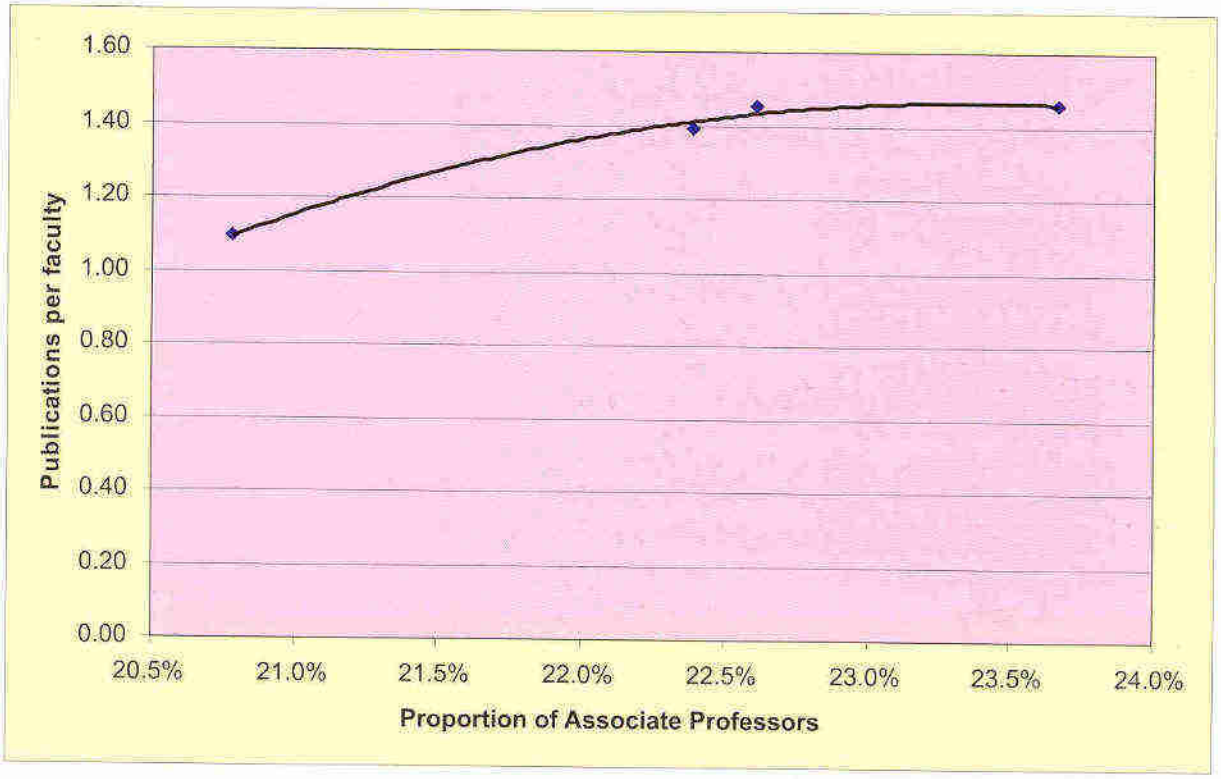


Figure 6.3: Correlation between the proportion of Associate Professors and publications per faculty (Subject to correction as the data set is limited)

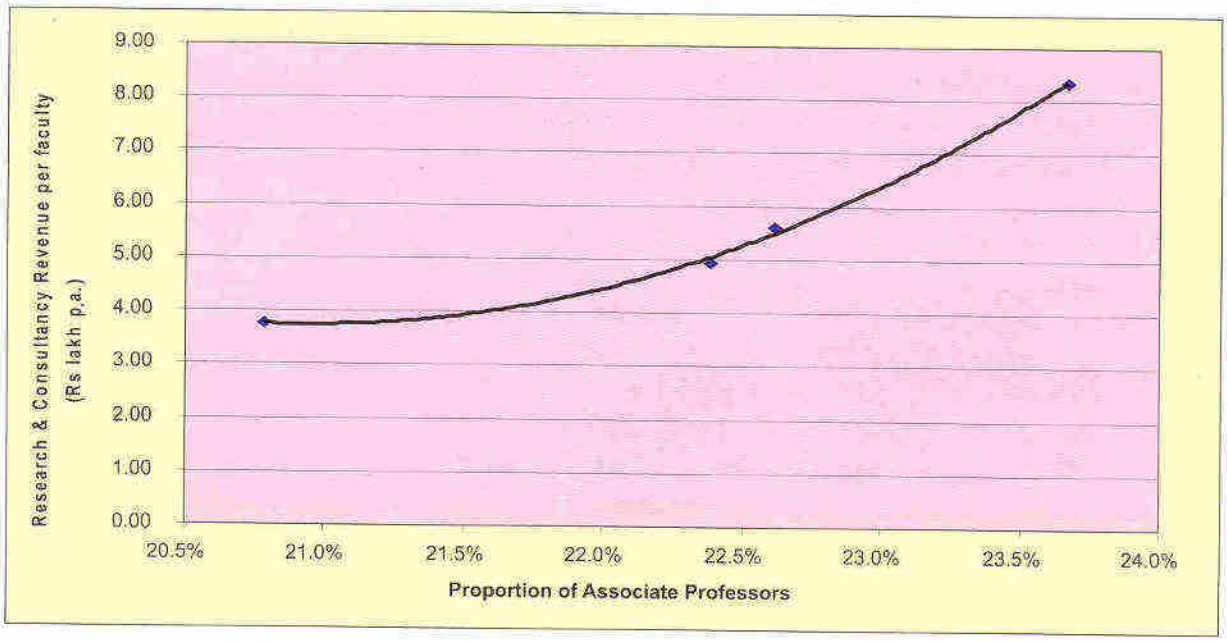


Figure 6.4: Correlation between the proportion of Associate Professors and revenue realisation (Subject to correction as the data set is limited)

However, the correlation with Professors or Assistant Professors is weak. Poor correlation between proportion of Assistant Professors and revenue realization is understandable since they are fresh to the system and may be preoccupied with teaching. But, why is the correlation with Professors weak?

In addition, factors such as lack of critical mass of star faculty (this is not to say that star faculty are totally absent), inadequate faculty initiation grants (about 2% of faculty gets this grant and the sum is not substantial), and physical infrastructure may be limiting larger academic output. More importantly, a system of incentives for good performers is not in place.

6.3 RECOMMENDATIONS

The Committee has deliberated on the questions arising out of the data presented above and has had the benefit of the views of leading academics. Based on these discussions, the Committee has strongly felt that certain improvements are essential in the processes for

(i) Fresh recruitment of faculty

(ii) Assessment of faculty performance for awarding incentives & for promotion

The recommendations in regard to the above are given in the next section. Since faculty matters are so critical for the academic health and robustness of the IITs, the Committee has proposed the setting up of a Human Resource Unit (HR Unit). The recommendations for a HR Unit are made in a separate section. The Committee has recommended further in regard to the age of retirement of the faculty and their scheme of pension.

In regard to the above two key issues related to the faculty, the Committee feels that the best practice in our own country is prevalent in the Indian Institute of Science. The Committee is happy to note that no new practice need be invented and the IITs would do well to adopt the IISc methodology. An analysis in this regard is presented below.

6.3.1 Faculty Induction

For recruiting new faculty members, the IISc practices a considerably more flexible system than the IITs. Advertisements for the required positions are available all the time electronically via their website. Applications are solicited and collated all through the year. As and when a reasonable number of appropriately meritorious applications becomes available, an expert committee is quickly put together for selection. Those freshly inducted are provided substantial initiation grants.

A comparison of the IIT and IISc practices is presented in Table 6.4

Table 6.4: Fresh induction of faculty

IIT STATUTE	IIT PRACTICE	IISc PRACTICE
All posts to be advertised. *Internal and external candidates are selected after interview by a Committee specified.* *For post of Deputy Director, Professor and others - the Selection Committee shall consist of Director, one nominee of the Visitor (not necessary for posts lower than that of Professor), two nominees of the Board, one being an expert other than a Board Member, one expert nominated by the Senate other than a member of the Senate and Head of the Department concerned (only for posts lower than Professor).*	Presently rolling advertisement posted on the website. Applications solicited throughout the year. The rest of the procedure for selection of candidates to be recruited to IIT is as per the present statutes.	Rolling advertisement posted on the website. Applications solicited throughout the year. Once adequate number of good applicants are gathered, a Committee of Professors (CoP) of Department concerned examines the cases and forwards to their Division Chairman its recommendations along with a list of experts to be invited to interview the candidates. The Divisional Chairman finalises the list of experts and the candidates to be interviewed. As a tradition, the Divisional Chairman keeps the other Chairmen apprised on all such recruitment matters. (there are 6 Divisional Chairmen and they meet once every week). The Divisional Chairman then forwards the material to the Director. The Director chairs the Interview and Selection Committee. The other members are Associate Director, the Divisional Chairman, the Head of the Department and 2 experts. Candidates from abroad can be considered *in absentia*. Information on selected candidates is placed before the Council by the Director. The Council of IISc appoints the persons selected. The above procedure is followed in respect of Assistant Professors. Most of the recruitment takes place at this level. In case of Professors, no interviews are held and the Director sends out an invitation to the persons identified by the Institute and approved by the Council. Identification of the potential Professors is done by a process involving consultation by the Committee of Professors, the Head of the Department, the Divisional Chairman and the Director. The Director also consults eminent experts in the field in the country, sometimes abroad, on the suitability of the identified candidate. The recommendation of the Director is placed before the IISc Council. Once approved by the Council, Director invites the candidate selected. Selection of Associate Professors may follow either of the procedures described above for selection of Assistant Professors, i.e, by an interview route or the one for Professors, i.e., by invitation after elaborate consultation.

Observations:

At IISc, interview is only for Assistant Professors, and even that can be skipped if an outstanding candidate has been identified and is accepted by the Selection Committee. The constitution of the Interviewing/Selection Committee is considerably simplified and decentralised. (It may be noted that a Visitor's nominee is not mandated). On the other hand at IITs, Committee constitution is highly structured as per the present Statute. The IISc system facilitates speedy action on positioning candidates.

Recommendation:

(i) IISc system may be adopted by the IITs as IITs also enjoy a high stature in the country.

(ii) For this recommendation to be implemented, the IIT statutes need to be urgently amended to enable the recruitment process in vogue at IISc to be adopted by the IITs.

6.3.2 Faculty Assessment for Promotion

As in the case of induction, so also for assessment and promotion, the exercise in IISc is carried out at regular intervals through the year. The practice at IISc has proved very effective in providing the necessary motivation for faculty to excel in research as well as in extension. A comparison of the IIT and IISc practices is presented in Table 6.5 (please see next page).

Table 6.5: Assessment of faculty for promotion

IIT STATUTE	IIT PRACTICE*	IISc PRACTICE**
All posts at the institute shall normally be filled by advertisement but the Board shall have the power to decide on the recommendation of the Director that a particular post be filled by invitation or by promotion from amongst the members of the staff of the Institute *Selection by an Interview Committee consisting of* *(i) Director;* *(ii) One nominee of the Visitor (only for the post of Professor);* *(iii) & (iv) Two nominees of the Board, one of whom is to be an expert from outside the Board;* *(v) One expert (who should be outside the Senate) nominated by the Senate; (vi) Head of the Department (only for the post of Assistant Professor).* *Where a post is to be filled on contract basis or by invitation, the Chairman of the Board may at his discretion constitute such ad hoc committees as circumstances may require.*	It is not common for a Director to recommend that a particular post be filled by promotion as allowed by the Statute. IIT Faculty have to apply against an open advertisement and seek the next level position: (minimum number of years in the lower post is not a statutory condition). Selection is by an Interview Committee chaired by the Chairman of the Board constituting an adhoc Committee to invite a person to occupy a regular post in an IIT is uncommon, although provided for in the Statute. This provision has been made use of for appointing visiting faculty and named Chairs.	IISc has a standing Promotions and Assessment Committee (PAC) whose Chairman is Chairman, IISc Council and consists of, in addition to the Director and the concerned Divisional Chairman, eminent experts from outside the Institute. Assessment is based on the candidate's achievements in his major area of endeavour, which may be research only, development work only or a combination of both. Contribution to teaching, student training, consultancy and Institute's work are also considered. The PAC meets at least 4 times a year, each time prior to the Council meeting, to consider cases coming up for promotion. No personal interviews are held. Six years standing is required for an Assistant Professor or Associate Professor to be promoted to the next step. (An individual can request or be recognised for assessment earlier if he/she claims or is seen to have exceptional achievements. So also an individual can request to be assessed later (this has happened quite frequently). For assessment, CV, full list of publications and reprints of papers, his accomplishments in the different areas of work (indicated in para 1 above) are to be submitted by the individual faculty member along with a list of 6 experts in all from India and abroad. The Committee of Professors (CoP) of the Department considers, adds further names of 8-10 experts and forwards the material to the Divisional Office. The Divisional Chairman finalises the list of 6-8 referees, of which at least two are from the candidate's list and about one half of the referees is from outside India. A healthy tradition is for the Divisional Chairman to consult the other Divisional Chairmen on all such matters (There are 6 Divisional Chairmen in all and they meet once every week). The Divisional Chairman concerned sends CV, publications etc to the expert referees soliciting their professional opinion regarding the suitability of the candidate for promotion. At least 6 referee responses are ensured to enable the Divisional Chairman to go forward with his consolidation of the candidate's case for promotion. The Divisional Chairman obtains a Report of the Department's Committee of Professors (CoP), consults the Committee of Divisional Chairmen and the Director before the case is placed before the PAC. It is the PAC which examines the material including letters from the referees and decides to promote the individual or defer his case for promotion. The Divisional Chairman makes an oral presentation of the candidate's case to enable the PAC to arrive at a decision.

Observations:

- ** IISc system has proved to be an effective system, effective in demanding from the faculty a respectable research output. PAC expert members have been all along of such standing and the selected referees have been of such stature that faculty members have always positively felt the pressure of their expectations. The process ensures collective judgement of several peers. These features have, as has generally been acknowledged by senior academics in the country, contributed in no small measure to the excellent research (creative endeavour) atmosphere in IISc.

- * Although the IIT regulation is based on the commendable principle that their faculty have to, for their elevation, compete with the outsiders, in actual practice it has not displayed the same positive impact as the IISc system. Generally, IIT faculty do not have to face severe competition from the external candidates. The promotion Committee being chaired by the Director of the same IIT, although in principle is a desirable feature, is not the same as the PAC of IISc being chaired by the Chairman of IISc Council with the Director being only a member. If the Director is also the Chairman, there is the possibility of local pressures being built up, which may not happen but which certainly provides room for such perception.

Recommendations:

For assessment and promotion of IIT faculty, a model akin to IISc system is recommended, as described below:

(i) A minimum period of 6 years in the case of promotion of an Assistant Professor and a minimum period of 5 years in the case of promotion of an Associate Professor is recommended. *This minimum duration may be reviewed from time to time and lower residence period may be seriously considered as times demand.* In any case, an Assistant Professor/Associate Professor with exceptional achievement can request on his own or be invited by the Institute for an assessment earlier. Also, an individual can request to be assessed later than the period mentioned above.

(ii) Assessment to be based on the candidate's submission of CV with his record of teaching, research and any other contribution such as industry related development along with his suggestion of a panel of 3 to 5 referees from India and 3 to 5 referees from overseas. The Committee of Professors, Chaired by the Head of the Department, to scrutinise the candidate's papers and, if satisfied, forwards the same to their respective Dean along with a further list of possible referees from India and abroad. It would be a good tradition for the Dean concerned to apprise the Committee of Deans on all such faculty matters. The Dean concerned then finalises the list of referees and moves to obtain the reports from the referees. When the case is complete with about 3 referee reports from India and about 3 referee reports from overseas (at least 6 in all), the Dean puts up the case to the Director. It has to be emphasized that the choice of referees is crucial in obtaining balanced and unbiased views.

(iii) A PAC (Promotion and Assessment Committee) has to be constituted by each IIT with its Chairman, BOG as Chairman, PAC. PAC for the IITs may comprise 6 to 8 experts representing expertise in the disciplines relevant to the IIT concerned. If such senior experts are members of the BOG, which could very well be in a few cases, the same experts could be in the PAC. Chairman, BOG may invite one, two or more experts to the PAC meeting specially and solely for consideration of the promotions, in case he feels that the available experts in the PAC are not sufficient for doing justice to the consideration of the technical speciality of any given candidate(s). The PAC meeting could be held the same day or the day preceding the BOG meeting in order to minimize the burden of time on the Chairman, BOG and the experts.

(iv) The decision of the PAC is to be placed before the BOG for approval.

(v) In order to have a new system of assessment for promotion of faculty members on the lines suggested above, the statutes require to be amended. The Committee recommends the amendment of the Statutes for this purpose. The new Statutes may be drafted under the guidance of the Board of Governors and finally approved by the BOG for further consideration and approval of the MHRD and the Visitor.

6.3.3 Faculty Service Conditions

The economic environment in the country has become unprecedentedly favourable for investment. With almost every sector experiencing growth and a renaissance in manufacturing anticipated, the demand for highly trained technical personnel is rising like never before. In order to be able to retain the existing faculty and to attract the highly able to take up positions in the IITs, their service conditions, including pay scales and allowances, have to be urgently reviewed. One possibility is to augment the emoluments through a professional allowance. These ideas require a more in-depth discussion. Recognising that this process will necessarily take time, the Committee has proposed to recommend a few immediately implementable measures. Thus, the Committee suggests that the best performers among the IIT faculty may be retained beyond 62 years age to the age of 65. Also, in the Committee's view, the pension scheme has to be such as to encourage faculty to continue with the IIT system. (**Incentives** to those commendably productive in high quality research have been separately recommended in Chapter 7).

The suggestions, with reference to the provisions in the IIT statutes, are given in Table 6.6.

Table 6.6: Age of retirement

IIT STATUTE: Section 13 (2)	RECOMMENDATION
Subject to the provisions of the Act and the Statutes, all appointments to posts under the Institute shall ordinarily be made on probation for a period of one year after which period the appointee, if confirmed, shall continue to hold his office subject to the provisions of the Act and the Statutes, till the end of the month in which he attains the age of 60 years (now raised to 62 years). *Provided further that where it becomes necessary to re-employ any such member beyond the end of the semester or academic sessions as the case may be, the board may with the previous approval of the Visitor, re-employ any such member for a period up to three years in the first instance and up to two years thereafter and in no case exceeding the end of the academic session in which he attains the age of 65 years.* *A new scheme for retiring teachers has been ordered by the Government of India to come into effect on January 1, 2004.*	There is a serious dearth of highly experienced and well-qualified teaching staff in our educational institutions. At the present time, some of the best teachers with experience and high academic credentials among the more than 1200 engineering and technology colleges are in the IITs. In order to retain the very best among the IIT teachers, the age of retirement has to be raised from the presently fixed 62 years to 65 years for those who meet certain criteria. To make a decision on the persons to be retained beyond the age of 62 years, the Committee recommends that the Director should set up a special Committee to be chaired by the Chairman, BOG. The Director and 3 experts selected by the Director in consultation with the Chairman, BOG will be the members. The criteria for evaluation will simply be high quality performance in the core functions, namely teaching, research or development work or a combination of these. The recommendation of the Special Committee will be placed before the BOG for approval. This provision will be made applicable only to those who have attained the level of Professors. At any time, the number of Professors going up to the age of 65 years should not exceed 20% of the total number of Professors. Keeping in view that the IITs are the country's best academic institutions in engineering and technology and the essentiality of making teaching positions in the IITs as attractive as possible, the present pension scheme for faculty should be retained. Adequate medical facilities post retirement need also to be given.

6.3.4 Recommendation for creation of a HR Unit

(i) Faculty recruitment, their retention and providing opportunities for their professional growth should occupy the highest place in the management agenda of the IITs. In order to give it the highest importance and the sharpest focus, each of the IITs should create a separate Human Resource (HR) Unit headed by a Dean.

(ii) The Dean, selected to perform this function, should have, during the course of his tenure with the IIT, demonstrated acumen in spotting and nurturing talent and should have developed valuable contacts in the academic and related circles in India and abroad. No doubt, there will be several claimants in the IIT system to these attributes as IITs are rich in terms of quality faculty. The person selected by the Director must be the one who has shown the most inclination towards this kind of HR activity. Once so selected, the Dean may not be entrusted with other administrative duties or disturbed from this responsibility for at least 5 years as it takes quite a while to hone skills and develop an information base on eminent academic groups and leaders in a wide spectrum of disciplines of interest to the home institution.

(iii) The HR unit should also be staffed by at least two dedicated HR professionals. They could be Associated Professors from IIT Management school (IITs have instituted courses in Management/Business who should be well versed in HR matters). If necessary, induction of one HR professional at the level of an Associate Professor may be made.

(iv) The HR Unit must develop aggressive methods for spotting outstanding performers within India and elsewhere in different disciplines and at different levels. (It is desirable that a Ph.D. from a given IIT is not inducted as a faculty at that IIT atleast for a period of 3 years). Such methods include maintaining constant contact with alumni in academics in various countries and interfacing with reputed institutions in India and overseas. The HR Unit can get an attractive brochure prepared solely to convey why IIT is an attractive destination for outstanding academics presently situated in leading institutions as well as those on the threshold of an academic career. Apart from the benefits available like the congenial environment and research facilities, the brochure should spell out such items as there being no financial limit on consultancy earnings.

(v) The Committee recommends that a research initiation grant up to a sum of Rs. 20 lakh be made available to the fresh recruit depending on his research proposal and needs.

(vi) The HR Unit should also arrange for senior faculty members to act as mentors for the new recruits. The unit similarly can concern itself with faculty counselling and training in various spheres including management processes where relevant.

(vii) If an eminent person were to be located during faculty search and the person so identified is working in a frontier field in which a given IIT has interest but has not yet entered into, there should be no hesitation in building a new field of activity of interest to the IIT around such a person. This is an excellent way to nurture new areas.

(viii) At present, mobility of faculty members from one IIT to another IIT is not easy at all. A faculty member desirous of such transfer has to go through the induction process in a sister-IIT more like he were an outsider candidate. The IIT Council needs to consider this issue and provide for easier movement of a given faculty member from one IIT to another, for limited periods or on a permanent basis. Such a movement should be particularly encouraged when it helps to build a substantial strength in a particular technical field. A scheme for this purpose is urgently warranted and the IIT Council is in a position to consider and approve a proper scheme.

(ix) There are several other issues with regard to faculty such as their assessment and promotion and also providing avenues for their professional growth. The HR Unit should be able to monitor these issues and bring matters on a regular and efficient basis to the notice of the IIT authorities viz., the Director and the Board of Governors. The HR Unit could also draw attention to these authorities of the outstanding results obtained by a given faculty member in research and extension activities for their consideration for possible financial rewards.

(x) Alumni of IIT today occupy distinguished positions worldwide. HR Units should be able to establish an active interface with the academics among these Alumni and take their help in locating talented individuals. In particular, several bright Indians obtain Ph.D. degrees from some of the world's best Universities such as in US, Europe, UK, Japan and Australia. HR unit by themselves, through their nurtured contacts and with the help of the alumni, should attempt to develop a data base on such candidates. There is also value to have faculty drawn from diverse countries, and diverse academic backgrounds, as the academic set-up, content and demands are not the same in every country. The HR unit should also be on the look out for outstanding professionals in the industry. If such professionals are inclined to take up teaching and research in the IITs, their joint appointment with the IITs should be considered and brought up to the BOG for a decision.

(xi) At the present time, IITs call for applications for faculty positions strictly from Indian Nationals. There has to be a policy change in this regard. The world's best schools, especially in the U.S, have benefited from outstanding professionals drawn from countries outside their own. In this regard, IITs should be enabled to break new ground. To begin with, outstanding Indians, who may possess foreign citizenship, should be permitted to be considered for induction as IIT faculty, if found suitable. It is time now to open this door for the benefit of the IIT system.

(xii) On a case-to-case basis eminent foreign nationals, who are in a position to complement the IIT academic programmes at a distinctly higher academic level, should be considered for invitation to join the faculty for long durations of up to 5 years (short duration terms of Visiting Professors is certainly useful but does not go very far).

(xiii) Housing and such other facilities are also important. The HR Unit should be able to suggest ways by which improvements can be made in all of the areas which affect their comfortable living and efficient functioning, which will go a long way in retaining good quality manpower.

6.4. SUMMARY OF RECOMMENDATIONS

1) A system akin to that prevalent in IISc for Faculty Induction as well as Faculty Assessment and Promotion should be followed. The IIT statutes need to be urgently amended to make this happen.

2) The service conditions, including pay scales and allowances of the IIT faculty, need to be urgently reviewed in view of the prevailing demand for highly qualified technical personnel. Certain measures could be immediately implemented. The Committee suggests that the best performers among the IIT faculty may be retained beyond 62 years age to the age of 65. Also, in the Committee's view, the pension scheme and medical facilities post retirement have to be such as to encourage faculty to continue with the IIT system. (Financial incentives have been separately recommended in Chapter 7 to reward high quality research output by faculty members).

3) The Committee suggests that each of the IITs should create a separate Human Resource (HR) Unit headed by a Dean for faculty recruitment, their retention and providing opportunities for their professional growth. The HR unit must consider innovative ways of augmenting the strength of high calibre faculty. Faculty initiation grant up to Rs.20 lakh and other faculty requirements such as housing and medical services are to be attended to by the HR unit.

4) MHRD to consider making provisions for enabling IITs to induct meritorious foreign nationals to join the faculty of their institutes. To begin with, those of Indian Origin could be attracted.

5) The possibility of joint appointment with industry and other institutions needs to be also considered.

CHAPTER SEVEN

RESEARCH ENHANCEMENT

"Research is civilization and determines the economic, social and political development of a nation"

Sir CV Raman, NL
(1888-1970)

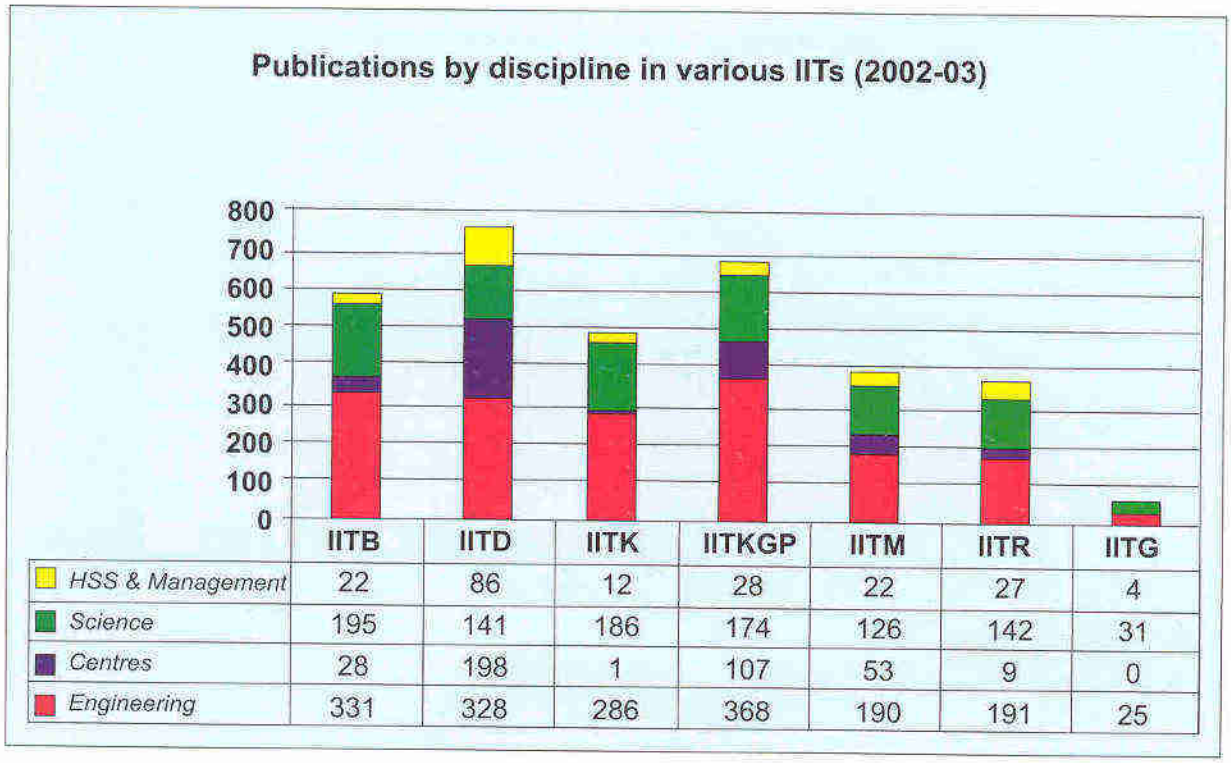
CHAPTER SEVEN

RESEARCH ENHANCEMENT

The tangible results of research at the IITs are typically in the form of Ph.D.s (Ph.D. theses), research publications, books, patents (discussed in a separate chapter) and knowledge-intensive products. Other parameters such as Government sponsored research, research grants resulting from the MoUs (alliances) with other institutions, performance of national facilities (located within IITs), and the conferences organized also provide insights into the research intensity of IITs. The presentation of the relevant data will be followed by several recommendations which are aimed at IITs achieving a higher level of research accomplishments.

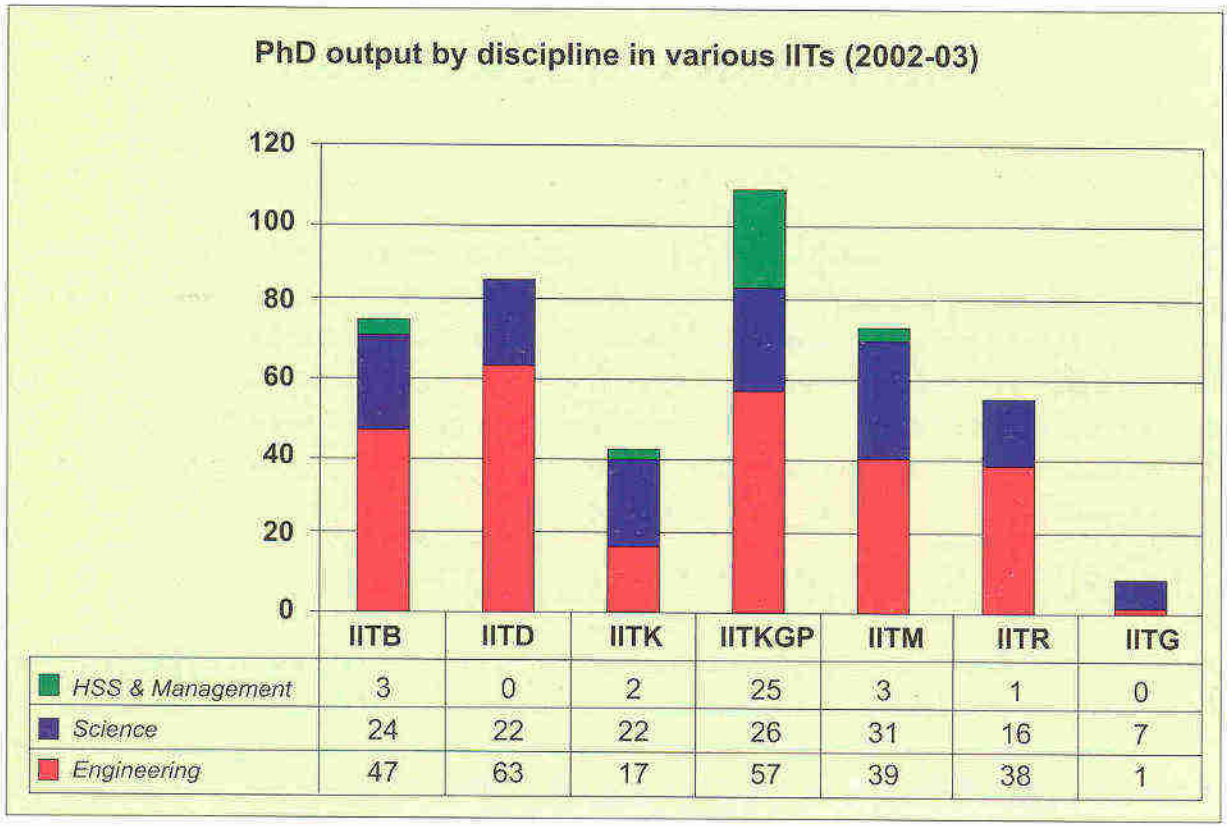
7.1 PUBLICATIONS AND Ph.D. OUTPUT

Figure 7.1 shows that, at an aggregate level, engineering departments have produced higher number of refereed publications than science departments, research centres and departments of Humanities/ Management. However, there are differences across IITs in terms of this break up. The centres of IITD and IITKGP publish more compared to the centres of the other IITs. Though IITK has several centres, the research output of the centres *per se* is not high. This points to probable differences in the role/interpretation of centres among IITs.



