

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)*

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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.**
 - o **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.

- o 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.
- o **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 institutionalise 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.