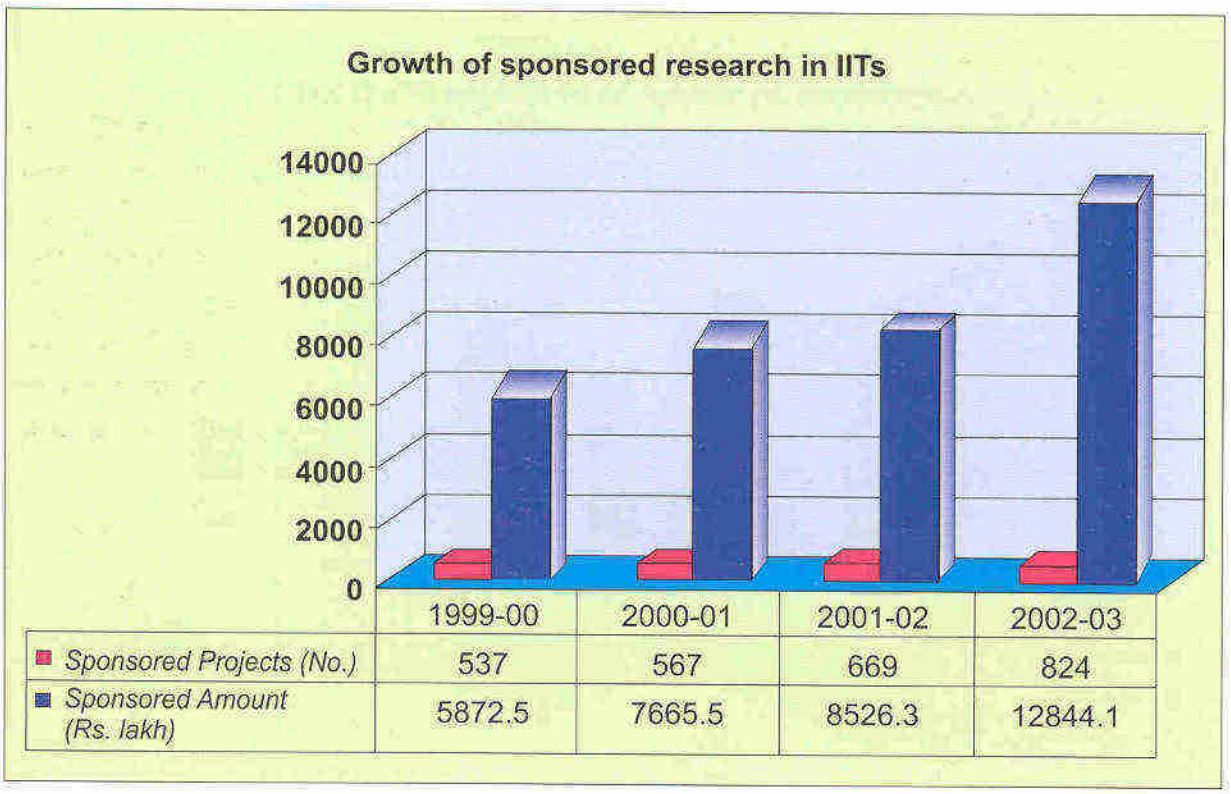
	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
HSS & Management	22	86	12	28	22	27	4
Science	195	141	186	174	126	142	31
Centres	28	198	1	107	53	9	0
Engineering	331	328	286	368	190	191	25

Figure 7.1: Publications by discipline in various IITs (2002-03)



	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
HSS & Management	3	0	2	25	3	1	0
Science	24	22	22	26	31	16	7
Engineering	47	63	17	57	39	38	1

Figure 7.2: Ph.D. output by discipline in various IITs (2002-03)



	1999-00	2000-01	2001-02	2002-03
Sponsored Projects (No.)	537	567	669	824
Sponsored Amount (Rs. lakh)	5872.5	7665.5	8526.3	12844.1

Figure 7.3: Growth of sponsored research in IITs

Figure 7.2 shows the Ph.D. output by discipline in the seven IITs.

- At an aggregate level, engineering Ph.D. output exceeds science and HSS output.
- However, IITK and IITG produce higher proportion of science Ph.D.s compared to the other IITs.
- IITKGP output of Ph.D.s in HSS & Management is more compared to the other IITs.

7.2 SPONSORED RESEARCH

The sponsored research in the IITs (mostly Government agency sponsored) has grown at about 40% p.a. over the past four years. The average size of sponsored projects increased from Rs. 10 lakh per project in 1999-00 to about Rs.15 lakh per project in 2002-03 (Figure 7.3).

However, the picture is not consistent across IITs (Figure 7.4).

7.3 INTERACTIONS WITH OTHER INSTITUTIONS

Another key stakeholder group of the IIT system is all the other educational/research institutions. IITs interact with other technological institutions within the country and abroad to exchange the best practices in education and research. These interactions are facilitated through alliances and conferences.

7.3.1 Alliances

Figure 7.5 shows that the number of active MOUs has gone up over the years. National MOUs have risen at a faster rate than the international MOUs. These alliances have yielded sponsored research projects in some cases. A strategy for the MOUs, in particular with eminent universities abroad, has to be thought through. It should be possible for each IIT to build close links with one or two leading universities overseas. The outstanding example of the University of Cambridge partnering with MIT, USA (there are several such partnerships emerging in the world) deserves to be emulated. It should also be possible to build into such alliances Ph.D. programme for students in the two partnering institutions, as is being attempted by the Department of Science and Technology in the Indo-German programme of collaboration in nanoscience and technology.

Table 7.1: Research grants obtained from MOUs

	1999-00	2000-01	2001-02	2002-03
Research grants from International MOUs (Rs. lakh)	558	571	897	667
Research grants from National MOUs (Rs. lakh)	2016	2310	3911	4562

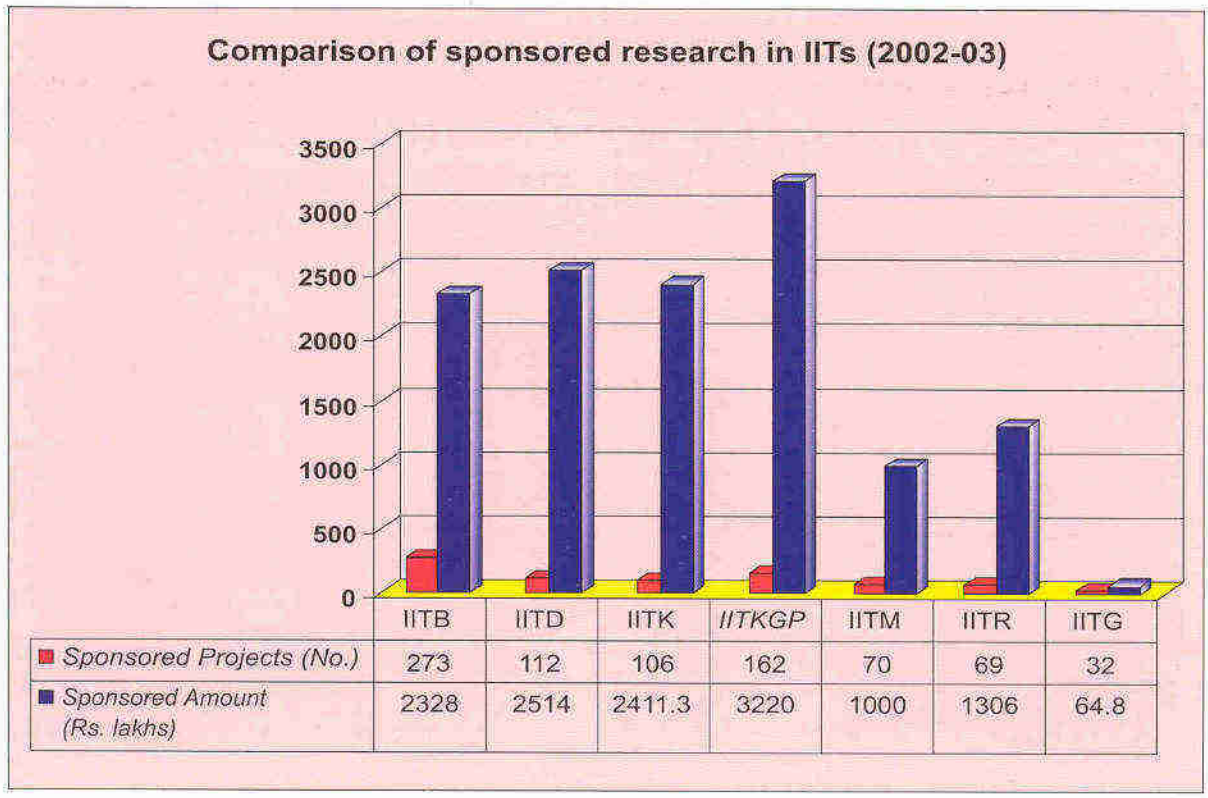
Table 7.1 shows the research grants acquired by IITs through MOUs. It is clear that most of the grants have come from the national MOUs. It implies that sponsored research in IITs may be directed towards national issues. However, the average project size of a national alliance is much lower (Rs. 6-8 lakh per project) than that of the international projects (between Rs. 15-20 lakh per project).

India has chains of national laboratories under various agencies, like CSIR, DRDO and DAE. Research funding is also provided by DST, DAE, DRDO, DOS, CSIR and MCIT *(please see page 151 for expanded form)*. IITs could consider working on developing carefully crafted MOUs with these agencies for undertaking major projects. There is much to be gained in terms of research promotion via alliances with these agencies.

IIT's will also benefit from inter-IIT alliances. Such alliances can be cast between departments and/or between disciplines among a pair or more of the IITs. Once a mechanism is in place for meaningful interfacing between departments/disciplines, cooperative endeavours in research as well as for improvements in curricula can be attempted. Through such inter-IIT collaborative endeavours, synergy and complimentarity in their academic programmes could result. Moreover, duplication of efforts, if any, could be minimised or altogether eliminated.

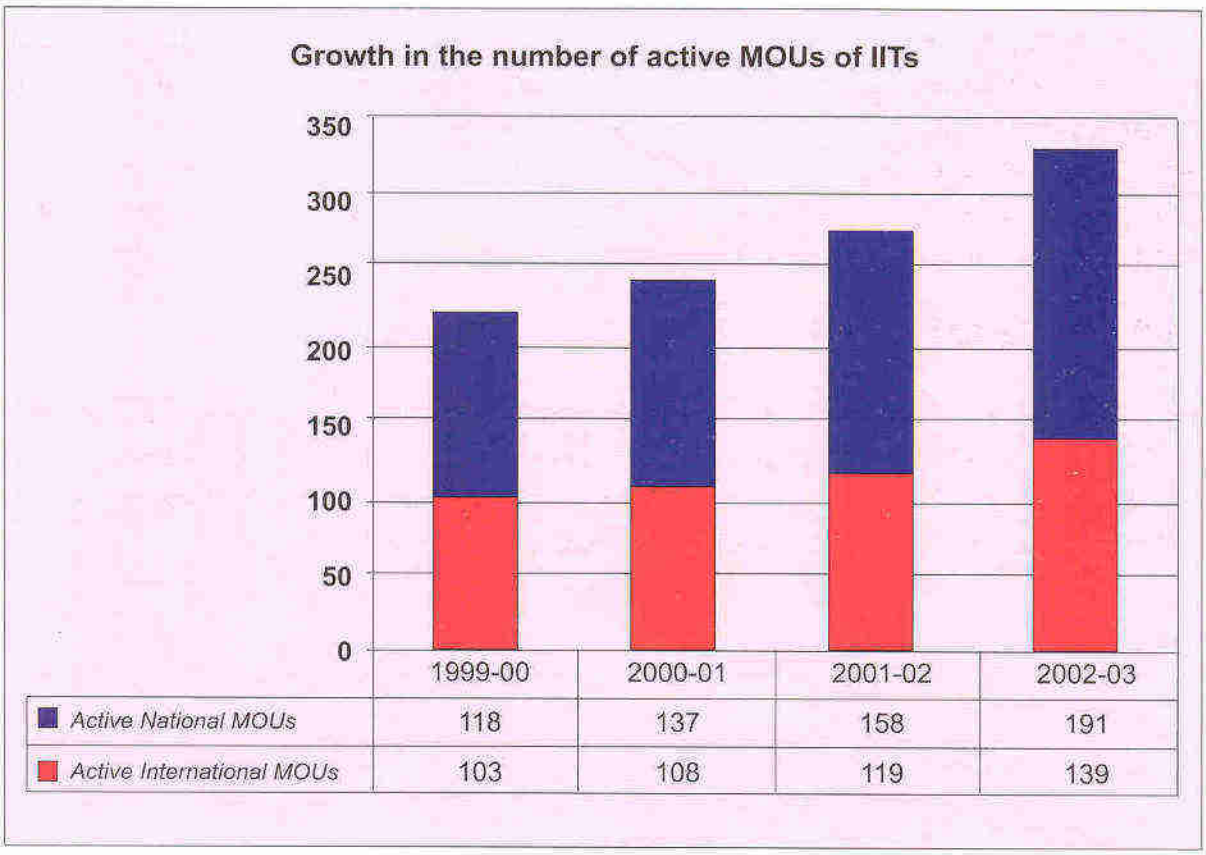
7.3.2 Conferences

Figure 7.6 shows that national conferences dominate the landscape of IITs. This suggests that IITs may be playing a critical role in facilitating knowledge dissemination within the country. However, there is inadequate data to comment on the quality of intellectual debate and networking fostered by these conferences. There is a need to think of appropriate metrics.



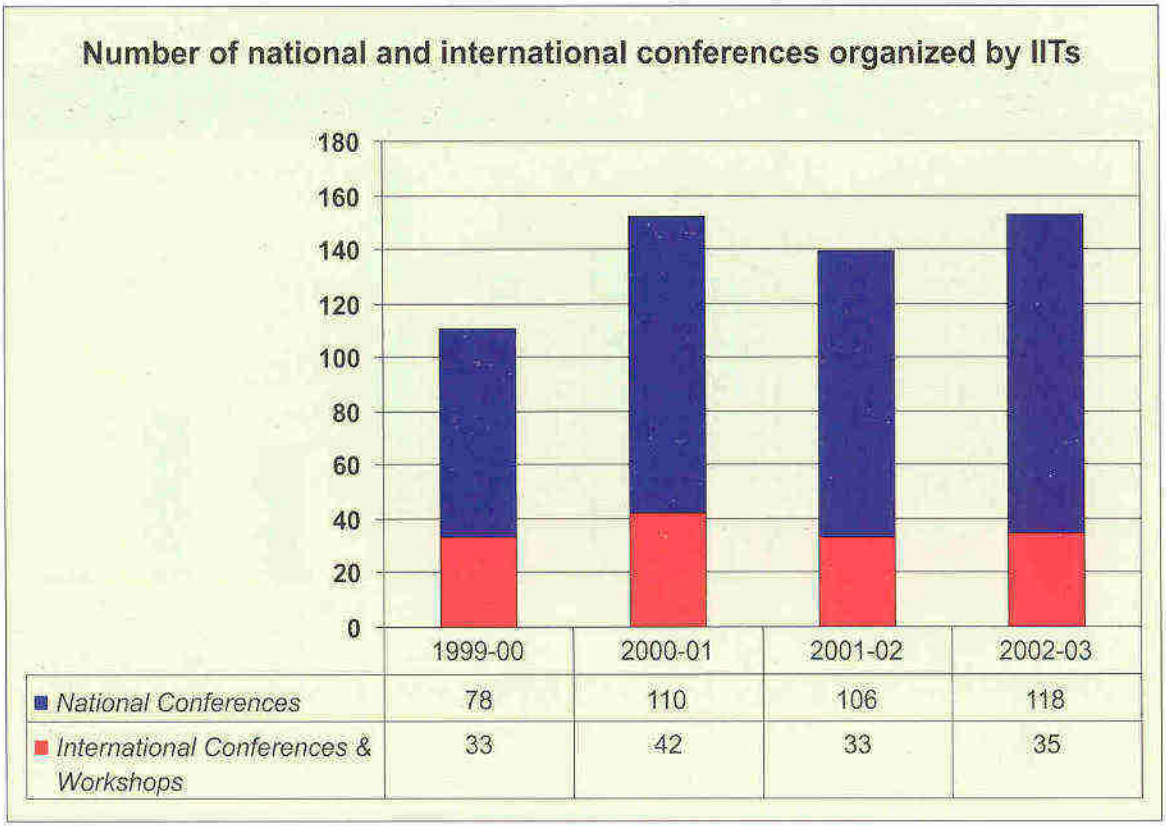
	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Sponsored Projects (No.)	273	112	106	162	70	69	32
Sponsored Amount (Rs. lakhs)	2328	2514	2411.3	3220	1000	1306	64.8

Figure 7.4: Comparison of sponsored research in IITs (2002-03)



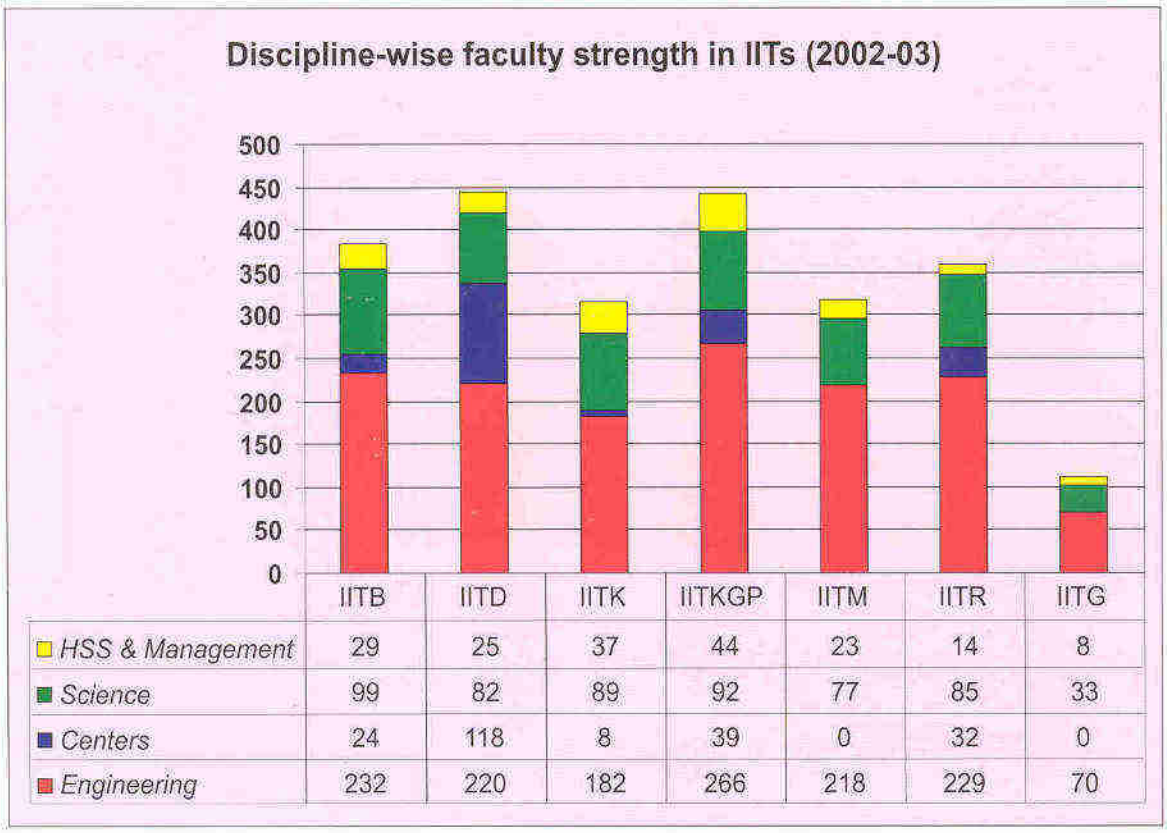
	1999-00	2000-01	2001-02	2002-03
Active National MOUs	118	137	158	191
Active International MOUs	103	108	119	139

Figure 7.5: Growth in the number of active MOUs of IITs



	1999-00	2000-01	2001-02	2002-03
National Conferences	78	110	106	118
International Conferences & Workshops	33	42	33	35

Figure 7.6: Number of national and international conferences organized by IITs



	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
HSS & Management	29	25	37	44	23	14	8
Science	99	82	89	92	77	85	33
Centers	24	118	8	39	0	32	0
Engineering	232	220	182	266	218	229	70

Figure 7.7: Discipline-wise faculty strength in IITs (2002-03)

Table 7.2: Conferences organized by individual IITs in 2002-03

	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
National Conferences	12	50	15	25	10	3	3
International Conferences	2	20	3	3	5	–	2

Table 7.2 shows the breakup of conferences by individual IITs. IITD hosts most conferences followed by IITKGP. It may be useful to understand the average number of participants per conference and the conferences per disciplinary area.

7.4 RECOMMENDATIONS

Principally, there are two key groups that can contribute to more and better research output from the IITs. These are A) the Faculty Community and B) the Ph.D. Student Community. These two groups are analysed further to identify possible ways of enhancing their performance. Accordingly, recommendations are made separately in respect of faculty and Ph.D. students.

7.4.1 Faculty Performance

The discipline-wise faculty strength in the 7 IITs is given in Figure 7.7.

- It is seen that the ratio of Science to Engineering faculty is 0.36 $\pm$ 0.1 in IITD, IITKGP, IITM and IITR while it is 0.48 $\pm$ 0.1 for IITB, IITG and IITK. The proportion of Science faculty is highest in IITK.

- While the ratio of HSS & Management to Engineering faculty is generally 0.11, it is 0.17 in IITKGP and 0.20 in IITK. The HSS/Management faculty is weakest in IITM, among the older IITs.

- The number of faculty members associated with the Centers varies widely. IITM & IITG have no faculty in the Centers. IITD has as much as 26.5% faculty in the Centers. The other IITs have between 0-9% of the total Faculty in the Centers.

While recruiting new faculty to fill in the substantial number of vacant positions, IITs may consider the balance between science, engineering and interdisciplinary faculty strength. Several frontier research areas fall into the category of science-intensive engineering fields. It has also been noticed that outstanding science capability has stimulated even more outstanding engineering research and development. It is, therefore, imperative that IITs look at the evolving situation worldwide in this respect, besides the developing needs in our country and accordingly plan fresh faculty induction.

At the present time, there is no system of offering rewards to outstanding performers among the faculty. IITs, like what the world's leading academic institutions have done, would do well to see what strategies will bring down the proportion of faculty members who are performing below the threshold of output set by the authorities. (There is one university, Harvard, in the World which claims that the number of Professors performing below international average is NIL!). **As an immediate measure, IITs should introduce a system of providing financial incentives to outstanding performers among the faculty which is further explained below.**

(i) Outstanding performance may be adjudged in terms of the following parameters;

a. Ph.D.'s produced by the Faculty member;

b. Sponsored projects earned by the Faculty member including their financial outlay;

c. Publications in citation-indexed journals;

d. Feedback on teaching performance from students and the Director and

e. Major awards like Fellowship of respected Academies, Bhatnagar Prize, International Awards and the like;

Let us consider (a) and (c) of the above, namely Ph.D.s produced and publications, since IITs need to expand their research base and gain prominence like the world's top ranking research universities. A high stature in research attracts high calibre (potential and demonstrated) researchers. This will enhance the quantum and quality of Ph.D.s and research publications. The Committee has the impression that this is indeed happening. This visible trend deserves to be encouraged, supported and built up. The IIT authorities have together the responsibility to ensure that the IIT system as a whole develops into a powerhouse of research and thereby makes an impact on the national and international plane. The ability of IITs to serve industry also stems from their research involvements.

- **At the present time, the IIT Ph.D. output works out to less than 0.2 per faculty. The BOG could set an appropriate target for each of the IITs, say to raise this by a factor of two (for the leading academic institutions in the world, the Ph.D. output would be 1 or more per faculty).**

  Just as a target like doubling the Ph.D. outturn may be a good target in the immediate term, so also doubling the number of journal publications would be a desirable goal.

- In regard to publications, presently the IITs do not report on citations (ie the number of references made to the IIT journal papers in the citation-indexed journals). If this is done, a useful parameter to assess the output, that is internationally used, is

$$\sqrt{\text{No. of publications per faculty per year X No. of citations per faculty per year}}$$

For the world's reputed universities, the index ranges from 5 to 10. The CSIR in our country have adopted the average impact factor as a measure of the basic research performance of their laboratories. **An average impact factor above 2.5 would place an institute high on the list of leading research institutions** in the country. IITs could adopt both the metrics, the first for comparison on an international scale (as the parameter is so accepted and has been indicated for top universities) and the second for a comparative assessment within the country (this parameter can be used for international comparison as well). Quantitative measures, like the ones indicated, help comparison with the best on a common basis. This is not to take the merit away from a few publications which are pathbreaking. They deserve always to be specially mentioned and recognised and this cannot be overemphasized.

- An assessment based on the above parameters i.e. Ph.D. per faculty and the publication index may be made by the HR Unit and placed before the Committee of Deans along with the material pertaining to (b) (d) and (e). The recommendations of the Dean's Committee are to be scrutinised and finalised by the Director who, in turn, will place the case of outstanding performers before the Board of Governors.
- The above suggestions have been made in order to have an accepted quantitative metric with which each BOG may look at their IIT research output in relation to the other IITs. If each IIT declares (as CSIR laboratories have been doing with positive results) one or both the indices, one can expect a healthy competition among the seven IITs. Each IIT would surely strive to come out better and better, in such a comparison, year after year.

(ii) The Committee suggests that the proceeds of the corpus amount with each of the IITs may be used for rewarding outstanding performances. Selection of outstanding performers and the quantum of the financial reward in a given year may be decided by the Board of Governors. If this were to become successful in yielding the desired results, the alumni, who have been generous all along, will no doubt gladly add to the corpus substantially to cater specifically for the purpose of rewarding outstanding performers.

(iii) The Committee further recommends that the Government institutes a new cadre of Distinguished Research Professors (DRP). Only Professors with an excellent track record of research would be eligible for DRPs. They will have no administrative responsibility and will devote their time wholly to teaching and research. They will carry higher emoluments, the salary of Secretary to Government of India. 50 such positions may be instituted for the 7 IITs as a whole. The proposed PAN-IIT Synergy Committee may recommend the basis on which the number of such positions is allocated to each IIT. These new positions could also be utilised to freshly induct star faculty for carrying out advanced research in the emerging interdisciplinary areas. Based on their present strengths, each IIT could discuss and determine which of the new frontiers would be within their grasp and accordingly propose additions to their present strength. The final selection may be made by a Special Committee of eminent experts to be recommended by the BOG for each IIT. Both internal and external candidates would be eligible for these positions. A special research grant of upto Rs.50 lakh, based on their research proposals, for a period of 5 years should be made available to each of the Distinguished Research Professors.

(iv) Similarly, each IIT should be supported for inviting outstanding scientists from anywhere, within and outside India. Each such visiting outstanding scientist could spend one year. Their emoluments (stipend) should be equivalent to that of a Professor, besides free furnished accommodation. There should also be a provision for a research grant to go with the stipend. A model for this is available in some advanced countries and may be studied for details.

(v) The Committee also recommends to the Government that each of the IITs be provided annually a sum of Rs. 2 crore for the following activities for which no financial resource is readily available:

- A faculty member could spend up to 3 months, and successively for upto 3 years, depending on the progress registered each year, at any leading institution abroad for joint work with a collaborating scientist/academic. Travel as well as *per diem* to be met out of the above grant. Decision on selection of faculty members is to be made by the Chairman, BOG in consultation with the Director.

- This grant can also be utilised to meet the cost of travel and stay up to 6 months by a Ph.D. scholar. The selection of the scholars is to be made by the Director in consultation with the Deans.

- Guidelines for utilisation of the needed amounts may be vetted and approved by the BOG.

(vi) As per the 2002 DST publication entitled "R&D Statistics", the country spent Rs.13,000 crore in 1999 on R&D. Less than 3% of this amount (i.e. about Rs.375 crore) was made available to higher education institutions i.e. Central, State, Deemed-to-be Universities, the IITs, the RECs (which are now NITs) etc. totaling as many as 300 entities. The national R&D expenditure currently is about Rs.25,000 crore. In relation to this amount, the quantum from the sponsored projects in all of the IITs put together in 2003 is only Rs.128 crore (most but not all of which is from governmental agencies), which amounts to less than 0.6% of the national R&D expenditure.

There has to be a radical improvement in the R&D funding of the IITs, considering that they account for about 60% of all Ph.D.s produced in engineering and that the Government has made substantial investment in the IIT infrastructure and that the IITs have highly qualified faculty. In this connection, each IIT, based on their respective strengths, should draw up a few grand challenge projects in interdisciplinary frontier areas and seek funding from one or the other science agency.

It has to be noted that India continues to be a target country for denial of certain technologies. Consequently, Indian experts will be barred from any manner of cooperation, including academic, with the advanced countries. IITs would do well to include such topics in their research portfolio. Funding for such projects can be expected to be forthcoming in a large measure. IIT Council could encourage IITs to identify a few PAN-IIT mega projects and thereby also promote inter-IIT collaboration.

(vii) It may also be noted that each IIT received Rs.100 to 120 crore per annum from the MHRD as non-plan and plan grants, but they do not have an annual R&D fund. Each IIT should, therefore, be encouraged to set up a Research Fund in their respective institutes. This is an urgent need. If each IIT adds annually up to an amount of Rs.10 crore from its own resources (earnings and donations) to the new Research Fund, the MHRD should match this amount with an annual allocation of Rs.10 crore. An annual research fund of Rs.20 crore, to start with, will empower the IITs to take up research projects autonomously without having to chase the funding agencies. Ready and speedy funding should make a big difference to the IIT research endeavour. Utilisation of the research fund by the faculty and the departments/centres should be determined via a competitive process. The Directors could set up a 3 - 4 member (one of which should be an outside expert) expert committee to evaluate the faculty research proposals to ensure judicious allocation as well as for the purpose of monitoring its utilisation.

7.4.2 Ph.D. Programmes

It is recognised the world over that the research output of an academic institution is significantly dependent on the number, quality and dedication of its Ph.D. research scholars who constitute the graduate research school. It is, therefore, important to review this aspect and propose ways to better the situation.

The Nayudamma IIT Review Committee submitted their report in the year 1986. This report contains statistics for the year 1984. The faculty strength in the then 5 IITs and the number of Ph.D.s produced by them in 1984 were respectively 1795 and 295. This works out to an output of 0.16 Ph.D. per faculty. In the year 2003, the faculty strength in the 7 IITs was 2375 and they together produced 444 Ph.D.s for an output per faculty of about 0.19 per faculty. Clearly, the growth in the Ph.D. output of the IITs in the last two decades has not been significant, notwithstanding the considerable expansion that has occurred during the period since the Nayudamma Review Committee. The small quantum of growth in the Ph.D. output may actually be a reflection of the engineering research scenario in the country. Ph.D. has not been hitherto a serious career goal of the engineering graduates. Securing employment immediately after the B.Tech. degree has almost become a cultural feature. Moreover, job opportunities for engineering graduates in general, and those of the IITs in particular, have been rising especially since the boom in the IT sector. The troubling trend has been that a candidate takes to Ph.D. only when other professional career prospects have been denied to him.

The above situation fortunately has changed in recent years. IITs have been able to take in far more number of Ph.D. students in the last 3 to 4 years (their strength in the IITs has gone up by more than 25% since 1995-2000). This trend must be strengthened. However, IITs too face what is a national problem, which is that highly talented youngsters are not attracted to research in science and engineering. A solution to this problem could lie in a new mechanism of career assurance. **The Committee would urge the Government seriously to consider this concept of assured career for promising researchers.**

In the quality improvement programme (QIP), MHRD supports and enables teachers in various engineering colleges including NITs to undertake Ph.D. research in the IITs. Between 1999-2001, under the QIP, 240 candidates obtained Ph.D. and 161 obtained M.Tech. degree from all the IITs put together. This has been a successful way of enhancing Ph.D. output as the teachers are invariably highly motivated researchers. The Committee recommends further enlargement of the QIP.

Although the Ph.D. intake has and can be increased substantially through direct intake or via the QIP, it is not clear if the calibre of those admitted is high enough. As of now, the IITs do not seem to have been able to attract their own undergraduate students to stay on for post-graduate and Ph.D. programmes. Now is the opportune time to take a close look at the quality of the intake as well as to render the Ph.D. degree an attractive career proposition for the bright IIT and other engineering graduates. Just as the JEE has proved to be an effective filter for screening in meritorious undergraduate students, it is important to institute a method for selecting the best possible Ph.D. scholars.

It is also necessary to introduce a structured pre - Ph.D. programme, not only to test their performance in selected courses related to their Ph.D. work but also to test their potential for original research. Clearing the pre - Ph.D. requirement should be made mandatory and, if a candidate is unable to do so in two chances, he should be advised to take to an alternative career-path. There is a system of a pre - Ph.D. process in the IITs but this needs to be examined afresh for making it more rigorous and for tightening it time-wise. We have the following further suggestions to improve doctoral and post-doctoral research at the IITs.

(i) It is recommended that MHRD institute 100 high value research fellowships. These Fellowships may be termed **IIT Golden Jubilee Research Fellowships and carry a monthly stipend of Rs. 20,000 (Rupees twenty thousand).** This works out to about 15 such fellowships in each of the 7 IITs.

The selection of the Golden Jubilee Fellows must be based on an interview to be conducted by a Committee to be set up by the IIT Directors for each of their institutes. The top rankers in B.Tech. and M.Tech. streams of the IITs, based on their performance at the B.Tech. final (or pre-final) and M.Tech. final (or prefinal) examinations, should be selected for the interview. With the introduction of a research project at the 2nd year stage and the one year project in the 2-year M.Tech. programme, the performance in these projects should receive due weightage in the final selection. For candidates from outside the IIT system, an entrance test may be conducted by each of the IITs, the best of whom are interviewed along with the selected toppers from the IITs, for final selection of the Golden Jubilee Fellows.

(ii) There is considerable merit in having a system whereby a candidate by the age of 25 years should be able to achieve a sound Ph.D. degree. The success of such a system will eliminate the deterrent that youngsters see in having to spend prolonged years for them to go through a Ph.D. programme. Encouraging the B.Tech. top rankers for admission to the Ph.D. programme provides the means for the brightest to get their Ph.D. by the age of 25. The Ph.D. research

monitoring and evaluation processes (including the time taken by the external examiners) should be rigorously managed by the Deans and Heads concerned to ensure that the duration that a meritorious scholar spends for his Ph.D. is not unduly stretched.

(iii) There is an unhealthy tendency in some of the Ph.D. research scholars to continue to stay on beyond 5 - years. This should be strongly curbed.

(iv) There is no system of Post-doctoral Associates in the IITs. Just as the Post-doctoral Associates have proved to be a useful cadre in the academic institutions elsewhere in the world, there is a need to have a Post-doctoral community in the IITs. The stipend for the Post-doctoral fellowship should be Rs. 25,000 and made tenable for a duration of 3 years with an annual increment of Rs. 1,000. Each IIT should have at least 25 such Post-doctoral Research Associates. These could also be assigned some teaching, laboratory and tutorial responsibilities, all of which put together not to exceed about 8 hours a week with the rest of the time available for advancing research in the respective fields.

(v) Currently, IITs have not been able to entertain scholars from overseas for their Ph.D. or M.Tech. programmes. IITs may be permitted to publicise abroad for attracting outstanding graduates for their M.Tech. and Ph.D. programmes. BOG's may set an upper limit for the number of such foreign students. This measure may prove to be a new way of augmenting the strength of high calibre students at the post-graduate and doctoral levels. Similarly post-doctoral associateships may also be made available to Ph.D.s from outside India to seek a place in the IITs. (In this connection, it needs to be stressed that foreign students are often deterred by the unfamiliar food available on campuses. Although a minor point, this aspect needs to be attended to while encouraging foreigners for Ph.D. as well as postdoctoral research at the IITs).

(vi) An excellent beginning has been made in formally interacting with overseas institutions and research leaders, on a mutual basis, in inter-country projects. The Department of Science and Technology, Government of India and the corresponding agency in Germany have agreed, through an MoU, on collaborative research in the area of nanotechnology. As part of the agreed arrangement, young scientists can register for Ph.D. in their respective countries. In advancing their research effort, they can spend a reasonable period in the other country (i.e. Indians in Germany and *vice-versa*). This enables access to advanced facilities and experienced research supervision on either side while providing for profitable collaboration at the student-and the supervisor-levels. This scheme deserves to be adopted on a wider scale. Figure 7.5 shows that, between the IITs, as many as 139 international MoUs are active. These MoUs may be revisited to examine if room for cooperative Ph.D. research can be provided in any of them.

(vii) Elsewhere (Chapter 8), a suggestion to introduce a credit-based research project from the 2nd year B.Tech. stage for the undergraduates has been made. The Departments may plan these B.Tech. projects in a way as to be part of the Ph.D. and post-doctoral research activities in the Department. This principle quite well applies to the one year M.Tech. thesis-based research

projects. The benefit of such a strategy is that the Ph.D. or the Post Doctoral scholar concerned can act as a mentor to the B.Tech. and M.Tech. students for their research projects.

(viii) There is a need to promote a wider employment base within the country, for candidates trained at the level of Ph.D. and experienced in post-doctoral research. **Though India boasts of a huge stock of S & T personnel, the number of researchers employed in the country is only about 160,000, a majority of whom are in the government laboratories.** As per the IMD World Competitiveness Year book 2004, total R&D personnel in business per 1000 people in India is 0.07 as against 0.35 in China, 0.38 in Brazil, 2.5 in UK, 3.7 in Germany, 4.4 in Japan and 7.3 in USA. The pharma and chemical industries have, in recent years, recruited doctorates for their R&D and the benefits are visible. The Committee is of the view that a new measure is required to expand the employment opportunities and recommends offering a tax-incentive. **We propose a tax-incentive directed to engaging R&D personnel by the industry in addition to an omnibus weighted tax deduction now available to outright donations for research in the industry. Once the principle is accepted, the details can be worked out.**

7.4.3. National Facilities

Figure 7.8 depicts national facilities allotted to IITs over the past 40 years (please refer to Table 3.1 for a list of these national facilities). It is clear that the frequency of allocation of national facilities to IITs has increased in the last 8-10 years.

A glance at the usage of national facilities points to a very positive feature (Figure 7.9). The aggregate performance of all the national facilities in IITs between 1999-2003 shows a strong positive correlation between the total annual expenditure (not counting the capital cost) and the percentage expenditure recovered (although with a limited data set). This builds a case for creation of additional national facilities in IITs, which will certainly help attract good quality researchers. The transformation in the research ambience in an academic institution brought about by the installation of a major experimental facility should be seen to be believed. For instance, a major computing facility came up in IIT Kanpur during this institute's early period and what an impact this has had on the computing culture not only in IITK but throughout the country! Advanced research tools have become even more expensive and some of these, like particle accelerators or synchrotron sources, can only be afforded by countries coming together. In this scenario, the major science agencies in the country can be approached by the IITs **jointly** to elicit funding for such major tools as high resolution microscopes and high performance computing facilities. It is a proven fact that ready availability of well-maintained research facilities have the power of attracting the talented to join the faculty, bright students to get into the system for research and eminent visitors to come and collaborate.

Microelectronics research and development did not take off in the country not because of lack of capability, but because of non-availability of foundries for access by the educational system. The same danger looms large in the emerging area of nanoelectronics for India to acquire nanodevice capabilities if institutions like the IITs cannot access nanofoundries. The same is true of electronic network research. Lack of dedicated networks has inhibited progress.

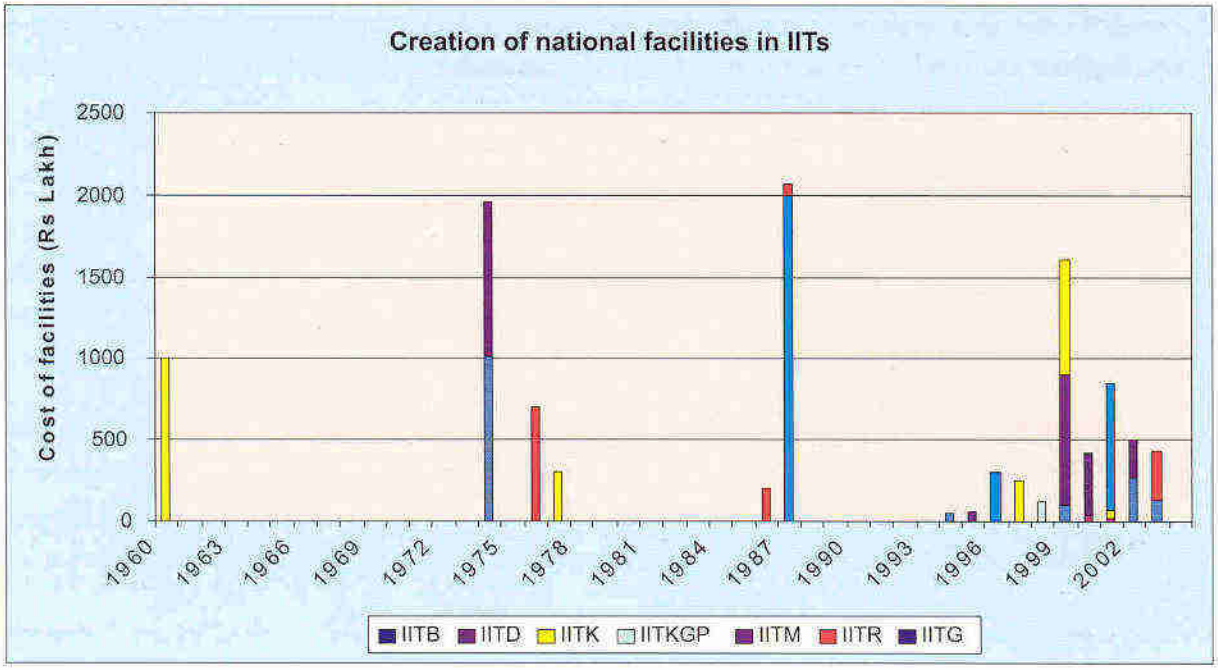


Figure 7.8: Creation of national facilities in IITs

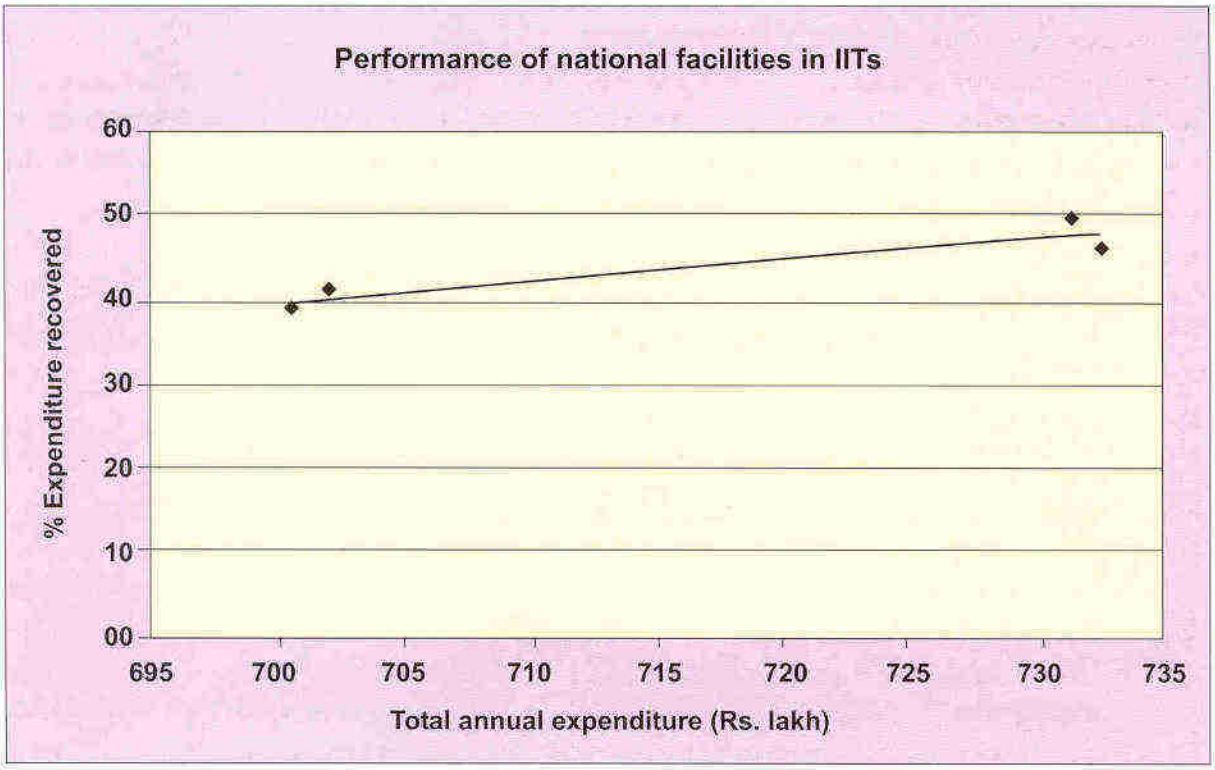


Figure 7.9: Performance of national facilities in IITs

Acquisition of major facilities, instituting systems for their management and creating a culture of shared facilities can surely be expected to raise the IIT research base and have a substantially salutary effect on the IIT research output.

7.5 SUMMARY OF RECOMMENDATIONS

1. While Section 7.4 contains the full set of recommendations, some are mentioned below. These are related to faculty (a and b), Ph.D. and Post-doctoral scholars (c to j) and research support (k to o).

   (a) Providing incentives to outstanding performers in research among the faculty members, with BOG determining criteria for performance evaluation, instituting Distinguished Research Professors and providing for financial support for adequate number of Visiting Professors and Visiting Outstanding Scientists from anywhere, within and outside India.

   (b) Budget for allowing faculty members (and their research scholars) to spend longer durations, up to 3 months, and successively for 3 years if necessary, for collaborative work abroad.

   (c) Efficient screening procedures for selecting Ph.D. students and rigorous pre-Ph.D. programme.

   (d) Assuring career to highly talented youngsters who choose to pursue research in the IITs. This will require a new mechanism to be considered by the Government.

   (e) Instituting, for 7 IITs put together, 100 Golden Jubilee Research Fellowships with a monthly stipend of Rs. 20,000/-.

   (f) Every effort to enable a bright candidate to complete Ph.D. degree requirements by the age of 25 (possible if bright B.Tech.s are taken into the Ph.D. programme). To enable this, introduce research project at the 2nd year stage for the B.Tech.s.

   (g) Build into alliances with foreign institutions a provision for Ph.D. work to be carried out as part of the collaborative project (e.g., DST's Indo-German Co-operative Project on nanotechnology).

   (h) Expanding QIP and ensuring quality at the same time.

   (i) Instituting Post-Doctoral Fellowships, 25 for each IIT (for all disciplines put together).

   (j) Permitting and attracting students for Ph.D. research from abroad, also as Post-Doctoral Research Associates.

   (k) Budget allocation separately for Research. IITs to use Rs.10 crore from their earnings and donations which is to be matched by MHRD with an equivalent allocation of Rs.10 crore exclusively for research.

(l) IITs to work out alliances with national laboratories and science funding agencies for research support.

(m) Identifying a few PAN-IIT grand challenge projects and promoting inter-IIT collaboration.

(n) Bid for more national experimental facilities to be installed in the IITs.

(o) Tax incentives to be provided to the Industry if they hire Ph.D. and research-trained post graduates.

CHAPTER EIGHT

IIT EDUCATIONAL SYSTEM

"The teacher who walks in the shadow
of the temple, among his followers,
gives not his wisdom but rather
of his faith and his lovingness.
If he is indeed wise he loves not bid you
enter the house of his wisdom, but rather
leads you to the threshold of your own mind".

Kahlil Gibran
(1883-1931)

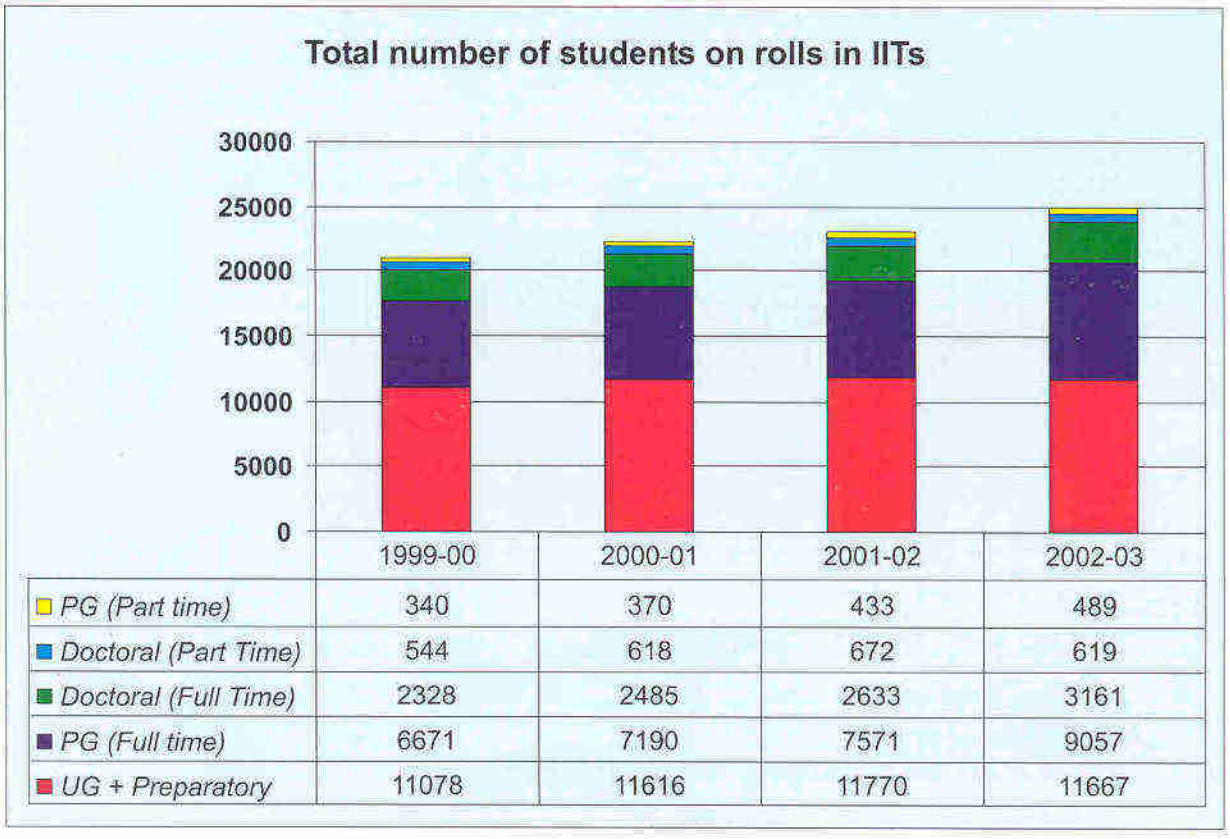
CHAPTER EIGHT

IIT EDUCATIONAL SYSTEM

It is widely acclaimed that the IITs offer high quality education. In particular, the Bachelor of Technology (B. Tech.) degree of the IITs is one of the few products of the educational system of India that is acclaimed worldwide and the brand name that the IITs have earned is largely due to the performance and achievements of their B.Tech. graduates. However, as past experience with commercial brands has shown, unless periodic reviews and, thereby, retuning is carried out to improve the product, its value tends to diminish over a period of time. Also, the brand name must extend to their M.Tech. and Ph.D. products. This chapter analyses the data pertaining to the students at UG, PG and Ph.D. levels and suggests possible improvements.

8.1 STUDENTS ON ROLLS DURING 1999-2003

Figure 8.1 shows the students on rolls in the IIT system over the past four years. The following trends in the growth in student strength during these four years are notable:



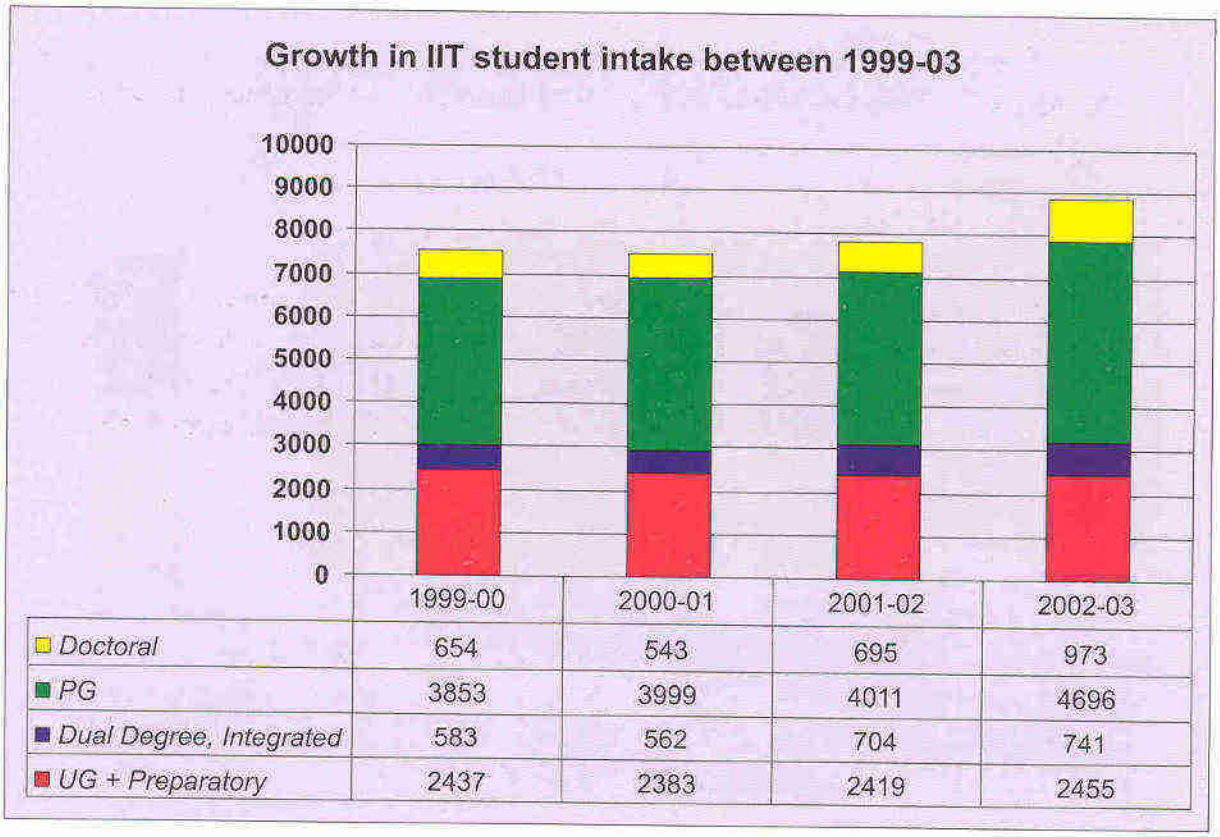
	1999-00	2000-01	2001-02	2002-03
PG (Part time)	340	370	433	489
Doctoral (Part Time)	544	618	672	619
Doctoral (Full Time)	2328	2485	2633	3161
PG (Full time)	6671	7190	7571	9057
UG + Preparatory	11078	11616	11770	11667

Figure 8.1: Total number of students on rolls in the IITs

- The total number of students on rolls in the IITs increased by 19% from 20,985 to 24,993 (about 4000 in four years). While the UG strength increased only by about 5%, the PG strength increased by over 30% and the Ph.D. student strength increased by over 25%.
- The (Ph.D.+PG):UG ratio increased from 0.89 to 1.14. On campus, the UG strength, in comparison to PG+Ph.D. strength, appears to be decreasing. This trend may alter the campus climate.
- Part-time students (PG and doctoral) account for 6% of the total students on rolls, with the remaining situated on campus. This points to the campus centric model of IITs. Proximity of students and faculty is a key factor influencing the IIT brand.
- The average student strength per IIT is about 3570.

8.2 STUDENT INTAKE DURING 1999-2003

Figure 8.2 shows the change in student intake over the last four years. The growth in intake over the 4 year-period has been about 18%. This is the same as the growth in the number of students on rolls.



	1999-00	2000-01	2001-02	2002-03
Doctoral	654	543	695	973
PG	3853	3999	4011	4696
Dual Degree, Integrated	583	562	704	741
UG + Preparatory	2437	2383	2419	2455

Figure 8.2: Growth in IIT student intake between 1999-03

Highest growth has been in Ph.D. intake (49%), followed by Dual Degree (27%) and PG (22%). Growth in UG intake has been 0.7%. In absolute terms, the number of PG intake exceeds the UG intake. **The UG brand, which has achieved international recognition, is not being scaled up although there is no shortage of quality students for UG programmes.**

- UG intake: There is sufficient number of quality students to increase intake for UG programmes by 3-4 times the current capacity. In 2003, nearly 1.8 lakh students appeared for IIT JEE. The number selected was about 3750 including those admitted to BHU-IT and Dhanbad ISM (selectivity for the IITs <2%). It is estimated that another 5-7% of students taking JEE would be suitable. That means that the UG strength in the IITs can go up to 17000, in principle, from the present ~11500 without any dilution in the quality of admissions.

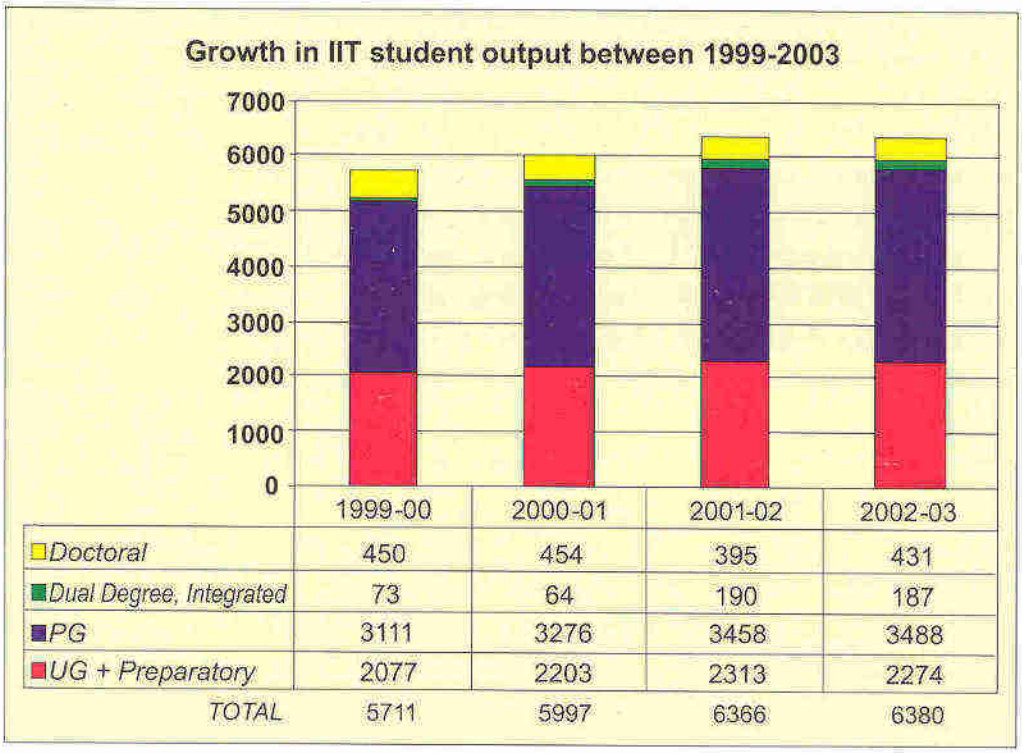
- PG Intake: In 2003, about 1.59 lakh students (out of 3.5 lakh engineers produced by the country) appeared for GATE. The number of qualified candidates was 28,877 (selectivity = 18%). Recall that the JEE is rated as a much tougher examination at the 10+2 student level, as also that the selectivity for admission has been only about 2% in UG. By comparison, the quality of PG students admitted is not likely to be as good. The rise in PG strength should not be taken, therefore, at its face value.

- It is hard to comment on Ph.D student selectivity, as they are not taken in by a single mechanism like JEE. The drop-out in Ph.D., in particular, is quite large.

- **The number of IIT B.Tech.s opting for PG and Ph.D. programmes in the IITs is worryingly small !**

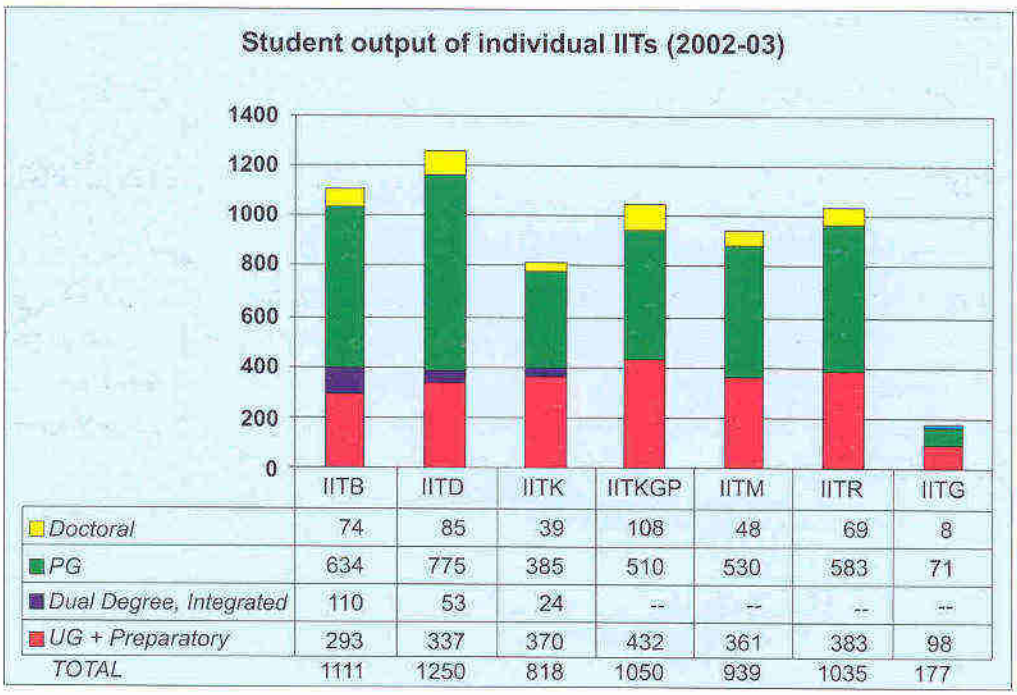
8.3 GRADUATE OUTPUT

The growth in student output during the 4-year period has been only 11.7% (Figure 8.3), considerably less than the growth in the student intake (19% as shown in Figure 8.2). While the out-turn of Ph.Ds has remained stagnant, the out-turn of PGs (M.Tech. + Dual Degree) has risen by 15.4%. The growth in UG output has been even lower at 9.5%. However, there are differences across IITs (Figure 8.4).



	1999-00	2000-01	2001-02	2002-03
Doctoral	450	454	395	431
Dual Degree, Integrated	73	64	190	187
PG	3111	3276	3458	3488
UG + Preparatory	2077	2203	2313	2274
TOTAL	5711	5997	6366	6380

Figure 8.3: Growth in IIT student output between 1999-2003



	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Doctoral	74	85	39	108	48	69	8
PG	634	775	385	510	530	583	71
Dual Degree, Integrated	110	53	24	--	--	--	--
UG + Preparatory	293	337	370	432	361	383	98
TOTAL	1111	1250	818	1050	939	1035	177

Figure 8.4: Student output of individual IITs (2002-03)

8.4 KEY FEATURES & POSSIBLE IMPROVEMENTS IN THE EDUCATION SYSTEM

We have here assembled key features of the educational system of the IITs. From such a PAN-IIT consideration, certain aspects requiring focused attention arise. These are:

(i) Degrees offered and the Disciplines in which they are offered

(ii) Number of Courses offered by each Institute

(iii) Definition of Credit and Credit Requirements for B.Tech. and M.Tech. Dual Degree

(iv) Science and Humanities & Social Science Components in the B.Tech. and M.Tech. Dual Degree programmes

(v) Research component in the B. Tech. Degree Programme

(vi) Continuation of the M.Tech. Dual Degree Programme?

(vii) Introduction of a New 4 year B.Tech. programme for B.Sc. graduates

(viii) Undergraduate Courses in Science in the IITs

(viii) Academic Units in the IITs

(ix) Continuing Education Programme

We will take up each of the above items and see what improvements may be possible.

8.4.1 Degrees offered and the Disciplines in which they are offered

Table 8.1 shows the different types of degrees offered by the IITs. The number appears to be large and with a little effort it can be rationalized to a more meaningful list. Just to give a few examples, the B. Design can be renamed B.Tech. (Design); the Master of Management, Master of Business Management and Master of Business Administration offered at different IITs can have a common nomenclature. The P.G. Diploma can be renamed as D.IIT like the D.IIT being conducted for the Navy in IITD and for Video Communication in IITK.

Table 8.1: Total number of Degrees offered

Degree	No. of Disciplines						
	IITM	IITD	IITG	IITK	IITKGP	IITB	IITR
B.Tech.	10	9	6	8	16	8	9
B. Arch.	-	-	-	-	1	-	1
B. Des.	-	-	1	-	-	-	-
M.Sc. (5 year Integrated)		-	-	3	5	1	-
M.Sc. (2 year)	3	3	3	4	5	6	6
M.Tech. Dual Degree	13	5	-	6	15	7	3
M.Tech.	26	36	4	13	46	16	38
Integrated M.Tech.	-	1	-	-	-	-	-
M. Des.	-	1	-	1	-	-	-
M. Arch.	-	-	-	-	-	-	1
M.S. (Research)	10	6	-	-	-	1	-
M.Phil.	-	-	-	-	-	1	2
M.B.A	1	3	-	1	-	-	1
Master of Management	-	-	-	-	-	1	-
M.B.M	-	-	-	-	1	-	-
M. Medical Sci.& Tech.	-	-	-	-	1	-	-
M. City Planning	-	-	-	-	1	-	1
D.I.I.T.	-	1 (for Navy)	-	1 (Video Comm.)	-	-	
P.G. Diploma	-	-	-	-	2	-	7
Ph.D.	13	26	11	18	30	21	19
M. Sc.– Ph. D. Dual Degree	-	-	-	1	-	-	-
Integrated Ph.D.	1	-	-	-	-	-	-

Table 8.2 shows that there also exists scope for rationalization of the disciplines in which the degrees are offered. Just as an example, B.Tech. degree is offered in Materials and Metallurgical Enginneing in IIT Kanpur, while Metallurgical and Materials Engineering is offered in IIT Madras, IIT Kharagpur and IIT Roorkee. The disciplines bracketed in Table 8.2 may also be seen in this context.

In regard to the Masters courses as well, there is similar scope for rationalisation (PG admission brochures of the IITs may be referred to for the full list of disciplines).To cite one example, there are two 5 year M.Sc. Integrated courses, one in Mathematics and Scientific Computing (IITK) and another in Mathematics and Computing (IITKGP). In addition, there is a 5 year Integrated M.Tech.course in Mathematics and Computing (IITD).

A common nomenclature for B.Tech., as well as Masters courses, can be arrived at to avoid the impression that each of these disciplines offers something very distinct.

Table 8.2: Disciplines in which B.Tech. Degree is offered (including B. Design)

Discipline	Degree Offered						
	IITM	IITD	IITG	IITK	IITKGP	IITB	IITR
Aerospace Eng.	•		•	•	•		
Agriculture and Food Eng.					•		
Biotechnology and Biochemical Eng.					•		
Biotechnology	•		•				
Chemical Eng.	•	•	•	•	•	•	•
Civil Eng.	•	•	•	•	•	•	•
Computer Sci. & Eng.	•	•	•	•	•	•	•
Design			•				
Electrical Eng.	•	•		•	•	•	•
Electrical Eng. (Power)		•					
Electronics & Communication Eng.			•				•
Electronics & Electrical Comm. Eng.					•		
Energy Eng.					•		
Engineering Physics*	•	•				•	
Industrial Eng.					•		
Production and Industrial Eng.		•					•
Instrumentation Eng.					•		
Manufacturing Sci. & Eng.					•		
Mechanical Eng.	•	•	•	•	•	•	•
Materials & Metallurgical Eng.				•			
Metallurgical & Materials Eng.	•				•		•
Metallurgical Eng. & Materials Sci.						•	
Mining Eng.					•		
Naval Architecture & Ocean Eng.	•						
Ocean Eng. & Naval Architecture					•		
Pulp & Paper Eng.							•
Textile Technology		•					

* In essence this is an undergraduate science degree.

8.4.2 Number of Courses offered by an IIT

Table 8.3 shows the number of courses offered by each institute at the undergraduate (UG) and post-graduate (PG) levels every year. The number varies for the different IITs depending upon the number of departments and programmes offered by the individual IIT. It has been indicated that not all the courses are offered in any given year. **Analysis of the list of courses in the IITs suggests that a reduction in the number of courses would be possible through rationalisation of obsolete courses and consolidation of overlapping courses** (for example, Finite Element Methods, Fluid Mechanics, Heat and Mass Transfer and Advanced Engineering Thermodynamics) **offered in the different departments in each institute.** This would release more time for the faculty for research and other more creative activities. If research (including research based teaching) has to occupy primacy, every aspect of the IIT teaching load has to be examined from the viewpoint of getting them more time and energy for research.

Table 8.3: Total number of Courses offered in a year

	UG	PG	Total
IITB	533	552	1085
IITD	639	829	1468*
IITG	340	130	390**
IITK	425	334	759
IITKGP	1437	1540	2977^
IITM	503	542	1045
IITR	422	950	1372

* 210 courses are common between UG and PG

** 80 courses are common between UG and PG

^ All possible electives are considered

8.4.3 Definition of Credits for B.Tech. and M.Tech. Dual Degree

Considering that, in the mind of the public, IITs constitute one educational system of high brand value and visibility, and that admissions are made through a common entrance examination (JEE), it is logical to expect that this system functions by certain common guidelines so far as organisation of certain basic elements are concerned. While this is largely so, definition of a credit and the credit requirements for the award of B.Tech. and M.Tech. Dual Degrees show differences. This is illustrated in the analysis of the credit requirements for the B.Tech. and M.Tech. Dual Degrees presented in Tables 8.4 and 8.5. One major reason for this is that the definition of a credit in IIT Mumbai and in IIT Guwahati is different from that in the other IITs. IITs should consider having a uniform definition of a credit, as indeed 5 of the 7 IITs do have (1 credit for 1 hour Lecture or 1 hour Tutorial or 2 hours of Laboratory, all per week).

Table 8.4: Credit requirements for B.Tech. Degree

Subjects	No. of Credits						
	IITM	IITD	IITG^	IITK**	IITKGP	IITB^	IITR
Basic Science	31	20 min	64	35 (28)	24	62	27
Humanities	12	15	30	15 (16)	14	18	16
Professional Courses including Departmental Electives	93	90	155 ±	90 (90)	73-81	213	102-110
Engineering Science	15	20 min	40 ±	20 (10)	27	—	35
Non-Departmental Compulsory Subjects and Electives	18	25 min Typically 31-35	36 ±	-	15	12	12
Projects + Practical Training	11	10-13*	28 ±	(15)	12	20	14*
Others	-	-		(9) (Tech. Arts)	-	-	14 (Extra Curr.)
Total	180	180	340-360	180(168)	165-173	325	206-214

* These credits are included in the credits for Professional Courses
^ The method of calculation of credits is different from that of the other five IITs
** The figure in the bracket indicates the credits for 2004

Table 8.5: Credit requirements for M.Tech. dual Degree

Subjects	No. of Credits						
	IITM	IITD	IITG^	IITK**	IITKGP	IITB^	IITR
Basic Science	31	20 min	-	39 (28)	24	62	27
Humanities	12	15	-	25 (16)	14	18	16
Professional Courses including Departmental Electives	87	78-80	-	90 (90)	99-109	235	94-102
Engineering Science	15	20 min	-	20 (10)	31	--	35
Programme Core	19	48-50	-	36-40 (32)			16-24
Non-Departmental Compulsory Subjects and Electives	18	25 min Typically 31-35	-		12	12	12
Projects + Practical Training	20	20-23*	-	(32)	37	108	40-44
Others	8	-	-	(14) (Tech. Arts)	-	-	14 (Extra Curr.)
Total	210	180	-	216-220	217-227	435	254-270

* These credits are included in the credits for Professional Courses
** IIT Guwahati does not offer M.Tech. Dual Degree
^ The method of calculation of credits is different. Two credits here correspond to one credit in other IITs

8.4.4 Science Component in the B.Tech. and M.Tech. Dual Degree

The break-up of the credit requirements of the B.Tech. and M.Tech. Dual Degree programmes (Tables 8.4 and 8.5) shows that the Science component ranges from 11 to 19 % of the total credit requirement. The Science (including mathematics) content of the earlier five-year B.Tech. programme was about 20 to 25 % of the total credit requirement. Thus, the Science content in the IIT Engineering curriculum has undergone a reduction after the transition from the five-year to the 4 year B.Tech. programme. Modern engineering developments are increasingly being triggered by advances in science and by the use of mathematical approaches. Consequently, modern engineering education will have to be more and more science based. Professor Dutta Roy of IIT Delhi in his article in Current Science [Volume 78, No.10, 25 May, 2000, p 1183 - 84] has succinctly brought out the importance of science in the engineering curriculum. As he aptly puts it, it is essential to increase the science content in order to motivate and prepare bright graduates for engineering design, research, development and innovation. Emphasis on science and enhancing its content in the IIT B.Tech. and M.Tech. credit composition needs to be given serious and urgent attention.

For the admission test (JEE), the composition of basic subjects has included only Physics, Chemistry and Mathematics; Biology has not been a component so far. In making this observation, the introduction of Biotechnology in the IITs is set aside, which is a separate issue, albeit a welcome development. **Considering the emergence of Biology as a key field in recent years and its links to biotechnology, bioinformatics, artificial intelligence, neural networks, genetic engineering etc., it has become essential to accord a place for biology alongside Physics, Chemistry and Mathematics in the IIT B.Tech. programme.**

8.4.5 Humanities and Social Sciences (HSS) Component

The break-up of the credit requirements of B.Tech. and M.Tech. Dual Degree programmes (Tables 8.4 and 8.5) also shows that the Humanities and Social Science (HSS) component ranges from 6 to 9% of the total credit requirement. The five-year to four-year transition has had its negative effect on the HSS component as well.

Several employers have observed that the communication skills and societal awareness of the four-year B.Tech. graduates are not commensurate with their technical skills. The importance of reversing this trend cannot be overemphasized. Ignoring the importance of HSS education can place at risk technical leadership that is increasingly graining prominence, within our own country and on the world stage. Language skills, genuine awareness of all that the term humanities comprises (also known as liberal arts) and the cultural-ethical dimension of our own country in a world-perspective are all to be assimilated at an impressionable age alongside technical education. It has become imperative, therefore, to re-examine the Humanities and Social Science component in the B.Tech. and M.Tech. curricula, including their contents.

8.4.6 Research Component in the B.Tech. Degree Programme

Having inducted a select lot, it seems imperative that they are exposed to a flavour of research at an early age. This step is likely to have a positive influence on those inclined to opt for a career in research, an important need of the hour for our country's competitiveness. When opportunities and encouragement are provided, even during the course of the B.Tech. programme, a bright undergraduate can come out with a creditable publication. If these were to happen frequently, it will contribute significantly to enhance the research culture on campus.

It would be most desirable to introduce credit-based project work in the 2nd year to be taken forward in the 3rd and the 4th years.

IIT Delhi (may be some others as well but not all IITs) is operating a non-credit Summer Undergraduate Research Activity (SURA) in which the students work out a research problem of their interest under the supervision of a faculty member. This is yet another mechanism to encourage research involvement in the undergraduates. In this context, **it should be heart warming to note the invariably excellent performance of the IIT undergraduates who take up summer fellowships awarded by the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore. This latent research potential needs to be tapped in the IIT 4 year programme from an early stage as suggested.**

8.4.7 Continuation of the M.Tech. Dual Degree Programme?

Several senior academics have observed that the Dual Degree programme is constrained by the existing B.Tech. and M.Tech. programmes. There appears to be substance in their observation. The break-up of the credit requirements of the Dual Degree and B.Tech. programmes is provided in the (Tables 8.4 and 8.5). Notice that the number of credits for Science or for Humanities & Social Science (HSS) has remained the same in the two programmes. The original idea of restoring the 5 year science or HSS contents in the 5 year dual degree has not materialised. The only difference between the Dual Degree and B.Tech. appears to be a few extra P.G. courses and a larger Project work component in the 5th year of the former than in the B.Tech. course. This suggests that the Dual Degree programme by and large has not served a greater academic purpose (when compared to the 4 year B.Tech. + 2 year M.Tech. system) and may have incidentally facilitated the entry of lower ranked students who could not make it to the B.Tech. programme of their initial choice. There definitely is a case for redesigning the whole course or scrapping it altogether in favour of a new M.Tech. programme suggested below.

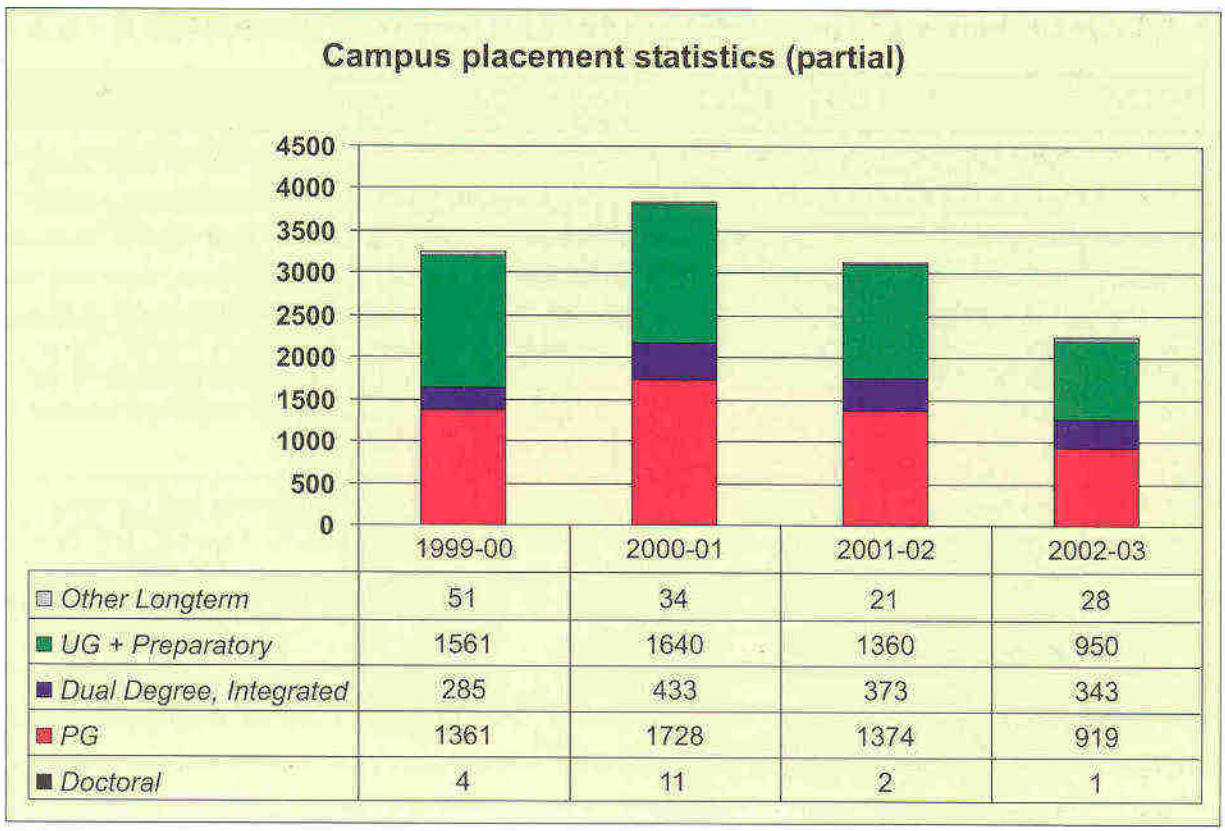
8.4.8 Introduction of a New 4-Year M.Tech. Programme for the B.Sc. Graduates

A better scheme could be to introduce a 4 year M.Tech. option for B.Sc. graduates. In our country, about 15-16 lakh B.Sc. students graduate every year. It is heart-rending to see them groping for good career prospects, with several of them ending up as technicians. A JEE type all India examination can be conducted to select the best say 1000 (about 150 in each of the 7 IITs at the rate of 30 seats in 5 such 4 year M.Tech. programmes). The selectivity for the M.Tech. admission could thus go up significantly. Improving selectivity in M.Tech. admission can be expected to make a significant difference to the quality of PG intake. The need for this exists since PG placement in campus interviews has been consistently below that of the UG placement (Figure 8.5).

Institutes with higher output (primarily due to higher PG output) show greater difference between UG and PG placement (Figure 8.6)! Greater proportion of UG students get placed compared to PG. This points to the widening gap between UG and PG quality, especially at higher outputs.

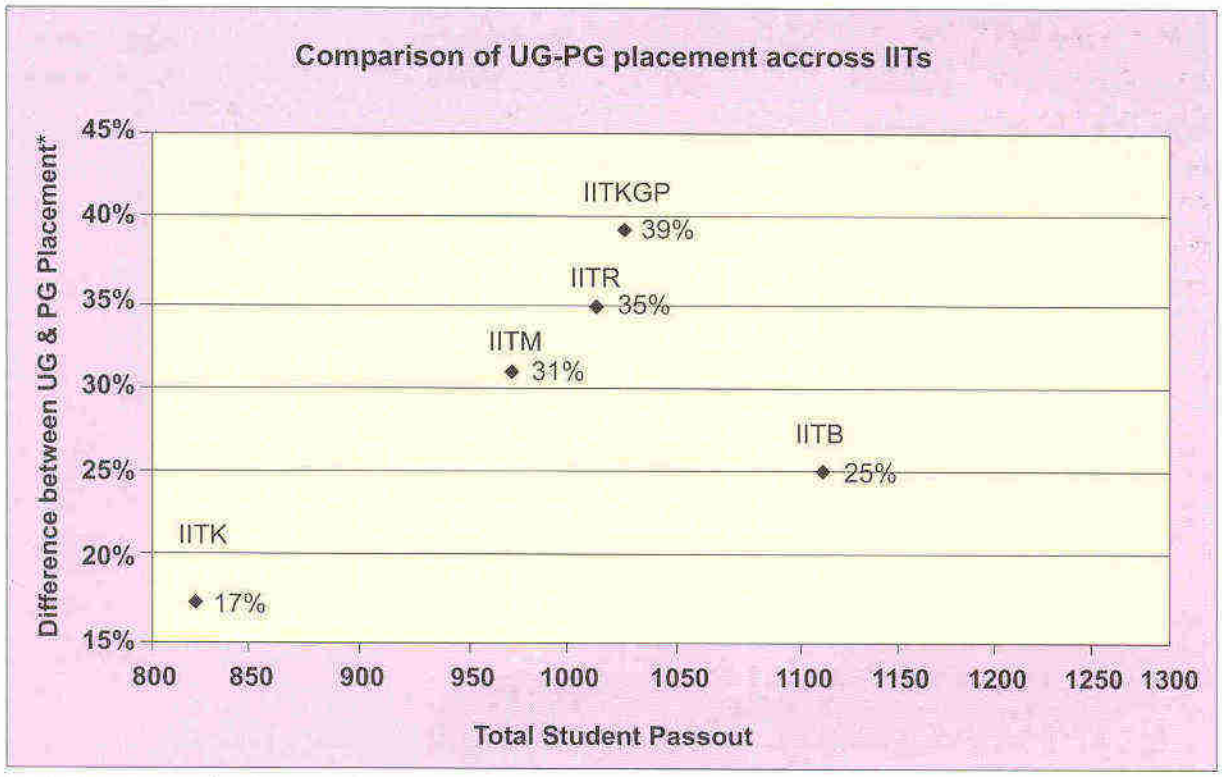
There is yet another notable point in favour of taking in the B.Sc.s, as suggested. These students would enter the IITs with a strong science base, whose value has been pointed out in the earlier paragraphs. Further, B.Sc.s with biology as their main subject would also see a new avenue for an engineering career. These graduates with their strength in science would be good material for pursuing an engineering research career and more.

The Indian R&D based industrial scene presents, as of today, an uneven picture. For example, chemistry and chemical engineering related industry has done significantly better than physics-based industry. Encouraging B.Sc.s to opt for M.Tech. in IITs would be a helpful measure for generating a greater number of well trained personnel with such composite background. This, hopefully, will add to the prospect of wider science and R&D based industry to grow and thrive in the country. (See Table 8.6 annexed for pros and cons of this suggestion).



	1999-00	2000-01	2001-02	2002-03
Other Longterm	51	34	21	28
UG + Preparatory	1561	1640	1360	950
Dual Degree, Integrated	285	433	373	343
PG	1361	1728	1374	919
Doctoral	4	11	2	1

Figure 8.5: Campus placement statistics (partial)



* %UG placed/UG passed out - % PG placed/PG passed out

Figure 8.6: Comparison of UG-PG placement accross IITs

Table 8.6: Pros and Cons of the proposed 4-year M.Tech. Programme after B.Sc.

Sl. No.	PROS	CONS
1.	B.Sc. level science base for potential engineering graduates	The social pressure of getting into an engineering programme after 10+2 could dilute to some extent the bright elements for this programme
2.	Will significantly improve the career prospects for the bright B.Sc.s among the 15-16 lakh graduates each year and offer IIT opportunity to late bloomers	To conduct a JEE type examination for the B.Sc.s will be additional burden on the IIT faculty. This has to be avoided. The solution will be to outsource the conduct of the examination to a carefully selected body with close monitoring.
3.	The brightest of the B.Sc.s can be picked up for the 4 year M.Tech. programme by designing and conducting a JEE type examination for the B.Sc.s.	Designing an appropriate 4 year M.Tech. curriculum, with a substantial project element, will be a challenging academic exercise.
4.	Selectivity in the M.Tech. admission, today being low at 15:1 (compared to better than 50:1 for the B.Tech.s.), is bound to go upto something comparable to B.Tech. selectivity.	Additional infrastructural requirement will have to be met.
5.	Will allow students with B.Sc. Biology to pursue a career in engineering	This will lead to scrapping the current 5 year Dual Degree programme as well as the integrated Masters programmes which may have lost their attractiveness. This becomes necessary to eliminate avoidable burden on the faculty.
6.	Most likely that B.Sc. + M.Tech. experience would encourage such engineering graduates to stay in research which is essential for advanced technology programmes. More such well trained personnel would be a resource for science and R&D based industry.	
7.	The trauma of not getting into the IIT system in those large numbers failing to make the required JEE grade will be mitigated to a significant extent.	
8.	The success of the 4 year M.Tech. programme is likely to have a positive impact on the quality of B.Sc.s. in the country.	

8.4.9 B.Sc.s for Integrated Ph.D. Programme.

There could be another good use for the suggested JEE type examination for the B.Sc. students. IITs could introduce an integrated Ph.D. programme in science, engineering and interdisciplinary areas for the carefully selected B.Sc. students. The Indian Institute of Science has introduced such an integrated Ph.D. programme for the B.Sc. graduates who are carefully selected. The IISc Ph.D. programme for the B.Sc. graduates is in the science subjects (Physics, Chemistry, Biology and Mathematics). Based on the happy experience with this experiment at the IISc, IITs could extend the concept to include Ph.D. in engineering subjects as well for select B.Sc. graduates.

The Committee considers suggestions made in sections 8.4.8 and 8.4.9 to be among its more important recommendations.

8.4.10 Undergraduate Courses in Science?

Undergraduate courses in science (B.Sc. courses) are conducted and managed in the country's numerous colleges (nearly 14000). In most of these colleges, research in basic science subjects is non-existent. Nor is there any room for educating the young students about application of science. There is no sign of a reform of this unsatisfactory situation. It has been suggested that it will signify a major corrective step if IITs decide to impart undergraduate science education alongside engineering education. The examples of MIT and CALTECH in USA are mentioned since the success of their products are attributable to science going together with engineering. Even though undertaking bachelors level science degree courses will require expanding the science departments in the IITs, the overall effort needed for this added programme may not be considerable. The Committee is recording this suggestion which demands a greater in-depth consideration. In this context, it may be noted that three of the IITs, namely IIT Mumbai, IIT Delhi and IIT Chennai, have recently started B.Tech. courses in Engineering Physics.

8.4.11 Academic Units

An analysis of the various academic units in the IITs (Table 8.7) indicates that they essentially consist of Departments and Centres. However, some IITs have introduced the concept of Interdisciplinary Programmes and/or Schools as distinct units. It is clear what constitutes a department. However, it is not clear when a unit is called a Centre, an Interdisciplinary Programme or a School in the IITs. There is also no consistency in the faculty strength in centres (Table 8.8).

Table 8.7: Total number of independent Units

IIT	Depts.	Centres	Schools	Int. Disci. Programmes
IITB	12	10	3	5
IITD	13	9	8	0
IITG	11	0	0	0
IITK	13	0	0	4
IITKGP	19	4	5	0
IITM	13	4	0	0*
IITR	18	4	0	0

Table 8.8: Faculty strength in Centres

	IITB	IITD	IITG	IITK	IITKGP	IITM	IITR
Faculty in Centres	24	118	0	8	39	0	32

IIT Delhi has evolved an organizational concept paper, which attempts to give precise definitions of the unit. This issue needs to be revisited by the IITs. **While doing so, IITs would do well to put into effect the trends in emergence of new disciplines.** Interdisciplinarity has yielded to borderlessness. **Breaking down of the compartmentalisation of disciplines has assumed importance.** Possibilities of flourishing new research directions at the interface between disciplines are being increasingly explored. The question then boils down to the following. **In what manner should one allow regrouping and coming together of disciplines so as to encourage research at potentially promising interfaces between subjects?** This is yet another academic challenge that needs to be addressed. **In addressing this challenge, the IITs would be well-advised to consider programme based academic structures, while perhaps retaining the Departments as administrative units.** Recently, IITM has developed 15 or so interdisciplinary programmes.

8.4.12 Continuing Education Programmes

Table 8.9 shows that the IITs conduct several short-term courses and Quality Improvement Programmes (the number ranging from 5 in IITG to 156 in IITB). There can be no two opinions about the importance of such courses. With faculty of the calibre that the IITs have, the general expectation is that they have a duty to help other institutions and industry personnel to raise their own standards. However, the following points are important in this context.

Table 8.9: Continuing Education Programmes (2002-2003)

IIT	Short Term Courses	Quality Improvement Programmes	Total
IITB	148	8	156
IITD	21	3	24
IITG	5	0	5
IITK	18	6	24
IITKGP	50	4	54
IITM	30	5	35
IITR	15	7	22

- The core function of the IIT faculty is to be engaged in advanced research and deliver advanced teaching courses. Other distractions have to be minimized if these core contributions have to be made at the highest academic level.
- The need for the above idea is accentuated when viewed in the context of the urgent necessity to impart momentum to advanced research in engineering and technology in the country.
- Engagement in continuing education programmes has to serve a larger purpose than merely training. Therefore, in this respect, IITs have to be involved with such industrial houses as are capable of adding significant assets to the IITs in the form of cooperative projects in new areas and in other ways (this has indeed happened in certain cases).
- The topics for the training courses and the target groups need to be chosen with incisive thinking so that there is value addition to the IITs as well, while the industry and other groups benefit from the IIT strengths.
- Continuing education programmes may be warranted where it serves a larger country or societal purpose.
- If a particular short term course does not meet the above criteria (or other such criteria arrived at by the IITs), they are best dropped from the IIT portfolio.

8.5 SUMMARY OF RECOMMENDATIONS

The main points brought out in this chapter are as follows:

(i) The nomenclature of the degrees could be rationalized, so also the disciplines in which the degree courses are offered at the B.Tech. and M.Tech. levels.

(ii) The definition of a credit attached to a given course may be revisited to avoid confusion that it may be causing to the outsiders, where there are differences among the IITs.

(iii) The total number of courses (B.Tech. + M.Tech.) appears very large. There is room for consolidation by exiting outdated courses and eliminating overlap.

(iv) The science and HSS content in the B.Tech. courses deserve to be enhanced.

(v) Research project (could be design centric or even business centric, besides basic research, depending upon the inclination of the student) should be introduced at the 2nd year stage to be taken forward through the 3rd year and 4th year of the 4-year B.Tech. programme.

(vi) The academic value of the 5-year dual degree programme should be reevaluated. Dropping this programme in favour of a new suggested M.Tech. programme deserves serious consideration by the IITs.

(vii) A new 4-year M.Tech. programme for the carefully screened in B.Sc. graduates has been recommended. A small number of select candidates from such screening process may be taken through an integrated Ph.D. programme.

The new M.Tech. programme cannot be introduced unless some of the others like the integrated Masters programme (integrated M.Sc and M.Tech. which may have in any case lost their attractiveness) are dropped. This will help IITs to consolidate essentially in terms of 4-year B.Tech., 2 year M.Tech. and the new 4-year M.Tech. for B.Sc.s, thereby easing the burden on the faculty, too.

(viii) The academic structure of the IITs may be freshly considered to achieve a shift towards programme based units.

(ix) The volume of continuing education programmes as well as the rationale for taking them up need a fresh look.

An attempt has been made here to offer a few suggestions, which in the Committee's view, will not only streamline the functioning of the IITs but also, in the long run, improve the quality of IIT education. It was not the objective of this Committee to attenuate the autonomy, which the IITs should continue to enjoy, but to look at various issues in a detached manner and in the context of the present trends. Eminent universities such as the University of Illinois, UC and the others have welcomed the observations made by a body such as ABET (Accreditation Board for Engineering and Technology) in the US. For the IITs, we do not envisage an externally formed committee. However, It is strongly suggested that a **PAN-IIT Committee of Academics** should be set up to give due consideration to the observations made here at the earliest. Decisions made thereby should be implemented expeditiously. Time is of the essence in the face of the galloping pace at which science and technology are undergoing changes in their texture.

CHAPTER NINE

THE UNDERGRADUATE ADMISSION PROCESS: JEE

"If you study to remember,
you will forget,
but if you study to understand,
you will remember"

Unknown Author

CHAPTER NINE

THE UNDERGRADUATE ADMISSION PROCESS: JEE

The Joint Entrance Examination (JEE) conducted jointly by the Indian Institutes of Technology is unarguably the most prestigious competitive science examination in the country. The way, year after year, thousands of final year school children prepare for and take to the test coveting the IIT admission can only be described as a phenomenon. **JEE has thus become the flagship of the IITs.** What are the general perceptions about the JEE? Is there a need for any reforms in this aspect? These issues are discussed in this chapter.

9.1 PERCEPTIONS

The reputation of the JEE is based primarily on the strikingly clean image that JEE has in the public perception. This reputation is fully deserved. In an examination that has currently more than 1,80,000 boys and girls competing for a mere 3,500 or so most sought-after seats for the 4-year engineering degree, there has never been a public scandal. The standards of probity and confidentiality in the conduct of the examination have been impeccable.

However, the nature of the examination is not widely appreciated. In our widespread consultations, the following points emerged:

(i) The level of the examination is not appropriate for the candidates who are completing the X+2 stage of their education. In fact, the level is so high that most candidates undergo a very strenuous regimen of coaching, which now spans, in some cases, over more than four years. This places undue, and perhaps undesirable, burden on the school-going youngsters.

(ii) The need for intensive coaching is having a deleterious effect on the education being imparted in senior-secondary schools and junior colleges. It has come to be commonly understood that preparing for the school examinations does not prepare a student for JEE. Therefore, students who are serious about JEE skip regular school to work on the assignments given by the coaching schools. Schooling is not just about learning academic skills. Schooling is for education and education is imbibed as much in the classroom as on the playing fields and through the pursuit of intellectual co-curricular activities. Social interactions, which prepare a person for life, are founded at school. If children do not go to school, or if school ceases to fulfil its historical functions, society loses.

(iii) Howsoever valid may the reasons for introducing the screening test be, the fact is that it, too, imposes an unacceptable burden on the already hassled candidates aspiring to get into the IITs.

The Committee believes that it should be possible to conduct the entrance test at a level which is suitable for the candidates at the school-leaving stage which, at the same time, will be able to discriminate the deserving from the non-deserving candidates. A very tough examination is probably never a good examination, since it encourages among the candidates a tendency to prepare for strategies to answer tricky problems. It appears that the more such problems that a student knows, the more acceptable he is to JEE. The coaching establishments do not educate; they break up the

material into little modules that consist of various problem types and the student learns to recognize and deal with hundreds of such problems types. Understanding of the concepts, obviously, has nothing to do with it. Consequently, it has been observed that, compared to the earlier years, coached students in recent years seem less motivated to learn.

9.2 SUMMARY OF RECOMMENDATIONS

(i) **The system that has been put in place for the conduct of the JEE should not be disturbed** as it has evolved, over the years, to be among the best entrance examinations at that level. This is recognised internationally and nothing should be done to interfere with it.

(ii) Among the most experienced members of the IIT faculty who have been associated with the JEE, a group should be constituted to go into the **following reforms:**

- **The candidates are admitted on the basis of one examination only,** as was being done for nearly 40 years since inception up to the year 2000 (In the year 1999, 1, 12, 347 candidates took only one admission test. When the screening test was introduced in the year 2000, the number registered for the test was 1, 22, 205).
- Although about 3500 successful candidates are admitted to the 7 IITs, now-a-days the results of candidates upto the rank of 4600 - 4700 are announced as qualified. This has helped other institutions, namely IIIT Allahabad, IIIT Gwalior and NIFTT Ranchi, besides IT BHU and ISM Dhanbad, to admit the remaining candidates into their own colleges. Since this has benefited a few other institutions, it may be considered whether even lower ranks upto 8000 may be announced in a similar way, even if more IITs are not set-up. This will facilitate NITs and other engineering colleges to take in students from the JEE list, **since the differences in the secured marks are not very significant even if the rank is as low as 8000.**
- **The level of the examination is made suitable** for what can reasonably be expected of a bright school-leaving child **without the need for intensive coaching outside of what the school curricula prescribe.** As has been envisaged, the purpose is to screen inherently gifted candidates capable of thinking on their own. Such students can be expected to have the right aptitude for higher levels of education and research.
- **A standing group be constituted to carry out research into the nature of the examination** to serve the purpose for which the JEE is famed the world over. **This group may also aim at transiting to an electronic web-based examination in a 3-year time frame.**

(iii) The reservations for SC/ST and the handicapped categories should be honoured. IITs have evolved methodologies to increase the intake of SC/ST category students. This has been done by appropriately lowering the cut-off level for clearing the JEE. The IITs have also introduced a one-year preparatory programme for those unable to clear the JEE even with the reduced cut-off. Those who complete the preparatory programme successfully are admitted to the regular programme without having to appear in the JEE again. If these practices at IITs are supplemented by help to the SC/ST students at their school-stage, the number of SC/ST candidates getting into the IIT system will further improve.

CHAPTER TEN

EXPANDING THE IIT BRAND THROUGH INTELLECTUAL PROPERTY RIGHTS

"The patent system has added fuel to the fire of knowledge"

Abraham Lincoln
(1809-1865)

CHAPTER TEN

EXPANDING THE IIT BRAND THROUGH INTELLECTUAL PROPERTY RIGHTS

Chapter 7 discussed the need and ways to enhance research in the IITs. This chapter will pay attention to IITs taking that extra step of translating their creative skills into practically useful innovations.

10.1 THE BACKGROUND

The General Agreement on Tariff and Trade (GATT), an international treaty to promote trade and economic benefits, was signed in 1947. During the Uruguay round of its negotiations in the year 1994, a decision was taken to form the World Trade Organisation (WTO). The WTO has brought about radical changes in the world's intellectual property regime and has activated worldwide the spirit of competition where it was dormant and intensified it where it existed already. In the face of this major international political development, changes have become inevitable in the approaches to S & T research and development. Knowledge production has spread beyond the realm of the academic institutions and has engulfed industry, national laboratories, non-governmental organizations and even individuals.

One of the radical changes in the IPR regime due to the WTO is the transition from process to product patent. The quickest response to the new regulations has come from the pharmaceutical industry in India. Between 1995 and now, the investment by the private pharmaceutical sector in R&D has risen more than five-fold. Major pharmaceutical companies like Dr. Reddy's Labs and Ranbaxy (just to name two examples from among several other companies in this sector) have undertaken substantial *ab initio* research ventures aimed at discovering new molecules with potential for their development as novel therapeutic drugs. In the changed context, these companies have also hired personnel with advanced research degrees like Ph.D. in larger numbers. Thus, the pharmaceutical sector in the Indian industry may be said to have blazed a new trail in this country to take on the challenges posed by the WTO. Among the national laboratories, the CSIR took the lead in imparting a major thrust toward the new patent regime. Their laboratories have not lost much time in coming up with their response and have steadily improved on their record of patents. In the current year, the CSIR has a proud basket of nearly 200 US patents.

However, the response of the academic institutions in India has not been impressive. In fact, even an awareness about establishing IPR does not exist among a majority of scientists. The Department of Science & Technology (DST) and the Department of Scientific and Industrial Research (DSIR) have played a facilitating role in bringing about awareness of the importance of patents and intellectual property asset generation and its protection. This has resulted in an attitudinal change as shown in Table 10.1.

Table 10.1: Patent applications by educational institutions*

Year	No. of patent applications by IITs & IISc	No. of patent applications by Universities & Institutes other than IITs & IISc	Total No. of patent applications
1995	31	4	35
1999 - 2001	137	99	236
2002	46	33	79

*Source: Patent Facilitating Centre, TIFAC, DST, New Delhi.

Prior to 1995, the total number of patent applications from the academic institutions was abysmally low and it stood at 35 for the year 1995 and the bulk of it was from the IITs & IISC. During 1999-2002 the first signs of changes were observed. The total from the academic institutes, which was hitherto 30-40 patents per year has roughly doubled. The number of patent applications from the IITs & IISc has increased, as may be noted from the data for 2002, so also the performance of non-IITs/IISc. **From the data collected by this Committee, the cumulative number of patent applications from the IITs as of March, 2003 stood at 166**. There is so much room here for the IITs to show their innate strength.

Poor patent production may be a reason why IITs have not been able to participate in or span powerful industrial clusters or innovation networks. Research into industrial clusters and innovation networks in USA (Silicon Valley, Massachussetts Route 86, California Wine Growers, life sciences), in Europe (Finland-Nokia, Italian districts), in Israel and so on has shown that top class universities can play a strong role in promoting and sustaining such clusters. For universities to be part of such networks, they need to compete with other institutions in industrial cluster/network for research funds and success critically depends on the ability of universities to convert research into intellectual property.

Thus, it is imperative that IITs develop a strong focus on intellectual property creation. By demonstrating their ability to translate research into innovations, IITs will become an invaluable resource to augment competitiveness of the Indian industry. **Highly competitive global economy is fundamentally dependent on innovation which, in turn, requires a strong science based engineering and technology system of schools. IITs are just that and, therefore, as a powerful academic system, have the onerous duty to add substantially to India's stature in international fora by generating a large and worthy patent portfolio. This will also show the way for students to become entrepreneurial.**

Some steps have been taken by IITs in this regard within the current structure of the Industrial Consultancy and Sponsored Research divisions. However, intellectual property creation, protection and its management require broader institutional change – they call for a more specific Intellectual Property System. The rest of the chapter discusses the issues pertaining to intellectual property creation in IITs and the design of an institutional model to address the same.

(United Nations have just released a report entitled *Innovation: Applying Knowledge in Development.* The UN report provides examples of countries which have been able to combine their science and technology policies with industrial policies into a comprehensive innovation policy).

10.2 FACTORS INHIBITING IP ASSET CREATION

Publications in internationally recognized journals have been the overarching criteria for determination of an individual's performance in academic institutions all over the world, so also in our country. Publications in prestigious journals and the quantum of citation of important papers have been the barometer of excellence in research. The IITs are not an exception to this rule. No wonder, therefore, that in the last 5 decades since their inception, the portfolio of intellectual outputs of IITs did not have a significant component of patents and generation of intellectual property rights with a commercial vector, as reflected in the data presented above.

With publishing scientific papers in technical journals having become a cultural feature among the academics, every research scholar experiences this pressure and is automatically trained and ground soundly in that activity right from his student days. As a result, no researcher depends on anyone else to convert his results and thoughts into a publishable document. However, this is not the case with the documentation of patents. What are then the issues related to patents?

(i) preparing a document for filing a patent requires assistance from other areas of expertise, principally legal;

(ii) the patenting process is expensive and time consuming;

(iii) IP asset creation encompasses, besides the patent, a host of other issues such as copyrights, trademarks, regulatory clearance/approval and design registration.

(iv) it is further complicated by the requirement of management of the patent(s) involving renewals, shared ownership, contracts, agreements, licensing, reassignment, infringement, damages, liabilities, indemnities etc.,

(v) there is no clear career incentive at the present time and

(vi) the financial returns are not assured in a reasonable time-frame.

Thus, the patenting process goes far beyond the principal act of inventing and the individual is less likely to take on the overall burden, that too without any incentive in sight. We have, therefore, to do as much as possible, first of all, to minimize the burden on the inventor and secondly to create a system of incentives.

While it is natural to compare the activities associated with patenting with those pertaining to a research publication, history of discoveries shows that the process of innovation and inventing need not be restricted to erudite researchers alone, but can extend to students, non-teaching as well as non-technical staff and even housewives. The analytical framework (discussed in

Chapter 2) suggests that the total available pool in the IIT system extends beyond the faculty, research scholars and others to those coming into contact with the system through various other avenues such as contractual arrangements and sponsored research. The drive towards patents should thus motivate the different segments of the IIT community. This requires a culture of its own which needs to be nurtured.

10.3 INSTITUTIONALISING AN IP SYSTEM

The potential for reaping the economic benefits of new and original knowledge is immense and IP asset creation is a strategic tool for achieving global competitiveness. The IITs have to mandate themselves to play a crucial and a leading role in the national IP asset creation. The primary mandate of the IITs being quality engineering and science education and research, it is necessary that the IP asset creation is dovetailed into the existing process of research outputs, including B.Tech., M.Tech. project dissertations, the Ph.D. thesis and the research publications. This would require institutionalizing an **IP system** in each of the IITs. In this connection, a stated policy of IP creation being a part of the research output is warranted.

An IP Management Cell will have to be set up to implement the policy and should be empowered with the necessary resources to be placed at its disposal. A reward and career incentive scheme has to be in place for the inventors who may be members of the faculty, research scholars, students in the B.Tech., M.Tech. and other educational programmes or non-faculty employees of the IIT community.

The IITs have since taken steps in this direction. IIT Bombay in March 2003 has come out with the policy document on IP and entrusted the management of it to the existing Industrial Research and Consultancy Centre (IRCC) while IIT Delhi in July 1992 has set up the FITT (Facility for Innovation and Technology Transfer) to handle IP related issues and technology transfer. Other IITs also have mechanisms as a cell or as part of an existing set-up for industrial consultancy and sponsored research. It is now appropriate to take these initial forays to the next logical step of creating a separate, full-fledged and comprehensive IP system.

As mentioned in the earlier paragraph, IP asset creation and its management is to be treated as a systemic activity and is required to be institutionalized as one. The IP system should comprise the following:

(i) a defined IP policy;

(ii) defined aims of the IP system;

(iii) an IP management cell and

(iv) a dedicated budget head to execute its functions.

Some of the features which may characterize the above are described below.

10.3.1 IP POLICY

(i) To promote and support the creation and management of IP assets for a given IIT.

(ii) To provide **continuous support and assistance to the inventor(s)**. The support has to extend from the stage of recording his invention, to creation of the patent and subsequent management of IP assets for and on behalf of the inventor(s) and the institution.

(iii) To clarify unambiguously the ownership of the IP, i.e solely by the inventor or jointly with the institution. **The revenue sharing has to be spelt out. Since the patent culture is not there yet, the credit should largely belong to the inventor in order to encourage larger patent volumes.**

(iv) To sustain and grow the creative and innovative spirit and the **IP Culture in an environment upholding high ethical standards.**

Often, the research done at the IITs is financed by government grants from the Department of Science and Technology, Departments of Defence Research, Space, Atomic Energy and various other agencies and instrumentalities of government. Barring confidentiality and specific IPR conditions in regard to strategic projects, in majority of cases the IP ownership arising out of these public funded research projects rests with the IITs. The IITs should have the freedom to license the IP assets created out of research funded by the government. Experience elsewhere points to the fact that nations benefit from a policy that permits academic institutions and industries to take up IP ownership generated under government funded projects. The balance between regulation and incentives with regard to IPR has to be worked into projects in the initial stage itself in such exclusively government funded projects. While IITs should in general be permitted to retain the ownerships of IP, as well as the licensing rights, there should be an appropriate revenue sharing policy with the inventor(s).

10.3.2 Defined Aims of the IP System

The foremost role of the IP system is **to take away the onus of translating the innovation into an IP asset from the inventor(s) and render a comprehensive support system to the inventor(s).** In order to fulfil this fundamental objective, the IP system could have the following aims.

i) To facilitate systematic and timely development of IP assets.

The principal activities under this include distinguishing creations between patents, designs, copyrights etc., assessment of creations for protection, patent search and analysis support, patent drafting, filing processes for patents and other IP in the required jurisdiction and take care of prosecution, pre-grant hearings/oppositions, renewal, assignments and reassignments and weeding out patents and other IP equations which have no further commercial interests; dealing with post-grant issues such as opposition and infringements, licensing etc.

ii) To operate an IP system comprising the IP policy, IP culture, procedures and processes

(a) In relation to the IP policy referred to in the earlier section, operation of the IP system would be required to articulate, in a transparent manner, the mission statement, the rules of the game, the support services and the rewards and incentives.

(b) One of the cornerstones in the operation of the IP system is the inculcation of a healthy and permeating IP culture. Initiation into the IP culture should begin at the B.Tech. stage. Education and training in IP matters are required to be imparted to the next generation of engineers and technologists. A system and methods to engage the undergraduate student population in the innovation and patenting activity requires attention. When the B.Tech. students are tapped, patents could be generated before they leave the IIT shores. Even if every year, and in every IIT, 2 - 5% of the B.Tech. student population gets into innovation and patenting, the total number of applications will be significantly large and the IP culture will be entrenched. We have suggested in Chapter 7 on Research issues, that the research project needs to be introduced at the 2nd year B.Tech. stage. The initiation into the IP area could as well be dovetailed into the 2nd year project assignment.

IP culture could be promoted in many ways, as part of B.Tech. education itself *via* short courses on innovation and creativity, as a recognized component of research, as an open competition in an innovation festival, much like the cultural festival which is open to all members of the community, as periodic training which addresses the different constituencies of the IIT community, as newsletters and other propaganda devices which bring to light innovations from across the world, other institutions in India as also in-house achievements and as promotion of innovation as a hobby activity amongst various sections of the IIT community.

iii) While the IP policy and promotion of IP culture forms the basis for the IP system, operationalising the same depends on a comprehensive understanding and practice of several procedures and processes. Necessary procedures and practice of processes for various IPs range from first acceptance of a claim of an innovation to post-grant processes. Implementation, however, would require a dedicated multi-disciplinary and multi-functional team of professionals as part of an IP Management Centre.

10.3.3 IP Management Centre (IPMC)

In order to address the gamut of issues pertaining to IP, a structured set-up staffed with appropriate professionals and headed by a Dean, is required. IP Management centre should be in a position to access a digital library of existing patents to facilitate fast patent search and analysis. The IP issues encompass a multi-stage activity requiring different inputs and professional assistance at various stages. The various stages of IP system management are the following:

(i) First Information Record of Invention (FIRI) and establishment of IP potential.

(ii) All services to translate the invention into IP application; services ranging from patent search, preparation of documents, legal services, and execution of application.

(iii) Management of granted IP assets: ownership management, licensing, legal services for fighting cases of infringement and opposition, de-licensing etc.

Add to the above, administration of incentives and rewards scheme for the inventor(s) as well as proceeds from licensing, IP training schemes, and all activities pertaining to nurturing IP culture as outlined earlier.

The management of the above activities would be facilitated by establishment of two sets of teams under a unified management of a senior faculty member at the level of Dean or a senior professional in IP matters with a dedicated office for handling all IP related issues. The human resource requirement for the IP centre would be multi-disciplinary and multi-functional professionals with appropriate experience in IP matters, financial, commercial and legal professionals and scientific, technical, library sciences and IT related personnel to do internal patent search, internal examination of patents and analysis on a routine basis.

Once a candidate comes up with a claim for an item invented by him, a professional team should study and evaluate the claim. This team may comprise discipline experts and Dean/Head of IP centre as chairman for establishment of IP potential. A protocol for reporting and recording of the first information on invention with systematic documentation of significant results, findings, dates and record books etc. would be the starting point of the activity. **If the candidate's claim is accepted, he should be rewarded with a letter signifying acceptance of his claim. This can be included by the candidate in his list of academic achievements.**

In the next step, a second team of professionals in the IP centre will take over the second and third stage activity together with the help of legal retainers and consultants to prepare and process the application as well as manage the granted IP assets for entering into various agreements and licensing.

The IP centre should be adequately empowered to engage professionals with proven abilities to handle legal, financial and commercial aspects required for the centre. **Retaining a law firm to handhold the IP Management Centre would be required.**

When a patent is granted, the original author(s) credited with the record of invention action should be rewarded financially. The quantum of the reward is to be worked out as part of the IP policy. This financial reward is independent of any revenues that may be generated from a successful patent.

10.3.4 Dedicated Budget

In order to effectively execute the IP system, each IIT shall have a dedicated budget allocation to meet the following requirements:

i) maintenance of the IP centre;

ii) pay and allowances and fees for dedicated professionals and legal retainers for handling all procedures and processes;

iii) to cover fees and expenses involved in the IP process (Indian and foreign);

iv) to cover expenses towards maintenance of IP assets and post-grant expenditures including legal defence in case infringement related issues arise;

v) rewards and incentives for inventors at various stages;

A budget allocation for IPR matters is to be regarded as an investment in the future. As a matter of policy, the Government deliberately invests in education, training and research in the expectation that the individual beneficiaries would prove to be a success and generate worthy assets for the nation. Similarly, the return on IPR investments can only be expected in the future and would be contingent upon the success of the patented idea, product or process.

10.4 SUMMARY OF RECOMMENDATIONS

(i) The suggestions made here are aimed at bringing to the fore the spectrum of requirements to be met in order to make a greater success of the IIT IP regime. The need for institutionalization of an IP system is clear. The IITs should take steps to set up an IP system on the lines described above with suitable modifications matching the ethos of each institution and their own assessment of the requirements in this regard.

(ii) The system should be managed and operated by a dedicated IP management centre staffed with appropriate professionals and personnel. The core purpose of the IP management centre is to take away the burden on the inventor, once he has made his seminal contribution. The IP management centre should be headed by a Dean.

(iii) A separate budget head for IP centre and IP related activities is necessary and allocations for it shall be made in the annual budget plans for each IIT. The budget should have a provision for financially rewarding the inventor.

(iv) Such a budget head needs to be accepted and put in place by the MHRD. The Committee would recommend an initial grant of Rs.50 lakh for each IIT for this purpose. Once the budget head is created, further annual allocation by MHRD would naturally be based on the performance by each IIT and its stated requirements.

(v) **Looking into the future, IITs may have to promote a new thinking about innovation. Innovation today is understood primarily from a techno-economic and a narrow commercial perspective. However, if technologies have to address persisting issues of poverty, emerging challenges of sustainable development and creative networks of the knowledge economy, a much broader concept of innovation will be required. Such a concept should embrace many institutional dimensions and allow people from different sections of the society to participate. IITs, as institutions of national importance and endowed with a range of intellectual resources, have a crucial role to play in promoting such a broad notion of innovation. It is in this direction that the IPR concept of IITs may evolve.**

CHAPTER ELEVEN

IIT-INDUSTRY LINKAGE

"The philosopher may be delighted
with the extent of his views,
the artificer with the readiness of his hands,
but let the one remember that
without mechanical performance
speculation is an empty dream
and the other that without theoretical reasoning
dexterity is little more than brute instinct"

Samuel Johnson
(1709-1784)

CHAPTER ELEVEN

IIT-INDUSTRY LINKAGE

While research was the focus of Chapter 7 and innovation of Chapter 10, the present chapter addresses the connection of research as well as innovation to industry and business. This last bridge has proven the most difficult to conquer for the researchers and innovators in the country. How is this to be tackled will be the concern of this chapter.

11.1 THE PROSPECT

IITs were created by the Government of India for the benefit of the society, an important part of which is the industrial sector. Industry absorbs students graduating from the IITs. Several sections of the industry actually go out of their way to seek talented students from the IITs. Some of these have risen to high positions and have provided leadership to the companies - a list of such achievers has been presented in Chapter 1. Is industry stake in the IITs to be limited to this aspect only? It is good to note that industry in the developed world has reaped a harvest of gains from entrepreneurial universities carrying out cutting-edge research in their state-of-the-art laboratories.

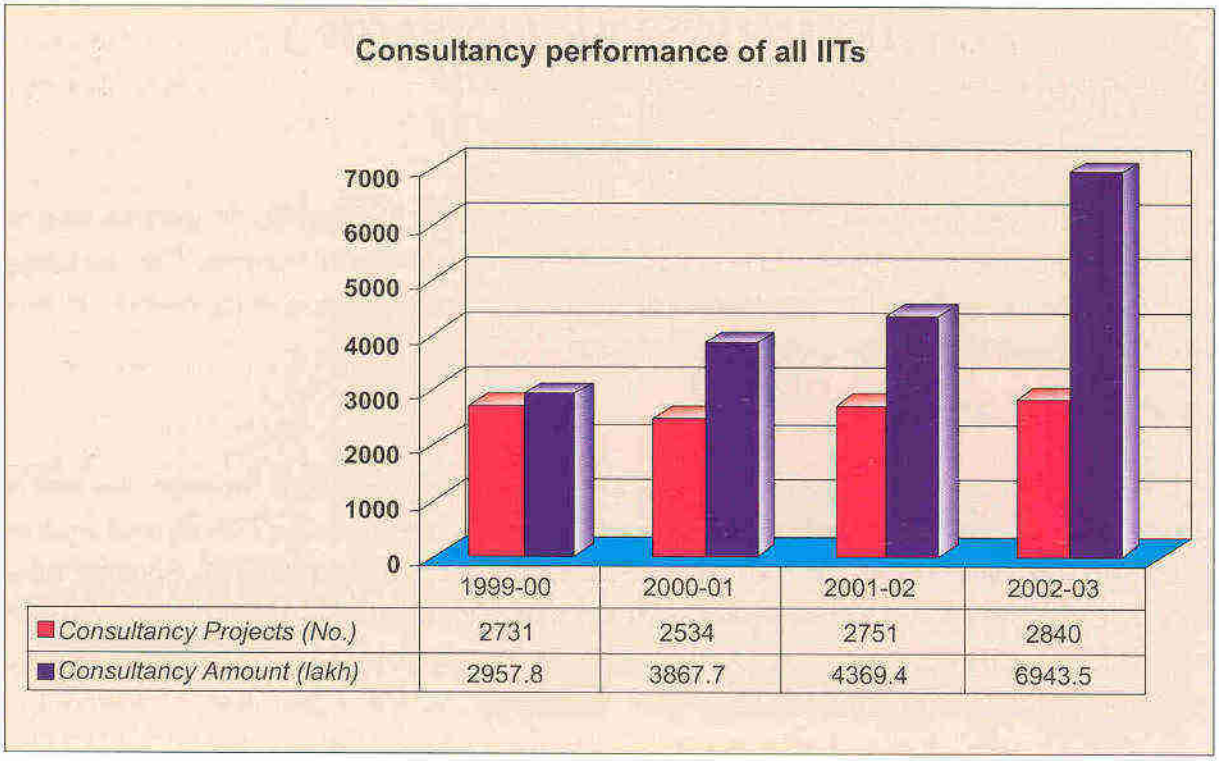
Industry are indeed in a position to pose challenges and generate opportunities, actually research opportunities for the IIT faculty and students. The prospect of IITs and the Indian Industry forming a formidable consortium of a kind is yet to be fulfilled. For this to happen, a favourable economic environment is also needed. For several decades since the inception of the IITs, such an environment was practically non-existent and consequently the IIT-Industry linkage was at best tenuous. However, there have been radical changes for the better since the 1990s. The New Industrial Policy of 1991 and the advent of WTO in 1995 have brought about significant changes. How then are we to trigger the IIT-Industry partnership to click in a way that IITs benefit by way of challenges requiring advancement in their research programmes and the industry gains in terms of development of novel processes and products. The overall result will then be such as to bring to reality **Nehru's dream of "building the nation towards self-reliance in her technological needs"**.

11.2 THE PRESENT STATUS

The IIT-Industry interface was institutionalised predominantly through units dedicated to industrial consultancy and sponsored research (IC&SR). These brought about a dialogue between industry and the IIT faculty through a number of consultancy projects. Such consultancy has been growing at a significant rate of 45% over the past four years (Figure 11.1).

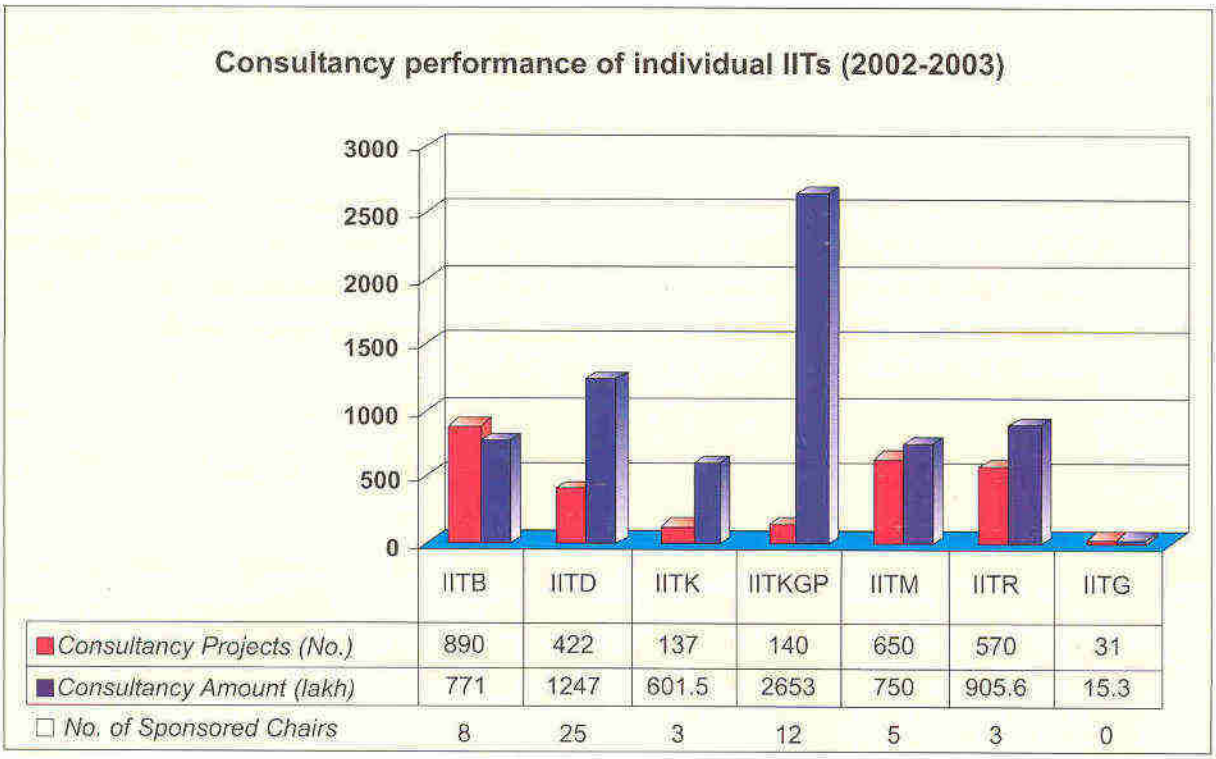
However, most of the consultancy projects are small in size. The project size increased from about Rs. 1 lakh per project in 1999-00 to about Rs. 2.5 lakh per project in 2002-03. As many as 2880 projects earning less than Rs.70 crore is indicative of the nature of industry participation.

It would be interesting to understand the typical customers of these projects: i.e., what proportion are MNCs, large Indian industries-private and public, SMEs, also by nature of the industry.



	1999-00	2000-01	2001-02	2002-03
Consultancy Projects (No.)	2731	2534	2751	2840
Consultancy Amount (lakh)	2957.8	3867.7	4369.4	6943.5

Figure 11.1: Consultancy performance of all IITs



	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Consultancy Projects (No.)	890	422	137	140	650	570	31
Consultancy Amount (lakh)	771	1247	601.5	2653	750	905.6	15.3
No. of Sponsored Chairs	8	25	3	12	5	3	0

Figure 11.2: Consultancy performance of individual IITs (2002-2003)

Apart from industrial consultancy, the number of sponsored chairs provides an indicator of the degree of industry interaction. The total number of sponsored chairs in IITs increased from 46 in 1999-2000 to 56 in 2002-2003 (Figure 11.2) and this growth during the recent years is not sizeable.

The industry interactions, however, differ across the institutes (Figure 11.2).

- IITKGP accounts for a significant proportion of the consultancy revenues.
- IITKGP also has largest consultancy projects (average Rs.18 lakh per project), which is significantly above that of the other older IITs.
- IITG has the smallest (Rs.50,000 per project). This is not only because IITG is new but mostly because of its remote location (Chapter 16).
- A majority of the Chairs is accounted for by IIT Delhi (25 out of 56). IITR and IITK have the lowest-3 Chairs each (as of March 2003).

It is clear, therefore, that much like the IP asset scenario delineated in the previous chapter, presently the industry-oriented and industry-sponsored activity represents a level much below that which would correspond to the awesome potential that is inherently present in the research capabilities and capacities of the IITs.

11.3 IC&SR CELL AND AUTONOMOUS BODY MODELS

There are two distinct models that have evolved in the IITs. Lessons from implementation of these models give us useful pointers for the future. The two models are the following::

i) **an internal cell completely within the system, namely IC&SR cell/centre (the nomenclature varies in the different IITs) and**

ii) **an autonomously governed industry-interface foundation.**

IC&SR historically is the first approach that started in 1972 in IITM. The cell is headed by a Dean holding exclusive charge or the Dean (Research) holds ex-officio charge of this portfolio. The cell operates as a window for various services that the IITs can offer as well as serve as a techno-commercial interface. Traditionally, it was the faculty that brought projects with their individual efforts and the cell provided the commercial coverage. Presently, the cells have taken a more pro-active role for marketing and business development with a professional outlook. Further, the cells have also taken up IP related activities, bridge and certificate courses relevant for industry and periodic dissemination of scientific and technical information.

The IT explosion has also contributed to an impressive growth in this segment of industry interface. The impact and success stories in this model are varied but a few pointers do emerge. It has been possible to do a large number of projects for wide ranging clientele as demonstrated by IITB and IITKGP. This is a positive feature as it can serve the small and medium enterprises with shoe-string budgets and in short time durations. Projects with large outlays and involving setting up of dedicated research centres have also been in place as in the case of Rice-Processing Research Centre of IITKGP, VLSI Design Centre in IITKGP, Software Validation and Verification Centre in IIT Bombay (These are mentioned only as examples to illustrate the point being made.

It is not intended to make out a full list of such programmes here). Another success story, alluded to in Chapter 1, is the development of WLL technologies from one research group in IITM which resulted in many a start-up company and significant impact. Enabling facilities and systems for start up companies are essential for success of cutting-edge technologies appropriate to the Indian scenario.

While it has been possible to effectively leverage the research competence and domain specialisation for providing technical solutions to the clients, it has most often been on a bilateral and on a one-one basis leading to a large number of projects, each of low value. The impact of the IC&SR activities has to be gauged on many fronts and levels, namely

(i) ability to serve SMEs,

(ii) leveraging of R&D output to large corporates that have significant R&D budgets (for example: top 100 in the country and the Fortune 500),

(iii) enable entry of IITs into new and emerging areas through engagement with industry in frontier areas and

(iv) provide continuous, innovative and ever-evolving-symbiotic interface.

IIT Delhi created in July 1992 a new forum called the Foundation for Innovation and Technology Transfer (FITT), as an autonomous industry interface organization to take care of IPR as well as technology transfer and industry interface issues. Registered as a society and an autonomous body, this interface organization was designed to take up a more proactive role to reach out to the industry on the one side and to the IIT Delhi faculty and researchers on the other. In contrast to the IC&SR cells, FITT functions as an independent body with one leg inside the IITD and one leg outside. The management of the society is under a Governing Council and is headed by an independent Managing Director. The society is financially autonomous with independent staff comprising professionals. Over the last decade, FITT has been able to handle contract research, technology transfer, training programmes and certificate courses and on an average is able to attract major projects for IITD. In the recent past, it has graduated to set up and manage a Technology Business Incubation Unit (TBIU). This initiative is an experiment in enabling technology-based start up companies and R&D interface units of companies in the incubator phase. IISc Bangalore has also adopted an autonomous society model in the creation of Society for Innovation and Development (SID).

The autonomous body model offers certain advantages. The relationship between the user agencies and the institution can be managed with greater flexibility in an autonomous system. This system offers an excellent umbrella facility to enter into omnibus MOUs and contracts with big corporates and leverage large projects of multi-disciplinary character with many departments and research centres within the institution and even other institutions. As the Society has to be self financing, it does not depend on the institution for its budget support other than for the initial seeding requirement, and it can obtain finances from wide-ranging sources. Furthermore, the centre is in a position to take up quality non-academic professionals as its staff without burdening the institution, which allows better business development and interface with the industry.

11.4 NURTURING THE IIT-INDUSTRY INTERFACE

- It is worth noting that the IIT-industry interface can be nurtured only when mutually beneficial win-win paradigms are put into place and the successful endeavours clearly bear out this aspect. While the benefits to the industry in sourcing research outputs and human resource training from the IITs can be a driving force that can bring the industry to the IITs, the gains that accrue to the IITs require careful attention. It is important that the interface systems promote a virtuous cycle and tangible benefits such as growth of research base, development of state-of-art core competence in specialized areas apart from resource generation for the faculty, staff, researchers and the institution. Recognising the growing demand for highly trained microelectronics engineers in the IT hardware industry, IIT Bombay and TCS collaborated to create an advanced microelectronics laboratory at IITB. Thus, 50 M.Tech.s in microelectronics are coming out of this IIT. The IBM, TATA Infotech and NIIT research centres at IITD illustrate the potential and the possibilities of high level research base creation. Recently, the India Semiconductor Association (ISA) has announced what they have termed "ISA Technnovation Initiative" to promote technology and innovation in the Indian semiconductor industry. Their intention is also to generate world-class talent in large measure by promoting higher education and research in the Indian Universities. At the same time, IITKGP has proposed twin knowledge-parks, one in Kharagpur and another in Kolkata, for semiconductor companies. These are highly welcome developments.

- The Principal Scientific Advisor of the Government of India has recently taken an initiative to promote industry-academy collaboration, again on the plane of the personnel. After extensive deliberations with industry representatives, a new proposal has been mooted by him. According to this proposal, it is suggested that industry should allow some of the engineers, recruited during placement interviews and having talent for research, to pursue higher studies in the IITs leading to Ph.D. in the field of engineering and technology. These engineers should be encouraged to work in the broad area of interest to the company without limiting them to solving short-term problems of the company. That means, in all respects, they are no different from the other research students. During the four years or so that the young person would spend in the IITs for his Ph.D., he would be paid the salary in the same way as if he were to be holding a job in the company for which he has been recruited. This principle may be pursued by the IITs.

- The Principal Scientific Adviser to the Government of India has also taken another initiative whose mention is relevant here. This initiative pertains to promoting R&D in the automotive area by bringing together industry leaders in this sector with promising researchers from the academic system, most of whom are actually drawn from the IITs. The Principal Scientific Adviser has named this initiative The CAR (Core Advisory Group for R & D in the Automotive Sector) Project, funding for which has been derived from more than one source in the government. This shows yet again that the financial burden for such collaborative projects does not have to fall entirely on a single government agency. This strategy needs to be developed in other areas of industry interest.

11.5 SUMMARY OF RECOMMENDATIONS

(1) There are four critical areas to be addressed when higher technical institutions like the IITs propose to work with the industry. These are

(i) The issue of sharing intellectual property rights,

(ii) The pace at which industry projects are executed in the educational institutions,

(iii) Formulation of enabling policies, including tax incentives, for industry to invest in industry-IIT partnership programmes, and

(iv) A framework in the IITs to encourage, assist and reward entrepreneurship.

The industry's greatest concern is that when they make substantial investments in a project, in association with the academic institutions, they should be able to derive as much financial and technical dividend as possible. Losing proprietary knowledge generated in such a project is also a concern. **So the foremost requirement for industry-IIT joint endeavours to succeed and be sustainable would be to have an IP policy in place.** Further, based on that policy, the participating partners should arrive at a written understanding for sharing the intellectual property rights.

Since time is money for the industry, IITs should do everything possible to maintain schedules and an acceptable pace in execution of the projects. **This will invariably call for institutionalising separate mechanisms for fast track procurement procedures and for speedy utilisation of funds for various mutually agreed purposes.**

The above-mentioned critical factors need to be adequately addressed for the IITs to progress rapidly towards creating and sustaining innovation clusters around their campuses. Such cluster developments elsewhere in the world have yielded rich dividends in terms of economic impact as well as growth of high technology R&D in the academic institutions.

(2) Further, collaboration with industry is significantly accelerated and deepened when industry personnel are able to work in the IIT environment for substantial periods of time. There are various modes of achieving this and some are already in operation. These are mentioned below:

(i) With the help of funding from All India Council for Technical Education (AICTE), the Indian National Academy of Engineering (INAE) supports short duration visits by the interested industry personnel to academic institutes in the country including the IITs. This has proved to be a reasonable success and should be built up to a much larger scale (a Professor from IIT, Delhi is actually in charge of this programme on behalf of the INAE).

(ii) Visiting chairs provide another avenue to bring industry executives and technical leaders to the IIT system. In this regard, it is often observed that the emoluments provided to the industry personnel are meager, compared to the compensation they get from their parent company.

Tata Steel has overcome this problem and their example is worth mentioning here. They have positioned their Chief of R&D in IIT Kharagpur for a duration of three years or so, during which period they are continuing to pay their person the same emoluments as he would be drawing in Tata Steel. Although it has created a disparity in the compensation level of Professors in IITs and the person who came from Tata Steel, the IIT Kharagpur authorities have not raised any objection. This example has to be commended and is likely to open doors for more people from the industry to spend substantial periods of time in the IITs.

(iii) This Committee further recommends instituting **Senior Fellowships for working level industry personnel** to visit and spend time in the IITs on joint projects. These fellowships should carry a sumptuous stipend and should be given a prestigious name. The details may be decided upon by the IIT Council, once this recommendation is accepted. One possibility is **to name this fellowship for industry personnel, the N.R. Sarkar Fellowship**, to honour the person who chaired the first Committee that led to the creation of IITs.

(iv) Finally, there is a need to encourage industry to recruit research trained graduates like Ph.D.s for employment in their companies either for R&D or even for general purpose engineering. Such highly trained personnel will clearly make a difference to the quality of work even in an industrial environment. Unless this is done in an increasing measure, doing a Ph.D. in engineering will continue to be an unattractive proposition to youngsters.

(3) This Committee has recommended, in Chapter 7, tax incentives to the industry, specifically in relation to their hiring Ph.D. level personnel. The details of tax incentives are best worked out by MHRD, if these recommendations are accepted.

(4) Similar encouragement is needed to motivate the industry to invest in major joint research projects with the IITs. It is reported that the Government is allowing 150% tax exemption to the industry for investment in automotive R&D. Our recommendation is that, in an analogous manner, if industry invests in-house for a joint project with the IITs, tax exemption of 150% should be permitted.

(5) In Chapter 4, while discussing Vision for the IIT system, it was pointed out that nurturing the spirit of entrepreneurship in IIT students was required to be articulated more forcefully in the vision statements of the IITs. Apart from educating about entrepreneurship in management and related courses, technology incubators in several countries have been instituted for the purpose of encouraging entrepreneurship. IIT Bombay (IITB) has experimented with this model of technology incubators in their campus. Quite a few groups of students, after graduation, have made bold to try their hand at setting up business operations based on their own skills as well as innovation. These operations have been in terms of developing innovative products or providing technology solutions to clients, often in the area of IT. The IIT faculty have been extending a helping hand. IITB has provided facilities in their campus, like built-in space and utilities, for the young entrepreneurs to develop their entrepreneurial activities in the incubators. (It is possible that some of the other IITs have done likewise). IITKGP was one of the earliest to set up a science and technology entrepreneurship park (STEP).

(6) The Department of Science & Technology (DST), Government of India has a dedicated set-up to manage programmes in entrepreneurship and extend funding for entrepreneurial activities. Science and Technology parks and technology incubators come well within their purview. DST also oversees the Technology Development Board (TDB). TDB is committed to support commercialisation of technology developed in our academic institutes or in national laboratories or in industry in-house R&D laboratories or in a technologist's own enterprise. An IIT Bombay graduate has actually been financed by TDB to set up a small scale industry to produce clean high-speed steel alloys. It would be refreshing to witness more examples of this nature.

(7) **The Committee, therefore, recommends that serious attention may be paid to develop a framework for the IIT system as a whole, as well as for individual IITs, to encourage, assist and reward entrepreneurship of their graduates as well as of their faculty.** The observations made in this chapter are intended to provide the backdrop for such a framework to be developed. With the country witnessing entrepreneurial sparks flying all over the different sectors of the economy, the IIT graduates have to be in the forefront of this revolution.

CHAPTER TWELVE

TECHNOLOGY IN EDUCATION AND RESEARCH

"Someday, in the distant future,
our grandchildren's grandchildren will develop
a new equivalent of our classrooms.
They will spend many hours in front of boxes
with fires glowing within.
May they have the wisdom to know
the difference between light and knowledge"

Plato:
(427-347 B.C.)

CHAPTER TWELVE

TECHNOLOGY IN EDUCATION AND RESEARCH

There are numerous possibilities for the application of modern Information and Communication Technologies (ICT) in the environment of the IITs. One straightforward application is to enable the IIT faculty, staff and students to access information available in the cyber space. The MHRD has generously supported these institutes, through an allocation of Rs. 90 crore in the Ninth Plan, to install facilities like the personal computers and communication infrastructure. Consequently, IITs and the various sections of their community today command a comfortable internet connectivity. In recent years, MHRD has incurred expenditure to subscribe to about six thousand technical journals and has enabled the IITs to access them through the INDEST Consortium. MHRD has also aided the programme on digital libraries. By and large, IITs can be regarded as the best endowed academic institutions, alongside the Indian Institute of Science, in regard to the basic ICT infrastructure.

We shall be concerned with two other areas of application of modern communication technology in education. The first relates to IITs helping the vast network of engineering colleges, their teachers and students by creating course material and making it available through an existing technology channel. This is a mammoth programme that has been entrusted to the IITs. It is also possible to install the means to transmit live lectures delivered at IITs directly to remote centers in the country. A good example of this practice is what is being done at IIT Bombay. The second is for the IIT students and teachers to collaboratively work with distinguished overseas institutions through the medium of modern communication. We shall briefly discuss these developments.

12.1 e-LEARNING PLATFORMS

Many institutions in the world have recently initiated programs for dissemination of their curricula through the web. A number of commercial e-learning platforms have been used by them. Notable among these are WebCT, Blackboard, Lotus Learning Space, Top Class (all commercially available software products) and Acado (an Indian product developed by IIT students who have formed a company in Thiruvananthapuram, Kerala known as Transversal E-Networks). These e-learning platforms commonly support the following objectives:

- Design course materials using text, animation, movies, interactive templates, quizzes and assignments along with voice help etc., using simple web tools or sophisticated multimedia editing software;
- Provide learning space through interaction, hyperlinks, searchable databases and other web resources;
- Conduct examinations and online course grading for classes with large numbers of students;
- Provide opportunities for chat/discussion among students and enable them to communicate their ideas effectively around themes specific to a given course and
- Set up virtual universities for distance learning.

12.2 e-LEARNING IN IITs

Courses with large enrolment (about 500 students) traditionally taught by several faculty simultaneously to small batches of students have proved ideal courses for the web-based approach in the IITs since the syllabus, examinations and assignments are all common for all the batches. The challenge has been to ensure that all students have electronic access to course notes, assignments and previous examinations. Typically, in IIT Madras, the experiment has been extended to cover approximately 200 courses and about 50 of them are currently accessed by students. The web contents are diverse: power point presentations of lectures, html, Java, Text content, animations etc.

12.3 THE NATIONAL PROGRAMME FOR TECHNOLOGY ENHANCED LEARNING

A Virtual Centre for Technology Enhanced Learning (VCTEL) has been formed with the seven IITs, six IIMs and Carnegie Mellon University, USA as Partner Institutions. VCTEL submitted a proposal to MHRD involving four topics: distance learning, core course development, digital library and collaboration in Ph.D programmes. MHRD has funded the digital library activity separately and has approved a modification of the VCTEL proposal. The focus of the National Programme for Technology Enhanced Learning (NPTEL) is on course development in video format (for the Technology Channel, "Ekalavya") as well as multicast, CD and web-based formats.

Offering multimedia courses in technology assisted modes has not only become invaluable for the learner, but is also an attractive and a creative option for faculty. Such courses have the potential to enhance the learning experience for students on and off campus in a distance learning mode. In India, where a large number of private institutions have entered the field of engineering education with inadequate faculty support and training, the project is aimed at providing a standard for academic content for both the teacher and the student.

Seven IITs and IISc will work together to develop web and video based material for basic undergraduate science and engineering courses in order to enhance the reach and quality of technical education in the country. In order to facilitate the distribution of course material, two modes of operation have been suggested, namely, digital video lectures of courses and web-based courses. Approximately 100 core courses in each of these modes are expected to be made available by December 2005. The target group for this project consists of students and faculty in institutions offering undergraduate engineering programmes in India. The course development teams in IITs/IISc will interact closely with the teachers in the target institutions to ensure the usefulness of the courses for their students.

The specific educational goals of NPTEL are the following:

- Make video lectures in a format appropriate for broadcasting that would provide quality content through the technology channel named the Ekalavya channel in recognition of the first student of distance education named in the Mahabharatha.

- Create web-based (e-learning) material and make it available in the form of a portal/CDs that would be tailored to meet the needs of engineering students across the country.
- Create a website for NPTEL activity.
- Make e-learning material available on the web for the video lectures to supplement class room teaching.
- Advise target institutions with regard to the software/hardware requirements for benefiting from the national project.
- Conduct workshops for teachers from other institutions who would like to use the contents.

Under NPTEL, IITs and IISc have set up or have augmented their facilities. They now have one or more full fledged studies staffed with project associates who are qualified graduates and post-graduates in engineering/science and well acquainted with the software. The Programme is expected to deliver the learning material in stages and complete its tasks by March 2006.

There is an international dimension, too, to e-learning, which IITs should not lose sight of. For instance, MIT in USA has encouraged their staff to provide their course material worldwide *via* the web. Thus, MIT OCW (open course ware) has made an international impact in academic circles. Is there a challenge and an opportunity here?

It is widely known that Indian institutions nurture good teachers. In some of the reputed universities and academic institutions, it is fairly common to come across outstanding teachers who would be prepared to dedicate all their working life to teaching. Scholars devoting themselves to teaching is, it would not be an exaggeration to state, an Indian tradition from eons. There is here immense potential waiting to be tapped.

IITs can and should very well be in the same arena as MIT, what with the talent and experience in teaching that their teachers possess which has made their B.Tech.s so greatly sought-after. The Committee would enthusiastically encourage IIT teachers to consider the possibility of their teaching materials, too, becoming internationally competitive. IITs can lead and also motivate teachers in sister institutions to join them in this activity. **In order for this to happen, effective technical support and the necessary funds would be paramount, so also a reward system that would be attractive to the teachers.**

12.4 THE DISTANCE EDUCATION PROGRAM AT IIT BOMBAY

The Distance Education Program (DEP) is an activity of the Kanwal Rekhi School of Information Technology (KReSIT). The DEP was set up in early 2002 with the specific mission of reaching IIT courses to teachers, working professionals, and students of other institutes and organizations across India. The program started out with modest four Remote Centers (RCs), including one at IITB. The program had eleven centers, as of March 2003, with several centers being commissioned to join shortly thereafter.

The goal of DEP is to offer courses taught by expert teachers to a large number of participants across the country. Objectives of the program can be summarized as:

- Creating a quality learning environment at a remote location, with facility for live interaction between participants and faculty
- Providing a cost effective and scalable solution for the participating centers and participants in the program, using technology to ensure that the dynamics of content delivery matches the learning needs.

The model provides the benefit of live interaction between the participants and faculty. The mechanism to provide interaction is briefly outlined below:

- Lectures from the central site are synchronously transmitted, *via* satellite based communication system, to the various RCs.
- A typical classroom at each RC has thirty to forty students viewing the lectures, which are projected onto a large screen. This classroom environment provides the opportunity for the participants to interact with each other.
- Any participant from any of the RCs has the freedom to ask a question during the lecture. The desire to ask a question is communicated to the faculty through video-conferencing software.
- The faculty may grant the floor to the RC, in which case the question being asked is heard by the faculty as well as the participants at all the other RCs. Subsequently, the floor is taken back by the faculty, the question is answered and the lecture continues.

To-date, the program has registered over 1000 participants for its semester long PG level courses and over 500 participants in the short-term courses run through the Continuing Education Programme (CEP) in a pilot mode. Around 1200 participants have benefited from the broadcast of lectures by eminent speakers to the participating RCs.

The program is now poised to leverage the available bandwidth during the day by transmitting recorded lectures in popular subject areas such as Linux, and Embedded Systems, free of cost, for the benefit of teachers and students in the partnering educational institutions. In the Autumn 2004 semester, several UG courses will be transmitted, as the courses are being conducted at IITB.

12.5 CYBER UNIVERSITY PROGRAMME AT IISc

The idea of an Indo-French Cyber University came up during a meeting between Indian and French Government officials in November 1999. In the beginning of 2000, applied mathematics was chosen as the first discipline to test the concept. The Toulouse University (TUN) was appointed as the coordinator on the French side and Indian Institute of Science as the coordinator on the Indian side.

The primary aim of the project is to create a cyber-platform devoted to information exchange between India and France within the fields of research, development, education and dissemination of knowledge on a long term non-commercial basis. In the first phase, the project is concentrating on developing and delivering a set of post-graduate level courses in applied mathematics. It is envisaged that this will progressively develop into an Indo-French consortium encompassing a wide range of disciplines and courses at different levels. The programme at IISc is generously supported by the Ministry of Human Resources Development, Government of India.

In February 2003, a Cyber workshop in Applied Mathematics was held at the Digital Information Services Centre (DISC) using temporary two-way satellite communication between IISc and France through the EuropeStar satellite. Six lecturers from India and six from France gave lectures during the course of the workshop. Based on the success of this workshop, IISc and TUN approved the offering of 2 courses to their students under this project for the academic year 2003-2004.

In order to facilitate the offering of the above courses, a permanent satellite transmit-and-receive earth station was set up at the Digital Information Services Centre (DISC), IISc, in an existing room seating 20 students. The present transmit-and-receive earth station set up is an integrated system and configured as per the digital video broadcasting standards. The complete set-up is made of two parts. One part is the set of equipment used for encoding and modulation of the video signal depending on the bandwidth allotted by the satellite service provider. Then the signal is amplified and transmitted using a transmit antenna. On the other hand, while receiving, the signals from the satellite are received by a receive antenna and decoded back to original video signal. The system is able to achieve a dedicated 2 Mbps data communication rate.

The first course (Control and Homogenization) was successfully started on October 1, 2003 and ended in January 2004. The second course (Combustion and Shock Waves) started on January 22, 2004 and ended in April 2004. A crucial aspect of this joint endeavour is that the course content is developed jointly by the Indian and the French tutors. When the French tutor lectures in TUN and the lecture is transmitted to IISc, the Indian tutor is present at IISc along with his students. The counterpart operates when the Indian tutor lectures at IISc. Any discussion that takes place in the class in France is witnessed and heard by the IISc students and vice-versa. Based on the feedback received from these courses, additional equipment (DVD recorders, cameras etc.) has been purchased to record the lectures live and store them on a server for the benefit of students.

In the academic year 2004-2005, it is proposed to offer four courses: Control and Homogenization, Combustion and Shock Waves, Cryptography, and Variational Methods. A learning management system is proposed to be developed so that registration, announcement of grades etc. for all these cyber courses can be done online. The lecturers will also be broadcast live over the local area network. Finally, research seminars and workshops between IISc and TUN are proposed to be conducted using the above set-up.

12.6 SUMMARY OF ISSUES AND RECOMMENDATIONS

The issues regarding the use of technology for educational purposes can be cast in the form of five core elements, namely (1) Technology (2) Content Generation and Delivery (3) Training of Mentors and Other Professionals (4) Cost-effectiveness and (5) Research Collaboration.

Since a couple of years have gone by since the launch of these programmes with substantial support from MHRD, this Committee recommends that a review be carried out by a small expert group drawn from IISc and the IITs. It is likely that this expert group will easily be able to clarify the key-issues related to the five aspects mentioned above. The major points concerning these programmes will be constant upgradation of technology infrastructure, regular updating of teaching material and sustainability in terms of the needed expenditure and possible recovery through revenues. More importantly, one has to resolve how best the cyber links can be advantageously utilized to embark upon and promote joint research endeavours between the IITs and eminent University groups overseas.

We now raise a few issues with respect to each of the five core elements mentioned above which can be considered by the expert group.

(1) Technology

There are 3 currently available technologies which can be used for distance education: ISDN (video conferencing), Internet and Satellite Communication. We analyze below the pros and cons of these three technologies.

(i) **ISDN** is used by many companies for video-conferencing and this technology can be adapted to give lectures.

Pros: The cost of the set-up is minimal.

Cons: The recurring costs are high. It is quite unreliable unless one uses dedicated lines between two points like many companies do. Many smaller towns may not have ISDN facilities.

(ii) **Internet** has been widely used for distance education by many Universities.

Pros: It has a wide reach. The costs of the set-up are minimal. Ideally suited for delivering lecture notes, web-based courses (for delivering video, see below) to a large audience. Can be used as a supplement to other technologies like satellite communication.

Cons: For delivering video lectures, even the receiving institutions need to have about 2 Mbps bandwidth. This makes it unaffordable for most institutions since they have to pay for the leased line costs irrespective of whether they are receiving the video lectures or not.

(iii) Satellite communication has been another popular tool used for distance education.

Pros: It has a wide reach. Receiving institutions incur no recurring costs for receiving the lectures. The equipment for receiving the satellite signals is the same one used by cable TV companies. So it is cheaply available throughout the country. Ideal for delivering live video lectures. The transmitting institution needs to pay transponder costs only for the duration of the lecture. With the launch of EDUSAT, even this may become simpler and cheaper.

Cons: The costs of the set-up for the transmitting institution is very high. One needs to reach out to a wide audience to make it cost effective.

Another issue which has to be addressed (in collaboration with ISRO) is how best to use the recently launched EDUSAT satellite for meeting many of the goals outlined above. Therefore, it may be useful to include a representative from ISRO in the expert group suggested above.

(2) Content Generation and Delivery

Web-based delivery of courses: It is easy to host course content on the web. The most difficult part is creating the content in the first place. NPTEL programme would go a long way in addressing this aspect. The second most difficult part is keeping the content current. This can pose serious problems. The advantage of web-based delivery of courses is that it can scale to any number of students.

Satellite-based live delivery of lectures: The main advantage is that the give and take that is always present in live delivery of lectures is faithfully captured. To ensure this, the lectures should not be given in a studio but in front of students which greatly increases its pedagogical effectiveness. The presence of students would be assured if the courses being offered are integrated into the existing curriculum of the Institute which is delivering the courses. This also has the advantage that the instructors would not feel any extra burden being imposed on them. No special effort needs to be taken and, therefore, more instructors would be willing to participate. Further, every time the course is repeated, the content gets automatically updated since the instructors keep modifying the contents based on current trends. Moreover, corrections made based on student feedback also get incorporated. Regarding scalability, the satellite based delivery scales to any number of students one way (i.e from instructor to students). However, the other way (student to instructor) does not scale up so easily. Therefore, for ensuring student feedback, it is necessary to supplement satellite communication with low bandwidth tools, e-mail or chat facility. One can also explore the recently released tool, Skype, which allows free voice communication over low bandwidth.

To combine the advantages of the above two systems of delivery, one can consider the following solution. The target institutions can be divided into Tier I and Tier II institutions. Tier I institutions can receive the live lectures with possibility of feedback in some form. Tier II institutions can rely fully on web-based material.

(3) Training of Mentors and Other Professionals

For long distance education to be effective, it is essential to have a mentor in each of the receiving institutions who can clarify doubts, conduct exams, award grades etc. This implies that the level of instructors in these participating institutions has to be raised. One possibility is that they can be brought to the institution delivering the course to attend that course one year before it is transmitted. To mitigate the load on the instructor, the following phased delivery schedule can be arranged. In the first year, mentors from 50 other institutions attend the live course. In the second year, this course is transmitted to the above 50 institutions which carry out their own evaluation and grading. Simultaneously, mentors from 50 additional institutions attend the live course. In the third year, the lectures are transmitted to a total of 100 institutions whose mentors have undergone the course. 50 additional mentors are brought in. This process continues.

For purely web-based courses, the content should be delivered to the mentors at least a year in advance so that they can go through it and get familiarized with the content. Some feedback mechanism between the mentors and the instructor is essential in this phase.

(4) Cost-effectiveness

From the viewpoint of funding agencies, the question of cost-effectiveness of any solution that is proposed assumes great importance. When performing a cost-benefit analysis, the cost of deploying a technological solution should be supplemented with the recurring costs which can be substantial. On the positive side, these costs should be balanced with savings resulting from the fact that a single instructor now reaches out to a much wider audience. Further, the result of having better-trained manpower can confer enormous benefits to India and will have a positive cascading effect throughout the Indian economy. This would be more difficult to quantify but has to be a crucial input in any analysis of the viability of the projects. Finally, since better-trained manpower would obviously reduce the retraining costs of companies (which many companies are forced to undertake, given the poor input quality), a public-private partnership to bring down costs could be considered.

(5) Research Collaboration

The final aspect to be considered is the use of technology to enhance research collaboration. For example, internet is an ideal medium for developing research collaborations between two high level Institutes (say, between an IIT and MIT) both of which have good bandwidth. If there is extensive collaboration between two institutes, it may even be worthwhile funding a dedicated internet link between the two. Using tools like Netmeeting, Skype etc. effective collaboration can take place. Another recent trend worldwide is to enable operation of specialized research instruments through the web. This would expand the user base of specialized facilities in a cost effective manner.

CHAPTER THIRTEEN

NON-FACULTY EMPLOYEES

"Trust men and they will be true to you;
treat them greatly,
and they will show themselves great"

R.W. Emerson
(1803-1882)

CHAPTER THIRTEEN

NON-FACULTY EMPLOYEES

The performance of the IITs, like that of any leading university, is aided by a congenial work environment. Faculty, students and non-teaching employees will all then naturally drive themselves to achieve as high a level of productivity as possible. During the visits made by the Committee to all the IITs, there was not a single jarring moment even remotely indicative of any discord between non-faculty employees and the others. The obvious commitment of the IITs to a work environment that enables all sections of the community to perform their respective functions harmoniously made a deep impression on this Committee. Having recorded this heartwarming impression gained by the Committee, we will highlight certain features associated with the non-faculty employees and some of their concerns.

13.1 SUMMARY OF CONCERNS AND RECOMMENDATIONS

13.1.1 Low Academic: Non-academic Staff Ratio

(i) The total strength of the supporting staff in the IITs is about 8025, while the strength of the R&D and Project staff is about 1850. When compared with the total faculty strength of 2375, the number of non-faculty employees in the IITs appears quite large and works out to a ratio of academic to non-academic staff of 1:4 or more.

(ii) The Expenditure Reforms Committee (ERC) has, on the other hand, recommended a ratio of 1:1.5 to 2 for academic: non-academic staff. IITs exceed this ratio. The ERC recommendation is quite general and cannot be strictly applied to IITs, since these institutions have a sizeable population of technical and scientific staff that constitutes a pillar of support to the wide-ranging technical activities in the IITs. The IITs are also residential in character, and this feature adds its own demand for support staff. The alternative of outsourcing has been successfully implemented in the campuses of several academic institutions and the IITs are also getting into this mode. IITs in the metro-cities have an advantage in this respect. However, for IITs in Guwahati and Kharagpur, outsourcing may not be an easy solution for the present.

Notwithstanding what has been stated above, there is a strong case for a review of the number of non-academic staff. The actual number of such staff, after an assessment of the IIT activity profiles and their locational features, need to be gradually reduced through the Special Voluntary Retirement Scheme as implemented by some of the academic institutions in our country.

(iii) There is a total ban on filling non-academic posts. The blanket ban sounds illogical as it does not quite address the pressing needs in a particular cadre, especially where it is related to progressing academic work. There is a case, therefore, for providing for exemptions of the ban when a strong justification is provided by any of the IITs for filling certain vacancies.

(iv) In this context it is important to differentiate between the needed and the productive staff on the one hand and the unproductive and the not-so-needed staff. If the number of project staff increases, the research performance, to which they directly contribute, improves. This is reflected in the correlation shown in Figure 13.1

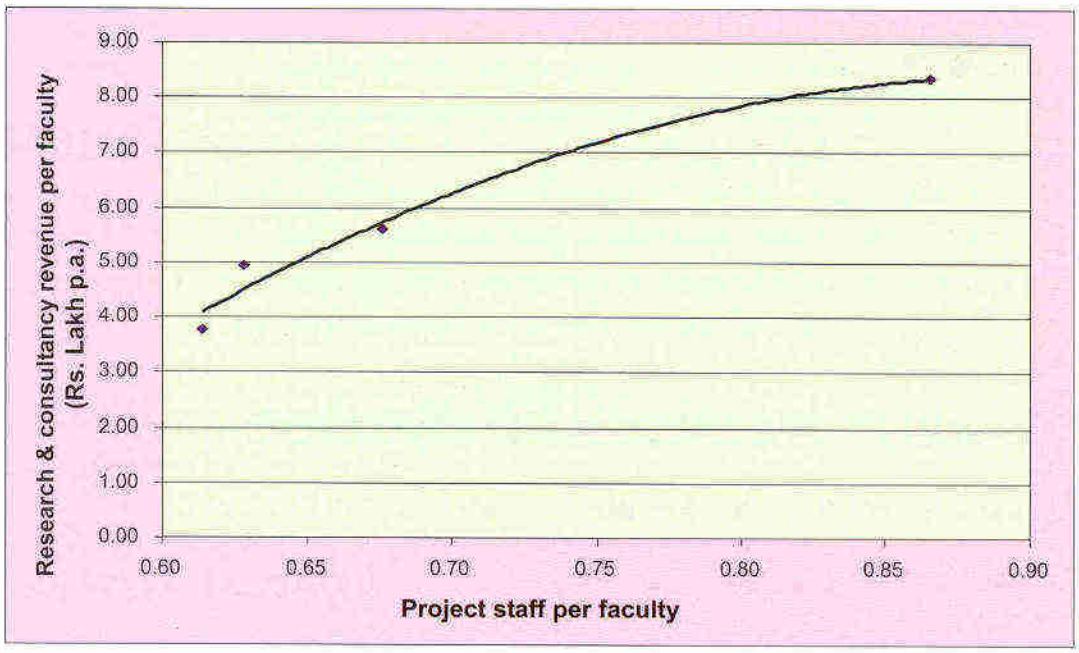


Figure 13.1: Project staff contribution to revenue realisation

13.1.2 Technology in Management

The IITs, being technologically strong institutions, have implemented the use of information technology devices for administrative purposes as well. Even so, it is not absolutely clear that IITs operate an automated system in regard to administrative and personnel matters as well as their accounting and financing processes. Similarly there is a need for an efficient and comprehensive management information system in the IITs. In all these respects, total modernization requires not only installation of advanced hardware and software systems, but also training and retraining of the staff. The Committee is confident that staff well trained in the daily use of modern and continuously updated technology will contribute significantly to higher productivity.

13.1.3 Staff Development and Training

All IITs should spend a reasonable proportion (not less than 2%) of their maintenance budget on staff training and skill development. Senior staff training would be appropriate in areas such as management and behavioural aspects besides IT usage mentioned above. For staff in the workshops and the technical staff, exposure to and training in the use of modern power tools and automated machinery would be relevant. Training office and finance staff to render them adept at exploiting

the power of the computer software in their daily work would also be an asset to the IITs.

Such training activities for lower staff could be organized at the institute level. For medium and lower level staff officers, such staff training and development activities are better organized centrally and at an appropriate location outside the IITs by pooling resources drawn from all the IITs. This step is likely to facilitate experience-sharing across the IITs.

13.1.4 Cadre Structure

Compared to the fast track promotion avenues available for faculty, non-academic staff in the IITs have very few promotional avenues. This problem can be addressed by a comprehensive review of the cadre structures of the non-academic staff in the IITs.

Further, with use of new technology, larger numbers of positions are required at the supervisory level. Therefore, there could be a review of cadre structure in all IITs so that suitable senior supervisory posts can be created in lieu of lower positions. There is also a need for review of recruitment rules to go with the changing work environment. Greater freedom needs to be given to IITs in terms of non-academic staff structures without, however, increasing the overall numbers or budgetary support.

13.1.5 Pay Scales

(i) The IITs had introduced and implemented Personal Promotion Scheme for non-faculty Group A, B, C and D staff. These differed in detail from one IIT to another IIT. Staff demands arose primarily from comparisons across IITs. The Council of IITs, therefore, laid down uniform ground rules which are equitable to the staff. The Council has approved three schemes viz. the Personal Promotion Scheme (PPS) for Group A, B, C & D staff, the Recruitment and Career Development Scheme (RCDS) and currently the Modified Assured Career Progression Scheme (MACPS) for Group B, C & D staff.

(ii) The pay scales adopted under RCDS and MACPS vary widely for the common categories of both technical and non-technical staff. The MHRD, while implementing the Fifth Central Pay Commission scales, stipulated as follows: "where pay scales and conditions of service are different from those available to the corresponding categories of the employees of the Central Government, it has been decided that the replacement pay scales to the pay scales which have been extended to the existing incumbents may be given as personal to the present incumbents of those posts on the consideration that they have already been drawing benefits of the grade in the pre-revised scale. It is to be ensured that once the present incumbent vacates the post on account of retirements, superannuation, death, resignation or promotion, the pay scales of such posts should revert to the level of approved scales in the Government for corresponding categories. New recruitment and promotion would also take place at the level of scales approved by the Govt. of India."

(iii) The RCDS scales are higher than MACPS scales in quite a few cases. Hence, by implementation of this rule, multiple scales have come into existence in the IITs. This is exemplified in the following table:

ENTRY LEVEL	Ladder 1	Ladder 2
Mechanic/Lab. Asst. 3050-4590 3200-4900	Senior Mech./Sr.Lab. Asst. 4000-6000 4500-7000	Technical Assistant 5000-8000 5500-9000
Assistant 5000-8000 5500-9000	Superintendent 5500-9000 6500-10500	Sr. Supdt./Section Officer 6500-10500 7500-12000
Technical Assistant 5000-8000 5500-9000	Senior Tech. Asst. 5500-9000 6500-10500	Technical Officer 6500-10500 7500-12000

(iv) The IITs are relatively small autonomous institutions which cater to the national and international requirements of scientific and technical manpower. In such institutions, there is little scope for the employees to have promotional avenues. It has been reported that the lower scales under MACPS have made the employees aggrieved and their Associations are now blocking the implementation of the MACP Scheme.

(v) Secondly, the Government has three promotional avenues for its employees viz. (1) Vacancy based recruitment, (2) Vacancy based promotion and (3) Assured Career Progression Scheme, whereas vacancy based promotional avenues are not adopted for the IIT employees.

(vi) Thirdly, the employees who have had two reviews after 16 years (8+8) in the previous promotion schemes are stagnating in a single scale for more than 10 years till their date of retirement. This is a source of considerable grievance.

(vii) As far as Group A Officers in the IITs are concerned, there is no clear-cut policy or scheme for the Cadre Review after 1993. Therefore, it is necessary to evolve a scheme as in the case of Group A Officers of the GOI.

IIT Council can help in finding solutions to the concerns mentioned in this chapter.

CHAPTER FOURTEEN

FUNDING POLICY AND DEVELOPMENT OF IITs

"Verily, when the day of judgement comes, we shall not be asked what we have read, but what we have done"

Thomas à Kempis
(circa 1380-1471)

CHAPTER FOURTEEN

FUNDING POLICY AND DEVELOPMENT OF IITs

The Government of India has been the most benevolent supporter of research and development and higher education in the country. From the time of independence, research and education in sciences and technology were considered as *'good'* and support for the same came through readily to the extent that the government could make funds available. The IITs were also beneficiaries of this liberal attitude on the part of the government. The pattern of government (MHRD) funding of the IITs is discussed in this chapter.

14.1 VARIATIONS IN FUNDING POLICY

Around 1990, there was an important shift in the funding policy which led to the introduction in the year 1993-94 of what is referred to as a ***block grant system*** for non-plan funding for IITs. This policy was aimed at reducing expenditure, and encouraging internal resource generation. The broad objectives of this policy were as follows:

(i) to infuse economy in operation, achieve higher level of efficiency to reduce administrative expenditure

(ii) to promote internal generation of resources

(iii) to provide greater financial autonomy by allowing interest income from corpus to be utilized to advance the interests of the institutes to meet crucial gaps.

Its main components were the following:

a) take the base level at RE (Revised Estimates) of 1992-1993 + 10%

b) allow endowment fund for creation of corpus

c) transfer of non-plan savings and all revenue receipts to the corpus

d) government grants to match savings, revenue receipts and donations

e) *force majeure* for steep increase in D.A and unforeseen expenses and

f) greater autonomy in internal administration with only constraints on pay scales and number of Group-A posts

The above funding policy was largely implemented. Although matching grants and *force majeure* grants could not be released during all the years since the time the block grant scheme was introduced, the funding for the IITs steadily rose, in particular during the recent years. The IITs themselves were impelled to build up their corpus fund and, in this respect, the IIT alumni have been extraordinary in displaying their readiness voluntarily to contribute to the well-being of their *alma mater*. Except in

case of IIT Guwahati and IIT Roorkee, the corpus in the IITs is in the range of Rs.60-100 crore. IITs have added Rs.130 crore during the year 2002-03. The fees for the students was also raised, although not abnormally. The recovery from the student fees accounted for about 6% of the total expenditure in the year 2002-03 for the IIT system as a whole. The earnings by the IITs through consultancy and research grants ranged between 15 to 22% of the total expenditure.

Recently, the government came up with another change in the funding policy and they conceived of what is referred to as *"performance-based funding"* for the IITs. A write-up authored by Nirupa Sen (source of information from MHRD) on the performance based funding for the IITs, along with data on plan and non-plan grants from the year 1993 to 2002-03, has appeared in Current Science, Vol.86, No.3, February10, 2004.

The Committee decided not to go into a detailed analysis of the merits and the demerits of either of the above funding policies and approaches. Looking at the grants released to the IITs in the last 2-3 years, the Committee gained the impression that, by and large, there was no major difference in the actual allocation of grants to the IITs, whichever policy was used to determine the quantum of funding.

14.2 GROWTH IN PLAN AND NON-PLAN EXPENDITURE

In 2002-03, the seven IITs put together spent a total of about Rs. 783 crore (of plan and non-plan funds). This has risen at an average rate of 22% per annum during 1999-03. (Figure 14.1)

The proportion of funds recovered through fees, consultancy and research grants varied between 21-28%. IITs are also accumulating a sizeable amount of funds as part of their corpus, as was pointed out earlier.

How are the IITs using these funds? Does the fund allocation priority point to differences among the IITs? To understand this we looked into the non-plan and plan fund allocation patterns.

A significant proportion of **non-plan fund** goes to pay salaries of faculty. As discussed later, the proportion of direct expenditure per student has increased from 0.38 lakh to 0.72 lakh per student between 1999-2003 (see Figure 15.3).

Figure 14.2 shows the **plan fund utilisation** by the IITs. This has been classified into three categories -buildings, academic and infrastructure. It is clear that, between 1999-03, there has been a shift in allocation towards buildings and infrastructure. The proportion spent on academic facilities has consequently decreased. Part of the reason for focus on buildings and infrastructure is due to expansion of the student population in the past few years and also due to several old buildings requiring restoration. (This classification has been done based on whatever break-up could be gathered).

The utilisation of plan funds across IITs for the year 2002-03 indicates variation from one IIT to another. IITK has spent all of the allocation on their academic needs and buildings but not much on infrastructure. IITD and IITB have paid greater attention to buildings and infrastructure. IITKGP, IITM and IITR have spent mostly on infrastructure and academic needs. In the case of IITG, the expenditure understandably was mostly on buildings and infrastructure. This is the pattern of

utilisation in 2002-2003 and it is quite conceivable that the distribution of expenditure would be different in another year. These statements may have to be revised once more precise amounts related to each of the IITs are known. The Committee finds this classification useful in assessing the utilisation of the plan funds from year to year.

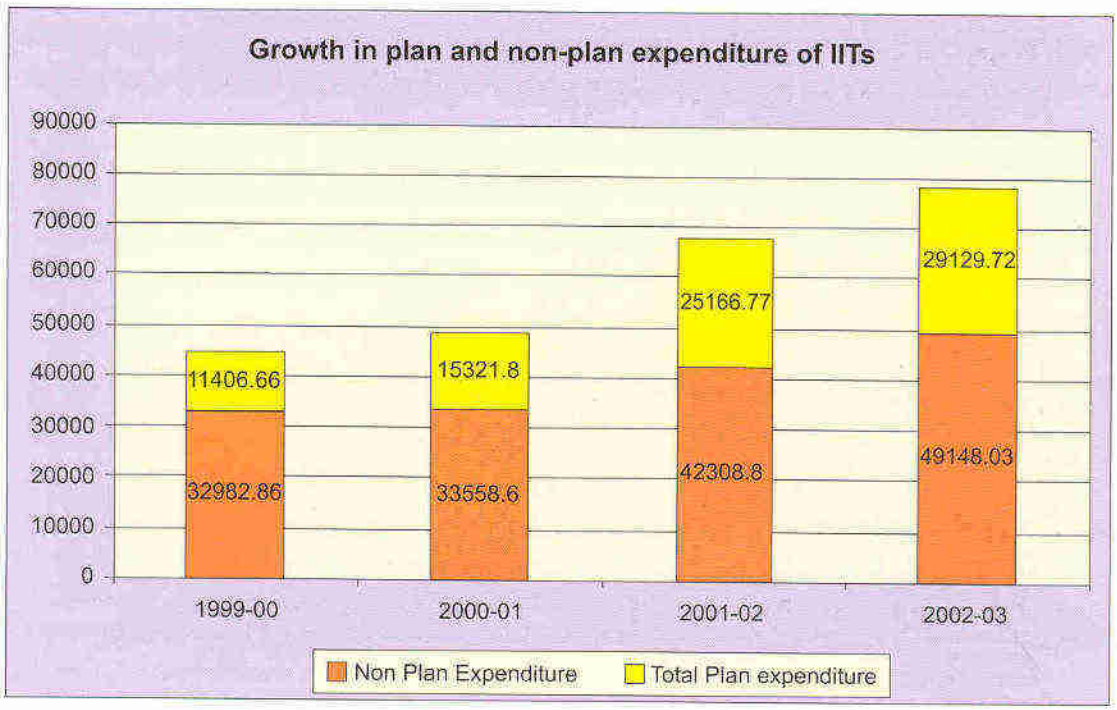
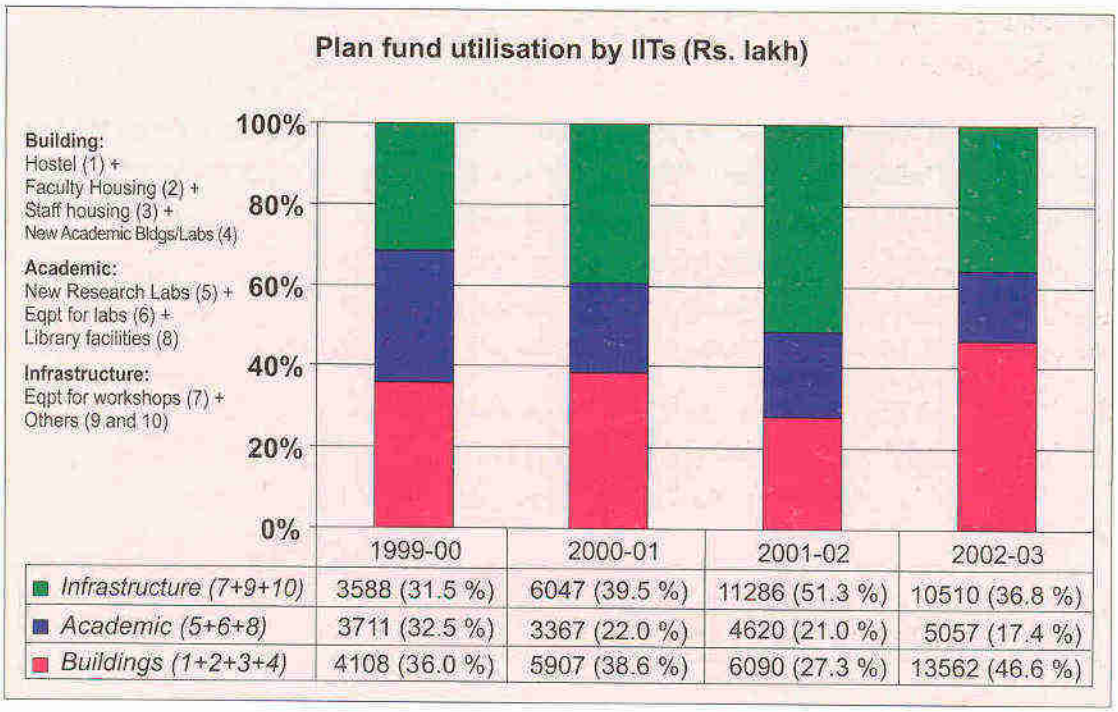


Figure 14.1: Growth in plan and non-plan expenditure of IITs



	1999-00	2000-01	2001-02	2002-03
Infrastructure (7+9+10)	3588 (31.5 %)	6047 (39.5 %)	11286 (51.3 %)	10510 (36.8 %)
Academic (5+6+8)	3711 (32.5 %)	3367 (22.0 %)	4620 (21.0 %)	5057 (17.4 %)
Buildings (1+2+3+4)	4108 (36.0 %)	5907 (38.6 %)	6090 (27.3 %)	13562 (46.6 %)

Figure 14.2: Plan fund utilisation by IITs (Rs. lakh)

14.3 SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

During the visits of the review Committee to the IITs, the members have formed the following impressions:

(i) As a result of sizeable grants received from the government, the IITs have improved upon their building infrastructure. New constructions have come up to cater for additional space required to take care of the expansion in the student population.

(ii) There is still a large requirement in this respect because a number of buildings which came up during the early decades have degraded. The task of rejuvenation is really much beyond repair and renovation. IITs must have worldclass infrastructure in terms of labs, lecture theatres, residences etc. There is an urgent need to build quality space for various day-to-day requirements. This need is greatest in the older IITs.

(iii) With the resources made available to them by MHRD, and quite substantially by the science funding agencies like DST, DBT, DSIR, DAE, DOS & DOD *(for expanded form please see end of the chapter, p-151)*, IITs have substantially equipped their research laboratories with modern pieces of equipment. In view of the pace of development of experimental tools themselves, continuous upgradation of the laboratories has to be sustained.

(iv) The areas which have **not received adequate attention** in the same way as the items mentioned above, **are i) undergraduate student laboratories and ii) the workshops.** Most of the student laboratories, if not all, require to be completely revamped. This rebuilding of the teaching laboratories is an urgent necessity.

(v) The workshop, too, requires special attention. In modern day world, most of the tools are power tools which enable any individual to operate with a minimum amount of physical effort without having to depend on technicians. (e.g BOSCH Power Tools have been providing information on modernising workshop facilities and also have been imparting training. Similarly there may be others in the field).This aspect has to be particularly studied so that the IIT students are trained in the use of such modern workshop practices which are likely to stand them in good stead in later life. In this respect, even the syllabus for workshop practice may have to be redone, if not already revised. Similarly, more and more automation could be incorporated in several operations, where experimental and R&D work are carried out.

Based on the above observations, the Committee recommends an allocation of Rs. 20 crore for each IIT during each of the next five years. This allocation should be directed to particular areas such as teaching laboratories and workshops and the related infrastructure.

The Committee has also recommended certain additional allocations for research and research fellowships, for initiation grants to newly recruited faculty, for supporting faculty overseas visits for collaborative work, for instituting visiting chairs, for engaging post doctoral research associates and for visiting industry personnel.

In summary, the Committee recommends the following approach to funding the IITs:

(i) An annual allocation of plan and non-plan funds as per the funding policy the Ministry decides upon.

(ii) Over and above item (i), each of the IITs may be given an allocation of Rs. 20 crore each year for the *next five years* for improving upon their teaching laboratories, workshops and the associated infrastructure. The IITs need to be supported to have world-class infrastructure

(iii) Additional grants have to be made available for research enhancement and for meeting the IPR requirements as explained in Chapters 6, 7, 10 and 11.

Abbreviations used:

DST – Dept. of Science & Technology

DBT – Dept. of Biotechnology

DSIR – Dept. of Scientific & Industrial Research

DAE – Dept. of Atomic Energy

DOS – Dept. of Space

DOD – Dept. of Ocean Development

MCIT – Ministry of Communication and Information Technology

DRDO – Defence Research and Development Organisation

CHAPTER FIFTEEN

EXPANSION WITHIN THE COUNTRY AND OPENING CAMPUSES ABROAD

"Cultural background surely plays a part in shaping identity; but it does not determine identity"

Maxine Greene
(1918 -)

CHAPTER FIFTEEN

EXPANSION WITHIN THE COUNTRY AND OPENING CAMPUSES ABROAD

It is widely accepted that IITs are the most sought after destination for students aspiring to get into higher education in engineering. It is also evident that countries outside India have expressed interest in deriving the benefit of IIT-like education for their students. Consequently, the two issues which have assumed much importance at the present time are: (1) the expansion of the undergraduate intake in the IITs in India and (2) IITs operating campuses abroad. These issues are discussed in this chapter.

15.1 THE NEED

Several distinguished IIT watchers have advocated large expansion of the undergraduate intake. Their arguments commonly run as follows:

1. IITs have developed into the most outstanding set of institutions for engineering undergraduate education in the country. The public perception is that none of the others in the group of 1200 or more engineering colleges is even close to the IIT calibre. (It may be noted that admissions to IT BHU are made through JEE for nearly three decades now). Most of the 10+2 students would therefore like to have IIT education.

2. Nearly 1.8 lakh students appear at the Joint Entrance Examination (JEE). Among them, about 10,000-11,000 students deserve IIT education because it is only for those whose ranks are lower than this that there is a big drop in performance.

3. Unless the quality of undergraduate education is high, it is not possible to supply the engineering institutions, including the best of them like the IITs, with quality intake for the post-graduate and research programmes.

4. The number of students taken in by the IITs, which is around 3500 every year is 1% of the total undergraduate intake in engineering colleges. This has to be compared with the 40% of the total engineering intake that gets into the 50 top institutes in USA.

5. India is a nation of more than 1 billion people. And the number of youngsters coming out of Higher Secondary Schools (HSS) and Junior Colleges (JCs) exceeds 10 million. Out of this, the country should be in a position to turn out atleast 40,000-50,000 engineering graduates of the IIT quality, i.e. about 15-20% of the total engineering B.Tech.s that the country produces annually.

6. Going up the educational ladder, the number of Ph.D.s in engineering that India generates per year, which is around 750, cannot be accepted as satisfactory.

What emerges is that while the base is vast and enlarging, we are not doing well in terms of scale as we move up to higher levels of quality higher technical education.

15.2 PERTINENT STATISTICS

Let us have a relook at some of the pertinent statistics. The seven IITs together have produced in the year 2002-03 about 2275 B.Tech.s, 3675 M.Tech.s and about 445 Ph.D.s. Presently on rolls are 11,700 undergraduates (all 4 years), 9500 Post-graduates (all categories and all years) and about 3800 Ph.D. scholars With a total faculty strength of 2375, the teacher to student (on rolls) ratio works out to 1:10, which is about the optimum for a good institution.

The students on rolls in the individual IITs is shown in Figure 15.1. IITB has the highest number of students, while IITG has the lowest number of students on rolls. Among the older IITs, the difference between IITK and IITB is notable (IITK has 3557 students compared to IITB with 4600 students). The scope for expansion in absolute terms is highest in IITG, IITK and IITR.

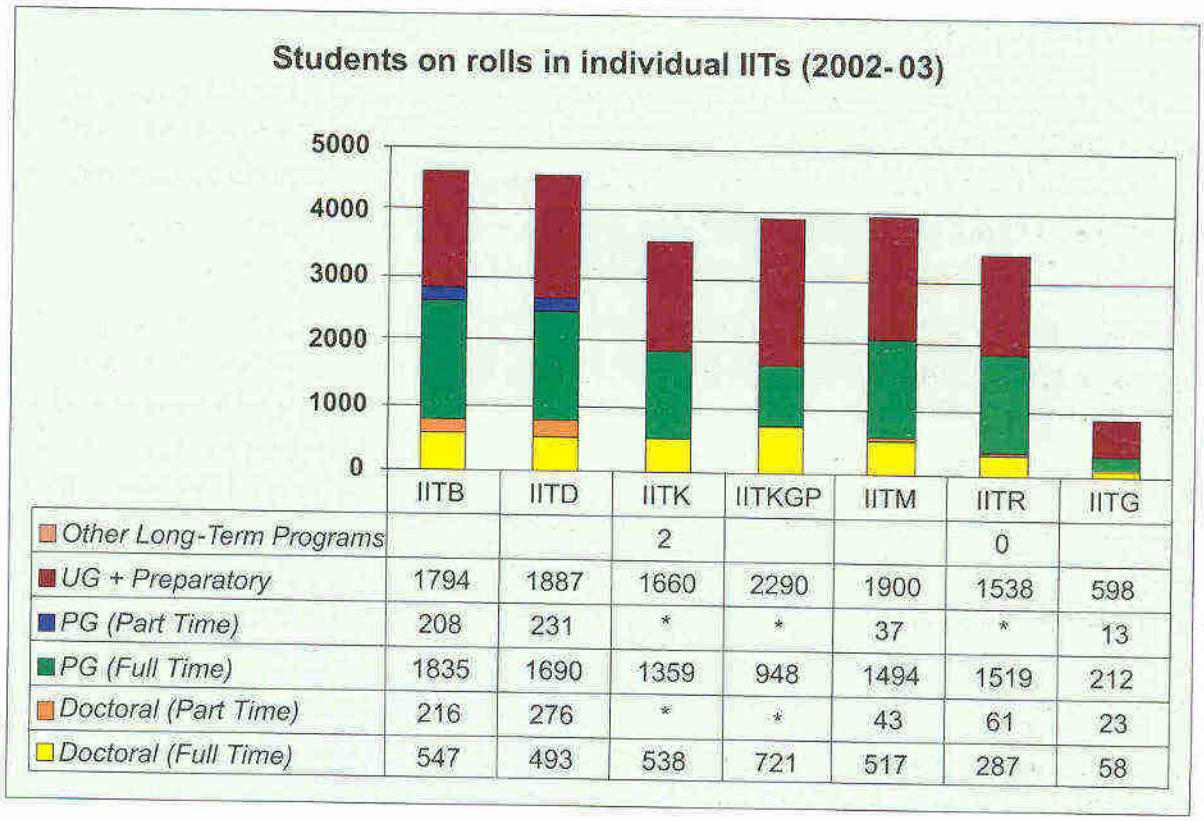
During the last 3 years, as has been pointed out in Chapter 8, the growth in the intake of Post-Graduate (22%) and Ph.D. students (49%) has been significantly larger than the growth in the undergraduate intake (less than 1%). In this context, IITB has the highest PG+Ph.D.: UG ratio (1.5) while IITG has the lowest (0.5). Among the older IITs, IITKGP has the lowest PG+Ph.D.: UG ratio (0.72).

We have commented earlier in Chapter 8 about the likely disparity in quality of the students admitted to the B.Tech., M.Tech. and Ph.D. programmes in view of the significant differences in selectivity among them. Also, the effect that larger population of PG and Ph.D. students in the campus may have on the general student climate is to be kept in view.

However, IITs have preferred to increase the PG intake. Three possible explanations for this are: a) Expansion of UG is constrained due to shortage of physical infrastructure and faculty, b) increase in PG:UG ratio improves faculty research output and c) Additional funds became available. However, further increase in PG:UG ratio may erode the IIT brand unless special attention is paid to enhance the quality of PG and Ph.D. intake. (This issue has been discussed at length in Chapter 8)

A look at the placement statistics across IITs points to an interesting trend. IITs with higher throughput had a greater difference between UG and PG placement (see Figure 8.6) (this interpretation is subject to revision when more complete data on placement become available).

A more realistic comparison of faculty output is provided in Figure 15.2. More students per faculty (especially PG and Ph.D.) may be contributing to higher number of publications. However, there is higher disparity at higher levels of workload arising from a larger number of students on rolls. Among the five older IITs, there may actually be a trend of decline in faculty research output with increase in student strength per faculty. (This interpretation is subject to error on account of data being limited).



	IITB	IITD	IITK	IITKGP	IITM	IITR	IITG
Other Long-Term Programs			2			0	
UG + Preparatory	1794	1887	1660	2290	1900	1538	598
PG (Part Time)	208	231	*	*	37	*	13
PG (Full Time)	1835	1690	1359	948	1494	1519	212
Doctoral (Part Time)	216	276	*	*	43	61	23
Doctoral (Full Time)	547	493	538	721	517	287	58

Figure 15.1: Students on rolls in individual IITs (2002-03) (* Data not separately given)

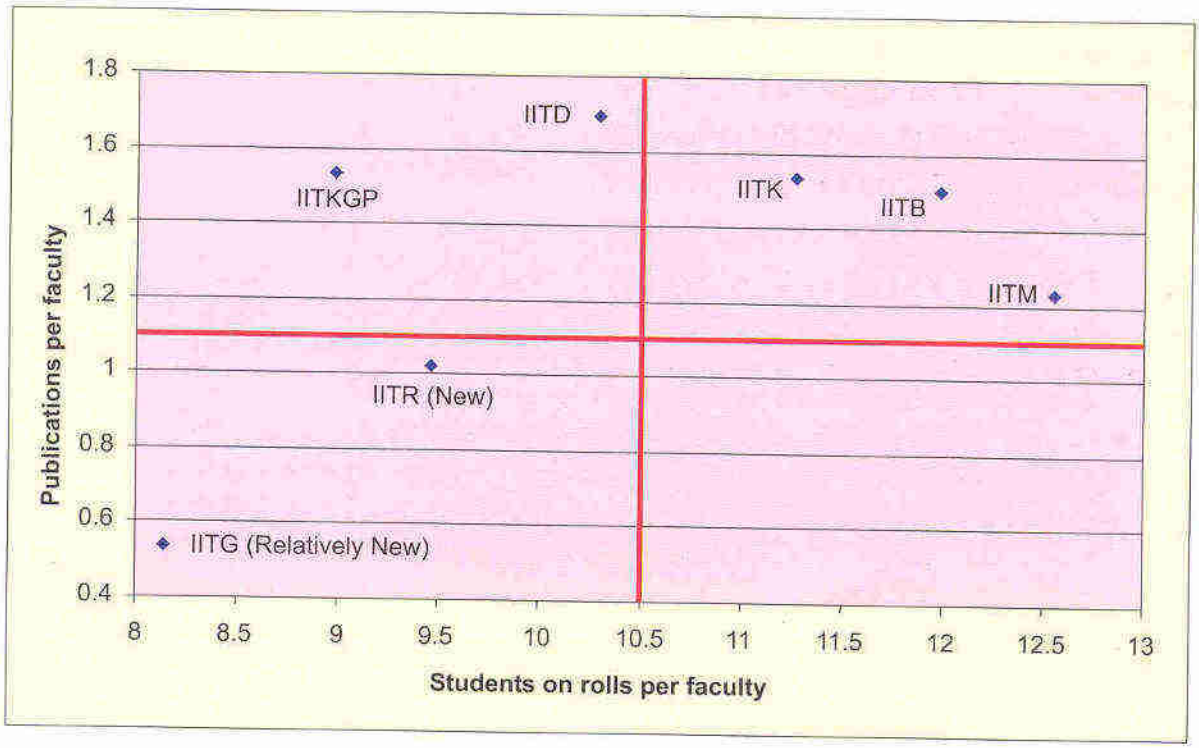


Figure15.2: Faculty output (publications per faculty) and students per faculty in the IITs (2002-03)

15.3 THE ESSENTIAILITY OF ADDITIONAL FACULTY

The data presented in the foregoing section shows that the IITs, as a system comprising seven entities, have presently a teacher-student ratio of 1:10. Individual IITs will obviously have variations of this ratio. It is clear, then, that increase in intake calls for induction of additional faculty. This presents the greatest challenge to the IIT system.

Doctoral research in engineering in the country in general has not picked up. The Committee is not going into the reasons except to echo the general observations which are that i) B.Tech.s in engineering are able to secure employment and ii) Industry has not shown a penchant for recruiting Ph.Ds. (This situation is clearly changing in the country). Whatever the reason, candidates trained in advanced engineering research are not available in large numbers from within the country. Therefore, IITs had to depend on those trained abroad for their faculty. There is also the issue of compensation that is frequently highlighted. Given this situation, candidates with a distinguished record for induction as faculty are not easy to come by. This is not to say that such individuals are not available at all, but are certainly not available in large numbers at the present time.

We have discussed the issues related to faculty in Chapter-6 and suggested a modest system of incentives. Any step taken to encourage good faculty to be taken into the IIT system will go a long way in helping the system. IITs also have to be assisted by way of visiting Professors, Adjunct Professors, Post Doctoral Fellows, Teaching Assistants (Senior M.Tech students and Ph.D Scholars) as well as by inviting experts from overseas. It is not necessary that every faculty position in the IITs has to be a permanent position. These have been discussed in Chapter-6 but deserve to be reiterated.

In summary, recruiting faculty is the most difficult hurdle to cross with respect to increasing the intake. The BOGs, the PAN-IIT Synergy Committee, and the IIT Council will have to pay the utmost attention to this issue.

With the changing international situation and the quality of life in India having significantly improved, IITs are bound to overcome this difficulty sooner than later. The prospect is certainly far better for the IITs than anyone else. Accordingly, this Committee would **recommend a steady growth in UG intake.** The brand quality of UG has been established and it is at this stage that the intake has to rise. However, abrupt or large-scale increase in intake may prove counter-productive. The magnitude of the growth in intake need not be identical in all the IITs and it is best left to be decided upon by each BOG. With PG and Ph.D. intake having improved, the attention has to be turned to further improving their quality.

We will now point out briefly cost implications of the increase in intake so that the decision makers have an idea in this respect.

15.4 COST IMPLICATIONS OF INCREASING THE STUDENT INTAKE

15.4.1 Recurring Expenditure

Figure 15.3 shows a strong correlation between the direct expenditure per student and the total number of students on rolls (all categories of students). Between 1999-2003, this expenditure has

gone up from 0.38 lakh per student to above 0.72 lakh per student. The direct expenditure includes items such as students scholarships, hall subsidy, administrative expenses, department/lab. expenses, transport subsidies, student activities, computer facilities and others. This, in one sense, is a good thing that has happened. Bright students getting into the IIT system deserve to be cared for. This care has to be on par with that provided in the best of institutions around the world. Indeed, with their international brand image, IITs are in a position to attract overseas students as well.

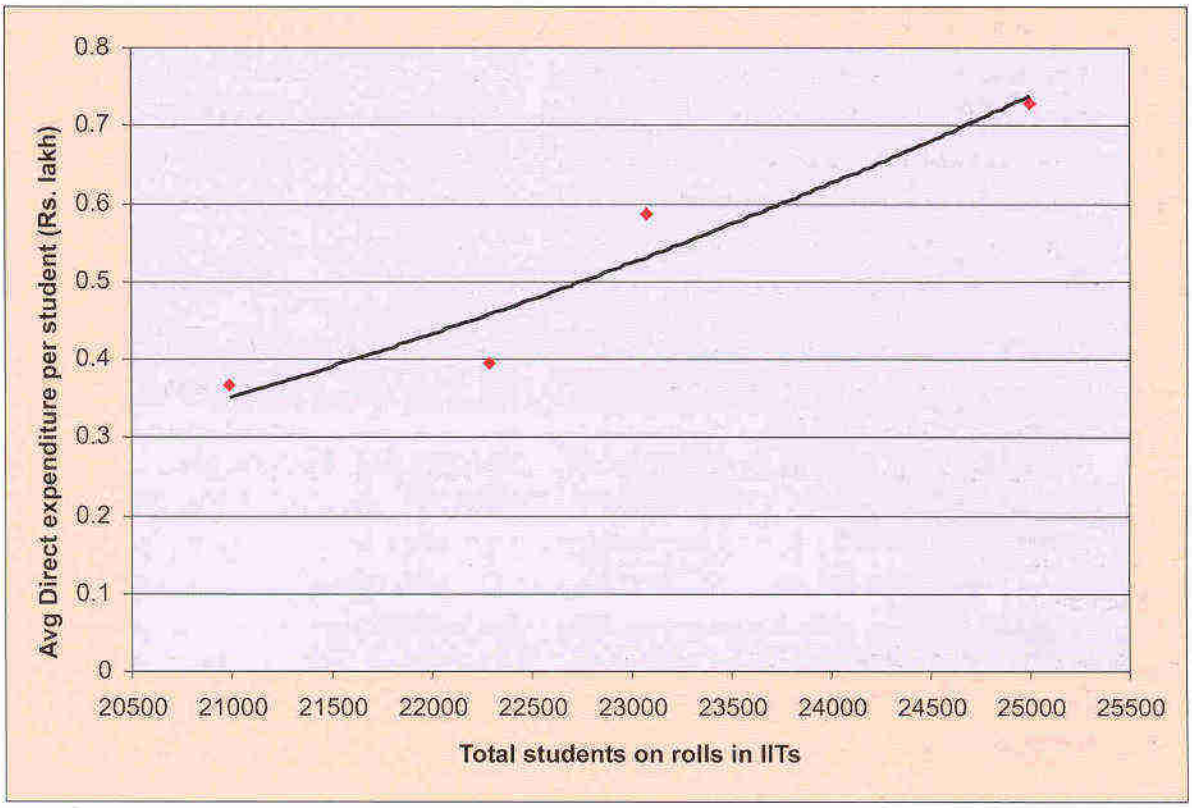


Figure 15.3: Direct expenditure per student for IIT system

The total non-plan expenditure per student has risen during these same years as follows:

1999-2000 (Rs.1.57 lakh), 2000-01 (Rs.1.50 lakh), 2001-02 (Rs.1.83 lakh) and 2002-03 (Rs.1.97 lakh). This increase is represented in Figure 15.4. A factor contributing to higher cost structure is likely to be the faculty mix of IITs. It was shown in Chapter 3 that IITs have an inverted pyramid structure, with more Professors compared to Associate or Assistant Professors.

15.4.2 Capital Expenditure

a) Construction

Enhancement in the student intake will necessarily require the creation of additional infrastructure like additional hostel accommodation; provision for power and water supply; additional space for

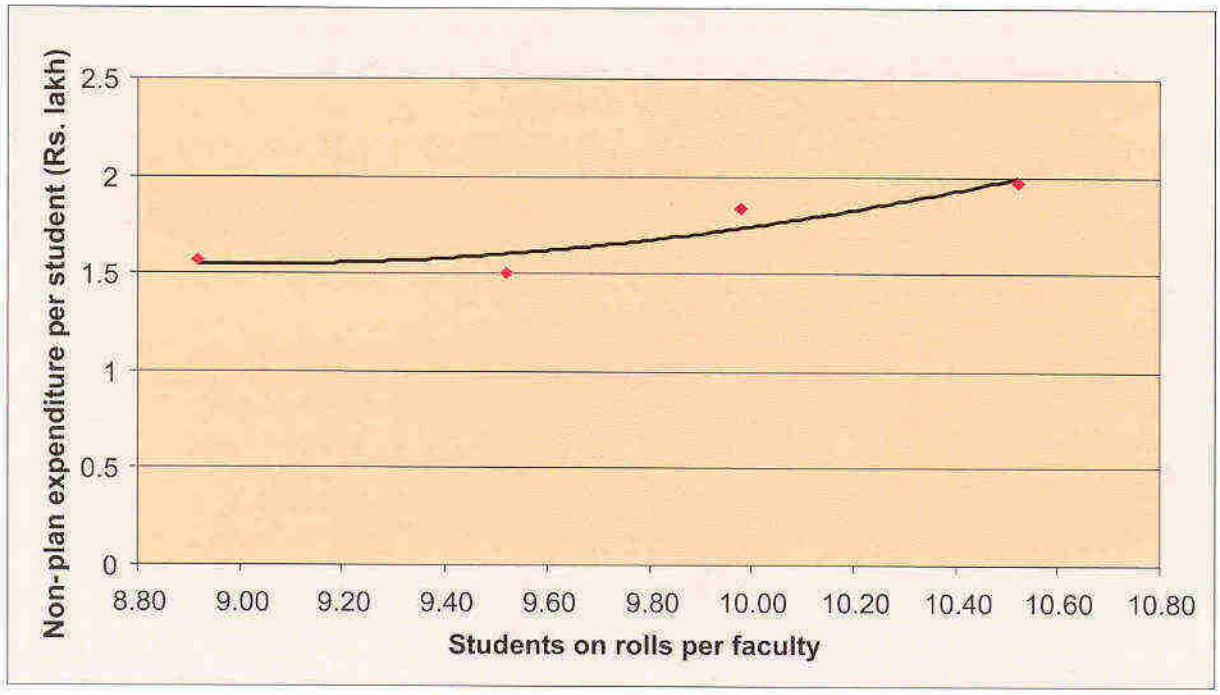


Figure 15.4.: Cost implication of increasing the intake

the existing departments/centers; lecture halls and teaching aids; faculty housing etc. IITK and IITKGP, among the older IITs, do have reasonably adequate space for some expansion within the present campus. However, in the case of IIT Bombay and IIT Delhi, the allowable space for buildings on the present campus has mostly been used up. IIT Madras faces restrictions because part of their campus is declared as a Reserve Forest. This IIT, in its present campus, also faces acute water shortage. Therefore, satellite campuses, with necessary amenities and easy access from the existing campuses, need to be developed in these three cases. Substantial investments would be inevitable if satellite campuses are to be developed.

b) Up-gradation of laboratory-equipments and laboratory space

In order to maintain the present high standard of education in IITs, it will be essential to augment the core laboratories, namely the undergraduate student laboratories, and the post-graduate student laboratories. The barest minimum cost for upgradation of laboratory equipment for increasing the student intake will be of the order of Rs.1 lakh per year per student for UG. The corresponding figures for M.Tech and Ph.D are roughly Rs.1.5 lakh and Rs.2.5 lakh, respectively. The minimum requirement of additional laboratory space for increase in the students' intake based on a recent study is about 8.0 sq.m.per UG student and about 4.0 sq.m. per PG student.

c) Additional hostel seats

One of the special features of IIT system has been its residential character. The data pertaining to student hostels and faculty housing as well as transit accommodation available currently are presented respectively in Figures 15.5 and 15.6.

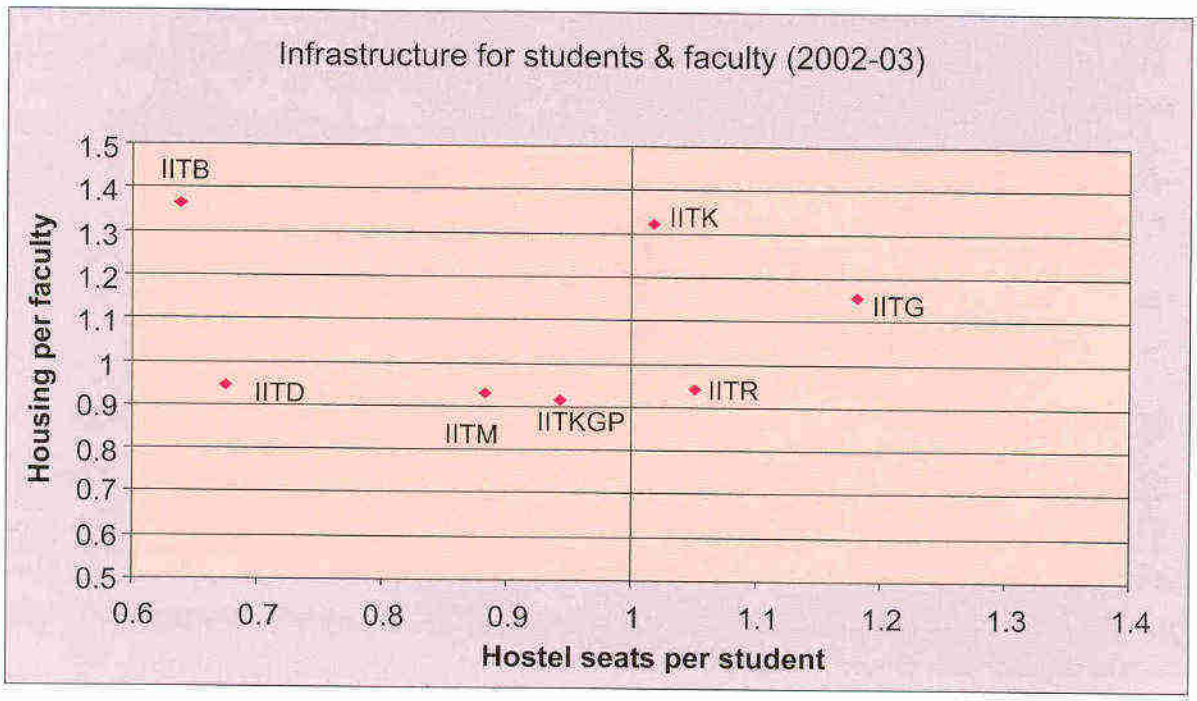


Figure 15.5: Infrastructure for students & faculty (2002-03)

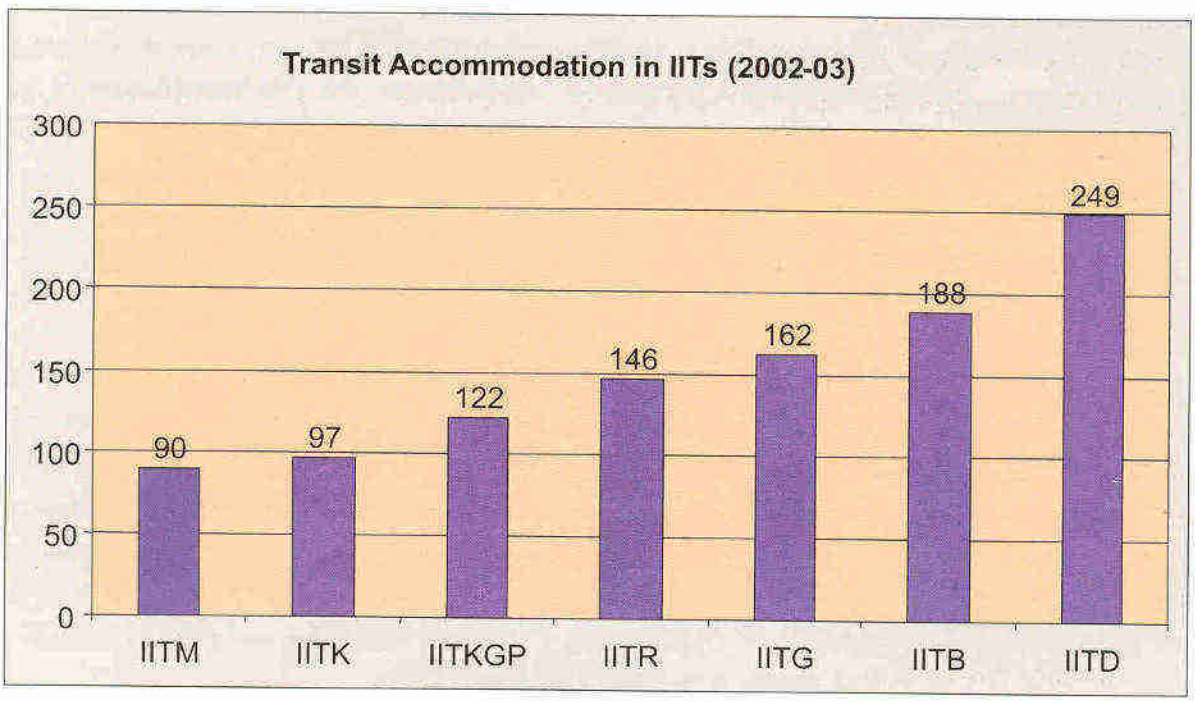


Figure 15.6: Transit accommodation in IITs (2002-03)

The cost of adding a seat on the present campus land is about Rs. 2.00 lakh per student. This calculation is based on the requirement of about 10 sq. meters per student plus 15 sq.m (in a six-storey building with lifts) to account for toilets, verandas and common rooms in the hostel at the present cost (about Rs. 10,000 per sq.m).

d) Additional space for faculty

The cost of an average office space of 12 sq.m. and an average housing space of 150 sq.m. is estimated to be Rs. 11.00 lakh per each additional faculty. It may not be possible to add all of this on some of the campuses and additional land may have to be acquired.

e) Academic infrastructure

At the present level of intake, the classroom and the library facilities have become over-loaded. The IITs have been experimenting with lecture classes at UG level as large as with 100 to 200 students. It is now important that, for better communication between students and the teacher, electronic classroom aids are provided. In order to increase capacity of the present classroom, additional furniture requirements have to be kept in mind.

f) Electronic classrooms

Because of the increased intake, classes are likely to have as may as 400 students. Students in such large classes tend to have diverse backgrounds and levels of preparation. Tutorials and assignments are an integral part of course-based education in IITs. Effective tutorials for such large classes require a combination of classroom/laboratory atmosphere. One of the best solutions is through use of virtual (electronic) classrooms. In such an environment, the conduct of quizzes and examinations can be automated. Such a classroom is a cluster of two or more classrooms, each with a capacity of, say, 100 students. Establishment of a Virtual Class Room is an interesting exercise in technology. Each such classroom is expected to be about 250 sq. meters costing about Rs.25 lakh including furniture. The cost of each cluster together with the equipment cost will be about Rs.1.5 crore.

15.5 SUMMARY OF RECOMMENDATIONS

(i) Increase in intake at the B.Tech level is an absolute need of the hour. While the growth in intake in PG and Ph.D (in the last ten years) has been impressive, new measures, as discussed in Chapters 7 and 8, have to be thought of and implemented. There are additional recurring and non-recurring costs to be incurred. While some more expansion is feasible within the existing IIT system, the extent of this expansion cannot be large and need not be uniformly undertaken by all the IITs. Each BOG can discuss the local constraints and possibilities and recommend possible additional intake for the IIT Council finally to decide.

(ii) In the light of the above discussion, large-scale quantitative improvement has to come from additional IITs. Focus on quality education should be zealously guarded while deciding on additional IITs. The necessary investments have, therefore, to be ensured.

There is also an exercise underway for upgradation of existing institutions. The seventeen NITs are a case in point. Progress in this respect will be slow but every effort has to be made to enhance the stature of the NITs. IITs have in one sense shown the way and this example is to be emulated in all its facets, and even improved upon.

15.6 CAMPUSES IN FOREIGN LANDS: OBSERVATIONS

In view of the international visibility acquired by the IITs, there is an express interest in the IITs setting up campuses abroad. On the face of it, it appears that export of the IIT model in this manner will greatly contribute to globalizing the IIT brand name. The other merits of the proposal are the following:

- This move will help students in foreign countries in gaining quality education like what the IITs impart in India.
- Over a period of time, foreign students graduating from the IIT system will build up into a formidable pool of goodwill for India and the IITs.
- The best of such graduates from foreign land may wish to pursue PG & Ph.D programmes in the IITs in India.
- This will be an effective way of nurturing a strong and emotional bond among the future generations of professional leaders in India and abroad who will always be inclined nostalgically to recall their life as students in similar academic environments.

However, there are a number of difficulties in going ahead with such a proposal, no matter how laudable it may be in the light of the points made above. The principal problem is the availability of faculty. The Indian IITs themselves are grappling with this issue at home. The difficulties get exacerbated if good faculty members have to be found to man institutions abroad as well. The demand is building up on the IITs to expand their student strength as well as on their authorities to add to the existing family of the seven IITs by creating more IITs. With such pressures, those who are manning the IIT system cannot be expected to pay the required attention to another need.

Finally, it has to be remembered that India has more than 10 million candidates coming out of the 10 + 2 stage which makes them eligible to aim at getting into the IITs. Out of this huge population, nearly 2 lakh students strive to take the Joint Entrance Examination. In view of the high selectivity in the admission process, the quality of the intake has been consistently high. It is not clear that similar numbers of aspirants would be available in the countries in question and, therefore, the

apprehension that the same selectivity and high quality as in India may not be achievable. Further, India can only have limited influence in certain matters concerning other nations and students in other countries may have alternative options operated by developed countries.

The best course of action seems to be that of a model somewhat akin to the one from which this country itself benefited when institutions in countries abroad spared their time and trouble and were willing to use their experience for nurturing the IITs during their fledgling days. In other words, the IIT system as a whole in India can act as a leading consortium when agencies abroad express an interest in adopting the IIT model. It may be recalled that, at the time when IIT Kanpur came into existence, MIT, a leading institution in USA, formed a consortium comprising quite a few American academic institutions. It is this consortium which took the trouble to design several aspects and features of IIT Kanpur. Indian IIT system today can play a similar role in contributing to the establishment of new institutions abroad for quality teaching and research in engineering and technology. IIT faculty and others experienced in the IIT system can be involved in this process. This will eliminate all burdens, such as financial, personnel and administrative, in taking up such an onerous task. It is also possible to conceive of participation by Indian IITs where it concerns some of the PG courses and research programmes abroad. These responsibilities will add to the IIT faculty load only to a marginal extent.

15.7 A MOST RECENT INDICATION

A most recent indication is that eminent universities such as Stanford University, Yale University and Georgia Institute of Technology are considering proposals to set up their off-shore campuses in India. However, no details are as yet known, but there is a distinct possibility that the off-shore endeavours of the universities named above could very well encompass education and research programmes in engineering and technology disciplines. It is entirely conceivable that this trend will build up in the coming years and more and more leading universities not only in USA but also in Europe, in the UK and in Australia could seriously get involved in India with their off-shore activities. IITs cannot be oblivious of such possibilities becoming a reality. This likely development has to be reckoned with in any policy related to expanding the IIT system in India.

In the face of this new challenge that is likely to be at their doorstep, IITs have to think and act ever more competitively. IITs should be seriously aiming at having their own presence in the advanced countries. Thanks to the sterling achievements of their alumni, IIT brand is well recognised abroad. With such indications as have been mentioned, it is time for the IITs to aggressively export and establish their own brand as an educational system in foreign lands. These institutions have to excel in every academic sphere so that their status as the most sought-after destination by students and faculty alike is not diminished.

In this context, the following measures may be considered by the IIT Council:

1. The IIT system acts as a consortium for helping other countries in establishing quality institutions for teaching and research in engineering and technology, as described above.

2. IITs develop a strategy in which their ventures abroad are undertaken in partnership with eminent universities in the respective host countries.

3. The Government is persuaded to set up more IITs in our own country. This has to be done at a steady pace, as quality institutions like the IITs demand substantial capital, financial and human. To the family of five IITs that were established during 1950-1961, one new IIT and another by conversion of an existing University were added in the last 10 years. It is time to consider adding at least two more IITs at this juncture.

4. IITs to be equipped and supported in setting up their own full fledged off-shore campuses. (The constraints in this regard discussed earlier in this chapter have to be overcome). IITs to be assisted in every possible way to excel in an environment of severe competition.

5. IITs reach well thought-out MOUs with such of those universities who are likely to position themselves in India. Such MOUs need to be focussed on joint research in the immediate future. This report has throughout emphasized research enhancement in the IITs. Partnership in research should, therefore, be an undiluted goal while welcoming leading universities coming into India.

The above are the immediate thoughts of the Committee which are placed here with the intention of assisting the IIT Council. IIT Council may please deliberate on how best they might enable and empower the IITs in meeting the challenges looming large in the way their overseas counterparts are contemplating on India as their promising destination.

CHAPTER SIXTEEN

THE SPECIAL CASE OF IIT GUWAHATI

"The significant problems we face cannot be solved at the same level of thinking we were at when we created them"

Albert Einstein
(1879-1955)

CHAPTER SIXTEEN

THE SPECIAL CASE OF IIT GUWAHATI

Setting up of an IIT at Guwahati in the north-eastern region is an extremely well-intentioned move by the Government of India. During this Committee's visit to IITG, and during subsequent discussions with the Director, it has become clear that IITG deserves special attention.

16.1 DIFFICULTIES FACED

IIT Guwahati (IITG) is located in the north-eastern region of India and is thus removed from the major metro-cities. Consequently, this IIT suffers from certain locational disadvantages. These are listed below.

16.1.1 Faculty Recruitment

The biggest challenge for IITG is the recruitment and retention of faculty. The factors responsible for this difficulty are the following:

a) Country-wide Shortage: There is a country-wide shortage of eligible persons for faculty positions in IITs and other leading technical institutions.

b) Retirements at other IITs: The large scale retirements at other IITs has increased the demand on the eligible candidates. In this situation, IITG invariably loses out to the other IITs.

c) Lack of Local Candidates: One of the major points of attraction of a person to a particular IIT is its proximity to his home town/or to where his family is. Due to the general under-development of this region, the number of eligible persons from this region, who can take up faculty positions in IITG, are very few.

d) Fear of a Remote Location: The general perception is that the North-East of India is remote, and that it is unsafe.

16.1.2 Attracting Students

IITG is the last choice in any branch among all the IITs. This seems to be the trend even though IITG may have better facilities and other resources in a particular Department. This is basically a matter of perception related to the remoteness of the north-east, and the fear factor among parents and relatives. Here, too, the lack of eligible candidates from this region has worsened the problem. In 2004 JEE, only seven of the 4200 or so qualified candidates, listed Assamese as their mother-tongue. The small market in this region has not attracted a sufficient number of all-India coaching centers.

16.1.3 Transportation Bottlenecks

Although Guwahati is well connected by air to the other parts of India, the rail and road connections are poor. The single track rail link from Guwahati to New Jalpaiguri is prone to disruption by accidents, floods and other disturbances. Goods take time to be transported from Kolkata, the nearest international port of entry, and there have been cases of damage to equipment during transhipment.

16.1.4 Lack of Local Industry

One of the ways by which an IIT can be successful is through its interaction with the industry. If industrial houses are located locally or nearby, it is a big help. The low level of industrialisation of the NE region is a major handicap. There are a few big public sector industries in oil, but the lack of sunrise industries makes collaboration difficult.

16.2 SUMMARY OF RECOMMENDATIONS

i) The greatest problem is to attract and retain meritorious faculty. The Committee recommends a special NE allowance to be added to the salary of the faculty. The quantum of this additional compensation may be decided upon by the MHRD.

ii) In a similar way, the students successful in JEE may be given a special stipend to study at IITG. The quantum of the stipend may be decided upon by the MHRD. Residence for teaching and non-teaching employees and student hostels may be suitably upgraded in order to make these particularly attractive to teachers, staff and students, respectively.

iii) Yet another source of attraction that one can build into IITG is through installation of major experimental facilities. An interested engineering scientist would be prepared to go anywhere if he can have ready access to a unique/powerful experimental tool like high performance computing and such other facilities. IITG needs to take stock of such possibilities and come up with a request that MHRD and other Government funding agencies would be prepared to consider.

iv) In view of its location, IITG could be given flexibility in regard to attracting faculty and research students from the neighbouring countries in the region.

v) In regard to the other problems faced by IITG, the Director may be requested to provide a detailed note. The note may contain possible solutions that he and his colleagues may have thought of. The Committee requests MHRD to conceive of special measures to assist IITG as much as possible. Clearly, there is much to be examined and done to help IITG succeed in the same way the other IITs have succeeded.